STIMULATING INTERNET DEVELOPMENT IN UKRAINE

by

Sergey P. Alekseychick

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Abstract

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by Sergey P. Alekseychick

Head of EERC State Defense Committee: Professor Serhiy Korablin

This thesis deals with support of Internet services in Ukraine. The rapid growth of the Internet along with the development of new multimedia applications opens up opportunities for growth and allows for faster convergence of Ukrainian economy. Usage of Internet in Ukraine still remains limited. As the theoretical part suggests, the main obstacle to faster Internet growth in Ukraine is undervaluation by consumers of benefits explained by existence of network related externalities. Private as well as corporate Internet users do not normally take into account the indirect benefits coming from their connection to other network members. The aim of the present work is to estimate whether Ukrainian Internet market needs government interventions and to suggest the effective ways for possible interventions. The theoretical part of the paper first investigates the decision behavior of Internet users and web-content providers. Second, it develops a baseline Internet subsidization model. The empirical work then estimates using econometric analysis the current behavioral characteristics of Ukrainian users of the Internet. Then needed measures are estimated using forecasts of expected policy costs. Finally the desirability of government's intervention is evaluated and is suggested whether it is preferable to subsidize the senders of broadcasting messages or consumers and technology providers under different sets of initial conditions. The results show, that in current Ukrainian settings, it is more welfare improving to subsidize consumers rather than content providers.

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GLOSSARY

Business-to-business B2b — Business concept based on telecommunication technologies and, particularly, on Internet that allows to personalize and manage relationships with customers and suppliers and to reduce costs along the entire supply chain

Business-to-consumer B2C — A concept meaning the set of web-based tools and methods for establishing interaction between businesses and consumers on-line

Computer Hardware — Computer equipment, connecting cable and devices.

Computer Software — Computer programs and data that make a computer hardware useful for performing specific tasks, such as typing text etc.

Content — The data and services available for access through Internet.

Cyberspace — The Internet and Internet users. This concept is used to denote exceptional improvements of communication possibilities for those connected to Internet.

E-business — The wide range of network services used to conduct business or part of business operations using Internet.

E-government — A concept meaning the availability of government services through the Internet, or feedback between government authorities and citizens.

Internet Service Provider (ISP) — A business entity which provides Internet connection services to public.

Minimum Efficiency Scale — A minimum number of users of a particular network-like service required for that service to be self-sustainable.

Network Externalities — A theoretical concept which is attributed to social networks. This concept is observed if the value of a service to users grows as user base expands.

Network (Electronic) Infrastructure — A set of computer hardware and software used to keep an electronic network operational.

Penetration rate — A term used to estimate the development of network in a country or among a specific group of people. It indicates the ratio of connected persons to total group population.

UkrNet = Ukrainian Internet — The Ukrainian segment of the global communication network or Internet.

User = Network Subscriber — A person or organization who is connected and uses network for different private or public purposes.

Chapter 1

INTRODUCTION

Information Technology (IT) and Internet growth observed during the last quarter of the twentieth century is often compared to technological revolutions brought about by invention of steam power, electricity or railroads. In Brad DeLong's words, information technology and the Internet amplify brainpower in the same way that the technologies of the industrial revolution amplified muscle power (The Economist, 2000, p.2).

Much of the growth in IT markets is attributed to the global information network - Internet. The average growth rate in number of Internet users around the World has been at the level of 50-55% per year. The Ukrainian Internet sector (UkrNet) has been steadily growing at 40% per year (Ukraine. State Telecommunication Committee, 2000). Information technologies have become significant engines for economic growth and productivity and are opening new opportunities for various aspects of learning, the social life and public policy. Though growing, Ukrainian Internet currently lags far behind the world average in terms of user penetration rate. According to ITU's "Internet Indicators", only 40 out of 10,000 Ukrainians more or less actively use Internet (ITU, 2000). This is very low compared to World's average 440 users. The penetration rate remains low even compared to Ukraine's nearest neighbors: Russia, 183 users and Poland, 542 users (ITU, 2000).

The main question inspiring this work is what policy measures, if any, should Ukrainian government employ in order to boost the growth of Ukrainian Internet sector? Adoption of the newest information technologies offers to Ukrainians higher living standards and productivity. Some of the specific benefits the Internet revolution could bring into Ukrainian economy include: improved economic efficiency and competitiveness; opportunities to exploit low factor costs in international markets when skills, infrastructure and institutional development have passed a certain threshold level; more efficient and effective education, health care and public administration; opportunities to increase social capital; opportunities to bypass failing domestic institutions. Lower communication costs mean that in a decade international phone calls could, in effect, become free, with telecom firms charging a flat monthly fee for unlimited Internet access. Significant cost savings also arise from paperless communication and transacting among economic agents. It becomes particularly motivating for Ukraine to connect to global information superhighway in order to take advantage of the saving offered. Such savings are important during the transition period as they allow more effective use of scarce financial resources.

The savings come from so-called B2B (business-to-business) and B2C (business-to-consumer) solutions. Such systems have already been introduced in wholesale and in financial transacting by enterprises in economies with high Internet penetration rate. The lion's share of benefits arises from transaction costs savings and improved competition. According to estimates made by British Telecoms, online sales results in 90% savings on transaction costs and allows 11% price cut (The Economist, 2000, p.5). Another significant source of savings comes from increase in communication speeds. Faster communication between agents allows taking better advantages of information and business opportunities that become open.

Real-time access to information on commodity prices and proposition of goods allows agents to take adequate decision without time lag and the problem of imperfect information becomes less evident. Information technology allows an economy to better approach the standard assumptions of perfect competition, based on full information access by agents, large number of agents, zero transaction costs and free exit and entry (The Economist, 2000).

Before any of the discussed benefits may be realized, the UkrNet has to build up a significant user base, as the subsequent analysis will suggest. Ukrainian Internet has high potential to attract foreign investment. Foreign investors are potentially willing to invest millions of dollars into Ukrainian Internet according to Michael Bleyzer, president of "SigmaBleyzer" – one of the largest investor companies in Ukraine (Bleyzer, 2000). This capital may significantly speed up the development of UkrNet with above discussed benefits. The market of any good or service becomes a mass market only when its share in nation's GDP approaches at least one percent (Gabovich & Azarov, 2000). Any significant foreign investments into Ukrainian IT sector will not come until Internet attracts significant number of repeated users.

The Ukrainian government has expressed its special interest in supporting Information Technology sector and Internet. This was officially stated by decree #928 of the President of Ukraine: "On Measures to Develop the National Component of the Internet Global Information Network and Provide Broad Access to this Network in Ukraine" (Ukraine Development Gateway, 2000). The above decree has very broadly set the intentions to support Ukraine's digital economy. Definite ways in which efforts must be directed still remain a subject for active debates among Ukrainian policy makers, economists and technicians.

The main question inspiring this work is what policy measures, if any, should Ukrainian government employ in order to boost the growth of Ukrainian Internet sector? As foreign experience indicates, government may have to play a significant role on early stages of Internet popularization. Policies supporting Information Technology are pursued in all developed countries including the United States, Germany, UK and others. The policy choice for Ukraine requires careful evaluation of current market tendencies and costs involved. This research area is new for Ukrainian economists and, until recent general survey articles (see: Gabovich & Azarov, 2000; ITC, 2000; and others), lacks due attention. The situation is usually explained by saying that more important issues such as tax reform, shadow economy estimation and direct foreign investment attract attention of Ukrainian economists. The authors' opinion is, however, that IT represents an increasingly important sector of Ukrainian economy, which is likely to determine sustainable long-term growth in Ukraine in the future. The current work is an attempt to find the solution to the policy question by conducting analysis based on modern theoretical approaches to IT industry.

As with most networks, the Internet is subject to positive network effects. This means that benefits from being on-line increase exponentially with more and more computers being connected. According to Metcalfe's Law, attributed to Robert Metcalfe, a pioneer of computer networking, the value of a network grows roughly in line with the square of the number of users (The Economist, 2000, p. 2). As almost intuitively follows from the presence of network effects, each new Internet user will increase the value of being on-line for all existing users and for the newcomers. With extremely few exceptions, the simple utility maximizing decision by individual users does not take into account the network effects. In this sense the Internet development may require governments to intervene.

My observations suggest that prices for Internet access within UkrNet have gone down significantly while number of users has not grown as fast as baseline supply and demand analysis would suggest. This observation has inspired further research represented in this work. I argue that the main reason that Ukrainian computer users are slow to adopt Internet is the scarcity of potentially utility improving web-based services in Ukraine. The government's intervention, particularly financial and institutional, thus needs to be called in to correct the market from failure.

Chapter 2 starts with a review of current literature on the matter. Further, the basic decision making framework for the Internet users and web-content providers are outlined. Finally in this chapter I develop the baseline optimization model, show the possibility for misconduct and theoretically predict the possible subsidy decisions. Chapter 3 then explores in detail the Internet market in Ukraine. The main focus of the chapter is on estimation of the relevant parameter values from the cross-sectional data on 46 economies including Ukraine. The results and the calibrated model are then further used to empirically estimate the welfare optimal subsidization decision. The main recommendations and forecasts are then developed. Finally the conclusion summarizes the work performed and sets main questions for further research in the area.

Chapter 2

THEORETICAL BACKGROUND

Review of Literature

Network industries play an important role in modern society. It would be difficult to imagine the world without such networks as telephone, television, railroads, and now Internet. The other kind of networks — social networks — play a crucial role in distribution of benefits among society members. Political economists devote much time to studying this issue. The further works on networks in other economics studies borrow much from political economy.

Among the first papers applying network approaches to analyzing industries was a seminal paper by Allen (1982). In his work he introduces a mathematical model attempting to describe dynamics of diffusion of innovations. It was this work that drew initial attention to network related effects in many industries, although Allen's paper does not exploit these effects in full.

A central idea in much of the network studies is related to network effects or, as it became more widespread, network externalities. The term “externalities” refers to the indirect effects that one user has on the other users of the same network. For example, when a person connects to Internet, he or she indirectly increases the value of everyone else’s connection since they can now send this person e-mail or other messages. (Network Externalities, 2000). Originally such ideas are coming from studies on standards.

The idea of network externalities is closely linked to an idea of “path dependence”. This idea basically implies that if the value of a service grows with user base, then there are positive payoffs from increasing the size of user network. In other words ‘’it pays to be big”. And, alternatively, the fact that agent i adopts a particular technology increases the payoff for the next agent i+1 to adopt it (Arthur, 1989). As a network related service becomes available a question arises on what this implies about the working of the economy and which policies authorities should pursue in order to increase positive effects of such service.

There is a substantial and growing interest in the issue of network externalities by Western economists. Katz and Shapiro basically pioneered and extended this research (Katz & Shapiro, 1986 and 1992). The Katz-Shapiro network model is used and extended by other researchers. But it was not until the birth of commercial Internet in 1990 and development of Web-browser "Mosaic" in 1993 that the issue of network externalities started to draw much attention of economists. The fast growth of the Internet in the United States, with over 50% penetration rate was achieved in 7 years, has exceeded the growth rate of any other revolutionary technologies in human history (The Economist, 2000). The multiple works by economists in the United States, France and Israel have shaped the idea of network effects into a solid theory. See for example works by Economides (1996); Cremer J (2000); Bental & Spiegel (1995) and others.

Jacques Cremer and et al. developed advanced analysis techniques based on data typically available in real market settings. The researchers conducted an extensive analysis of end-user and backbone Internet markets. They examined in detail the shape of network externalities currently observed in European Community and in the United States. They found that positive network effects are not always continuous but instead may go up sharply as population connectedness approaches 100% (Cremer, 2000). Going further, these scientists have analyzed several pricing techniques and developed optimality conditions for establishing welfare maximizing pricing under presence of network externalities. The research technique developed in that study has served as the basis for developing the theoretical model used in this thesis.

The idea of network effects and path dependence have become so widespread that some scientists have started to look for network effects in other industries and sometimes rush to declare market failure. This rush is criticized in Liebowitz & Margolis (1995). This paper argues that several important aspects of network externalities have been misunderstood or inapplicable in some analyses. According to the authors the concept of network externalities is improperly modeled in previous studies and incorrectly applied to real-world situations. In many cases, they argue, the focus on network itself merely prevents proper diagnoses of more familiar problems in related markets, conventional problems such as natural monopoly and ordinary production externality (Liebowitz & Margolis, 1995). Their paper also draws attention to the direct and indirect externalities as having different welfare implications. They also show that under less strict assumptions of upward-sloping or horizontal costs curves as compared to standard assumption of increasing economies of scale. The paper then sets up a well-structured and illustrative model for analyzing effects of network externalities in specific industries, which is of great contribution for future studies.

My work takes the criticism in account and, to the extent possible, avoids the past mistakes. This is done by extending the model to account for the effects of demographic characteristics, income level and ownership of hardware on consumer preferences. The last section of the paper also explains the weaknesses of the approach used and points out the possible dangers of excessive rush to declare market failures.

Choi, Laibson and Metrick in their 2000 working paper find that people are more likely to buy their first home computer in areas where a high fraction of households already own computers or when a large share of their friends and family own computers and explain it by the presence of network related externalities (Choi, Laibson, and Metrick 2000). My thesis takes their empirical approaches to developing testable econometric model and collecting data.

Gupta, Alok and et. al (1999) deal with estimation of demand characteristics of Internet users. Their paper investigates two parametric approaches and one non-parametric approach based on computer simulation. Their contribution to my paper is in development of an alternative approach allowing fine-tuning of policy settings by evaluating supply and demand characteristics of Internet markets.

In terms of Internet policies, the central issues for emerging markets does remain the choice of providing telecommunication services by state, a natural monopoly and competition. These issues mainly focus on effective competitive ways to provide telecommunication services in underdeveloped countries or regions. Gasmi, Laffont and Sharkey (2000) provide a simple characterization of the conditions under which urban-to-rural cross-subsidies prove to be a powerful tool for financing universal service under competition. This paper was useful in my work as it offers several alternative ways to subsidize Internet development in transitional and underdeveloped economies.

Empirical literature mainly includes IT industry reviews and theory tests based on public surveys and ISP data analysis. Several sources of world trend data in the industry are available on-line from ITU, NetSizer, Internet Securities Inc. etc. General reviews of Ukrainian market are available from both international and local sources. Detailed weekly IT trends in Ukraine are available from InvestGazeta (Kyiv) on page 15 weekly. Although these sources are note directly cited in the thesis, they have contributed much into development of background understanding and allows for observation of main industry trends worldwide and in Ukraine.

Theoretical Model

In this work I view Internet as a network competing for user base with other alternative network goods such as postal services, conventional telecommunications such as telephone, television and non-network goods as newspapers and magazines. The Internet, however, goes beyond the information search since it offers another way to conduct business. Being an electronic network, Internet cannot yet transfer physical goods in space without additional delivery services.

The Internet is composed of links that connect users, also called nodes. It is the nature of a network that Internet requires many components to provide services. These components include physical connecting cables or wireless transmitters and receivers and high-speed servers that allow for the data to be securely directed via the cables to users. The set of all software and hardware used to keep Internet in operation is considered network infrastructure. Since the Internet infrastructure is basically designed for Information retrieval on demand, it allows for two-way communication. The essence of the network value is in its users, which use the infrastructure to send and receive data and messages. Originally built to be highly reliable (Diamond & Bates, 1996), the Internet does not have a center and may stay in operation as long as some computers remain connected. The Internet was actually launched over 20 years ago by the U.S. Defense Department to provide reliable communication in the after-burn of nuclear war, when all conventional ways of communication would have been destroyed (Holzinger, 1996). Internet Service Providers (ISPs) now commercially provide access to the Internet. So the Internet represents a set of compatible interconnected networks.

Ordinary consumers and even professional economists tend to treat a new invention *sui generis*, so different in essentials that we cannot even speak of it in the same terms we have for other things. The Internet and information technologies are not an exception to this theoretical misperception. However, the Internet connectivity, as any other market phenomenon, operates according to standard economic theory of efficiency and utility maximization (Liebowitz and Margolis, 1995). This dose not imply, of course, that Internet connection is not a subject to market failures nor that its operations are completely studied. What is important in this argument is that this phenomenon can and must be studied using economic tools and methods.

The entire decision process is a type of a standard two-stage game situation. In the second stage, consumers receive messages through the technology they have chosen in the stage 1 by either connecting or not connecting to the Internet. Firms deliver the messages charging the consumers in accordance with the technology they chose. During the first stage, senders and recipients simultaneously decide which technology to choose. At this stage, neither consumers nor firms have *a priori* knowledge of total user base in the second period. They form their expectations and base their optimal decisions base on those expectations.

In further discussion I develop a modified version of the model presented by Jacques Cremer (2000) and generalized by Helmut Cremer and Jean-Jacques Laffont (2000). First, I fit the model to specific web-based service, mainly the delivery of an important message. Second, in my setting the model is derived directly from consumers' utility function, rather than based on a set of controversial assumptions. It is not immediately clear from Cremer (2000) how the consumer preferences are incorporated. Third, additional factors such as consumers' income and other demographic factors are included into and thus allow econometric estimations. And, finally, the focus of my model is limited to IRS Internet technology versus a conventional CRS.

The Firm

The firms in the market may be divided into two main categories: Internet Service Providers **(ISPs)** and web-content providers or on-line firms. The behavior of ISPs is normal, in terms that they are maximizing their profits by optimizing supply and pricing behavior (Bental and Spiegel, 1995). Contrary to general opinion as expressed in Network externalities (1998), ISPs do not face increasing returns to scale. It is true, however, that there exists minimum efficiency scale, but ISPs' total cost curves are U shaped. It is due to the fact, that for a small change in number of users the marginal cost is approaching zero. As each provider's user network increases in size, however, an additional substantial investment must be undertaken in order to avoid problems of congestion and reduction of traffic speed as in Liebowitz and Margolis (1995) and Economides (1996). This fact is also confirmed by empirical data, showing that number of ISPs in each developed Internet market exceeds several hundreds or even thousands ITU (2000). For instance, there are currently over 260 ISPs in Ukraine according to State Telecommunication Committee (2000). With such number of sellers a market becomes a fairly close approximation for perfectly competitive price-taking behavior conditions.

The firms, specializing in providing Internet content work in a rather different way. They also have to face high fixed costs if they plan to deliver professional web projects, but their technology allows them to take advantage of increasing return to scale, since a web page may be viewed by large number of users at near zero variable cost to firm. The revenues of typical web-content providers may come from advertisement and from charging their users some positive usage fee. Profits of such firms become positive only after minimum efficiency scale is reached and then continue to rise with number of users. Since the initial investment is large, they will invest only if their expected user base is large enough.

For this research, some representative firm faces a decision-making problem on whether to deliver a potentially important message to some group of individuals. For the purpose of the analysis this group is assumed to be large. To ensure compatibility of empirical research, I assume that the group is limited to all citizens of a country who own personal computers. This limitation is needed since in many less developed countries the cost of buying a personal computer is high relatively to ISP service charge, and because personal computers improve utility in great variety of ways aside of the Internet. In both cases this research is not asking whether it is worth buying or not buying a computer.

In this basic setting, the firm has two possible choices of technology to deliver an important message. First, it can use a conventional technology, in this case postal service, to mail a flyer directly to customer. The marginal cost to sender in such case is equal to c and zero fixed cost is assumed. As an alternative, the Internet technology with offers a large fixed cost F and a 0 marginal cost per consumer may be used. Thus, the web technology is subject to Increasing Returns to Scale (IRS). For the purposes of modeling, additional costs such as obtaining the list of addresses of target consumers, costs of preparation of a message and advertising cost are assumed to be zero.

Let the proportion of connected recipients be uniformly distributed on the segment (0,1) with 1 indicating universal service obligation (full connectivity) and 0 indicating that none is connected. Let the market be competitive and assume that firms and consumers are rational. That is, the firms will provide the service using the technology with a minimum possible cost. Thus, the costs of delivering a message are fully taken by the firm as in case of advertisement message.

The firm chooses a web-based delivery if:

$$F \leq cn \quad \text{or,}$$

$$\frac{F}{c} \leq n \quad (1)$$

Here, F — the fixed cost of IRS web-based technology;

c — cost per message of the CRS regular mail delivery;

n — the number of Internet users.

In other words, the firm would invest into IRS technology if such investment reduces cost per person reached. Let's denote N — the total number of relevant recipients to be reached. Dividing (1) by N then gives:

$$\frac{F}{cN} \leq \alpha, \ \ where \ \alpha = \frac{n}{N} \ \ (2)$$

From here and on, the parameter $\alpha \in [0,1]$ denotes the proportion of population connected to the Internet and thus able to receive web-based messages. During the decision phase, α is determined by firm's expectations. Since no perfect prediction rule for consumer behavior exists, α is just the proportion at the time of decision.

The Consumer

In most general terms, a consumer makes his/her decision on whether to connect to the Internet or not by comparing the costs and benefits from such connection in the framework of utility maximization. I will define the utility maximization problem as a choice under income constraint. That is the choice between spending entire income on other goods or, instead, spending some portion of the income to acquire Internet connection:

$$U(netw) = U(1, m - p) \ \ vs. \ \ U(alt) = U(0, m) \ (3)$$

Here:

$U(netw)$ — utility derived from being connected to Internet;

$U(alt)$ — utility from consumption of all other goods which must be sacrificed through necessity to free-up income needed to pay connection costs and, in more general terms, also time and abilities which are drawn from being used elsewhere;

m — disposable income;

p — price of Internet connection;

I — the discrete variable state of Internet connection status with 1 = connected and 0 – otherwise.

Under the standard utility theory the connection decision is made if the utility from such connection exceeds the utility from the next best way to utilize available resources. Assuming that consumers are generally rational, the number of Internet connections is optimal at each point in time. Coordination failure is likely in the presence of network externalities, however, as further analysis of the utility maximizing behavior will show.

As logically follows and theoretically presented in (Katz and Shapiro, 1986), (Economides, 1996), (Bental and Spiegel, 1995) and (Cremer, 2000) the utility from an Internet connection in most general representation consists of the following elements:

$$U(netw) = f(\overset{+}{content}, \overset{+}{income}, \overset{+}{education}, \overset{+-}{language}) \quad (4)$$

This means that individual utility level is a function of available web content, disposable income, education level and the language spoken by the individual.

Content — the available on the Internet data and services, which are useful for consumers. This variable has direct influence on the amount of utility derived from an Internet connection. Certainly, the utility improving content may differ for each consumer.

Income — a person with higher income, all other things equal, has more to find on the Internet. This includes access to some paid services or information about more physical consumption goods. The literature on Internet economics assumes the Internet to be a *normal good*. This means, that income elasticity of demand on Internet services is assumed to be positive and wealthier consumers are willing to pay more for a network of given size than the relatively less wealthy (Bental and Spiegel, 1995).

Education — education level increases utility from the Internet, since a better educated consumer has more productive uses of it. For example an economist may use it to download papers or a businessman can read latest financial news which is of no value to a high-school graduate.

Language — the amount of Internet content available depends on which languages a user understands. For a speaker of English there is much more content than for a person speaking, for examples, only Ukrainian or Belarusian. So a person's language may be an advantage as well as disadvantage. As of today, it is the fact that English is truly the dominant language in the Internet.

The above composition of the utility function is also confirmed by Internet user surveys conducted by FIND/SVP's Technologies Research Group (The American Internet User Survey, 1996) and by International Telecommunication Union (ITU, 2000). As these studies reveal, the Internet is primarily used for sending e-mail messages and information search. Fairly recent introduction of on-line shopping, e-banking and other services started to attract more new users. In my empirical research, I intend to test these theoretical conclusions on the data for 47 countries including Ukraine.

Consumers make their connection decision in accordance to the decision problem represented by (3) and their utility described by (4). The basic assumptions are now introduced to allow the modeling. First, I treat the Internet connection state as discrete good. It means that each consumer is either connected or not connected. Second, the total utility derived from the Internet connection and consumption of other goods is represented by quasilinear utility function. Under these two assumptions, the utility for each connected representative consumer is:

$$U(netw) = U(1) + m - p \quad (5)$$

At this stage, I assume that utility derived from the Internet is zero for non-connected recipients:

$$U(0) = 0 \quad (6).$$

Therefore, from (3) and (6):

$$U(alt) = m \quad (7).$$

This allows deriving the theoretical solution for the willingness to pay of the Internet connection:

$$U(1) + m - r = U(0) + m \quad (8).$$

Solving to get:

$$r = U(1) \quad (9).$$

That is, a consumer's willingness to pay (reservation price) for the Internet is equal to his/her utility from being connected, as follows from the quasilinear form of utility function (5).

Based on the ideas expressed by (4), the utility and, as a result, maximum willingness to pay for the Internet connection is:

$$r = U(1) = \boldsymbol{t} + V \quad (10)$$

Here, $\boldsymbol{t}$ — the observed additive parameters of consumers' characteristics such as income, education etc.

V — unobserved individual preferences. I assume $V \in [0, Z]$, ranging from indifference to some finite strongly positive attitude towards internet.

Dividing V in (10) by positive scaling factor t I get:

$$r = U(1) = \boldsymbol{t} + tv \quad (11)$$

Where, $V = tv$, such that v is uniformly distributed on $v \in [0,1]$.

A typical consumer of scaled type v will make his/her Internet connection decision based on evaluation of expected benefit from such connection. The connection condition is then:

$$(\boldsymbol{t} + vt) - p > 0 \quad (12)$$

That is, net consumer benefit from connection must be positive. Rearranging (12) to obtain:

$$v \geq \frac{p - \boldsymbol{t}}{t} \quad (13)$$

For any given market price of ISP service, there will be consumers for whom reservation price is higher, equal or lower then market price. Fort the further discussion to make sense:

$$0 < \frac{p - \boldsymbol{t}}{t} < 1 \quad (14)$$

That is, I assume consumers of type $v = 1$ are necessarily connected and those of $v = 0$ are not: For the marginal user the following holds:

$$v = \frac{p - \boldsymbol{t}}{t} \quad (15)$$

A reasonable assumption is that the users with higher preferences connect first.

The Coordination Problem

Consumers and firms make their technology choice simultaneously. For the firms, the main condition is the number of connected users to be large enough — condition (2). Consumers decide to connect only if there is enough of useful web content available that is (14) is satisfied.

The proportion of consumers connected $\boldsymbol{a} \in [0,1]$ by definition and scaled individual preferences are uniformly distributed on same interval by assumption. Since users with the highest preferences are assumed to connect first, the following relationship between the proportion of connected consumers and their respective preferences holds:

$$v \in [1-\boldsymbol{a},1] \quad (16)$$

For the marginal consumer it is then true:

$$v = 1-\boldsymbol{a} \quad (17)$$

Using (16), I combine (2) and (15) to arrive at the coordination model:

$$1-\boldsymbol{a} \geq \frac{p-\boldsymbol{t}}{t} \quad (18)$$

Or, the Internet-based service will develop if:

$$\boldsymbol{a} \leq 1-\frac{p-\boldsymbol{t}}{t} \quad (19)$$

For the marginal consumer there is no immediate benefit from connecting to the Internet and (12) turns into an equality:

$$(\boldsymbol{t}+vt)-p=0 \quad (20)$$

But for consumers with higher preferences the payoff is strictly positive with (12) being satisfied. The higher the consumer preferences are, the more benefit from web-based service he/she receives if the marginal consumer decides to connect. The sum of these benefits constitute the total welfare benefit, which may be lost if the marginal consumer will not connect. The effect of network externalities thus comes into play.

Thus, due to the network effect, consumers do not take into account full benefit of their connection. As a result, proportion of connected individuals will at each point in time be less than socially optimal (Bental and Spiegel, 1995). Here the development of Internet comes to a coordination failure: firms do not invest into web-content because user base is too small and new users do not connect since their utility from being on-line is too low. Minimum efficiency scale has to be reached before Internet growth becomes self-sustainable (An and Kiefer, 1995). Such situation calls for governmental intervention.

From (19), possible states of the market are:

I) Due to network externalities effect $\frac{F}{cN} > 1 - \frac{p - \boldsymbol{t}}{t}$ and a representative firm will not invest into web-based service.

II) The second equilibrium is observed where: $\frac{F}{cN} < 1 - \frac{p - \boldsymbol{t}}{t}$ and the firm will invest.

III) The third equilibrium implies equality sign $\frac{F}{cN} = 1 - \frac{p - \boldsymbol{t}}{t}$ and the firm will be indifferent between investing and not investing.

I denote the difference $\boldsymbol{d}$ of the true state of market parameters from the desirable equilibrium as:

$$\boldsymbol{d} = \frac{F}{cN} - \left(1 - \frac{p - \boldsymbol{t}}{t}\right) \text{(21)}$$

The government then has to choose between subsidizing internet-based recipients, taxing postal services and subsidizing content providers. The postal service in many countries is state-owned or heavily subsidized. Privatization or removal of such subsidies could have given a socially undesirable effect. In Ukraine, however, approximately 98% of population does not even own personal computers (ITU, 2000). Therefore postal service remains yet more important for the society then the Internet. Thus, taxing the postal service (removing subsidies), which is increasing the value of c, may have socially undesirable effect and thus is not taken in account further.

Subsidizing faster Internet adoption means reduction of connection prices. The required subsidy is than calculated from:

$$\boldsymbol{d} = \frac{F}{cN} - \left(1 - \frac{(p - S_{cons}) - \boldsymbol{t}}{t}\right)$$

Solving for S_{cons} and rearranging: $S_{cons} = \boldsymbol{d} * t$ (22).

Subsidizing web-provider means reduction of their fixed costs:

$$\boldsymbol{d} = \frac{(F - S_{firm})}{cN} - \left(1 - \frac{p - \boldsymbol{t}}{t}\right)$$

And: $S_{firm} = \boldsymbol{d} * cN$ (23)

The further decision on which option requires less financing for the subsidy to have needed effect is determined by comparing values of parameters:

a) If $cN > t$, then it is more efficient to subsidize Internet usage directly through connection price p.

b) If $cN < t$, then it is cheaper to subsidize through content providers.

Which of the above options is currently more desirable in Ukraine is aimed to be answered by empirical estimation in the next chapter.

C h a p t e r   3

PARAMETERS OF THE INTERNET SUBSIDIZING MODEL

The Estimation Model

The theoretical model, presented in the previous chapter suggests that the optimal choice of policy depends on the size of the scaling coefficient of consumer preferences — t as compared to cost of service charge of postal service — c for delivery of comparable message. The estimation is required in order to fit the model parameters for further use in policy decision-making.

From Chapter 2, the proportion of connected users is determined by user preferences, scaling factor t and Internet access price. The relationship between those is:

$$1-\boldsymbol{a} \geq \frac{p-\boldsymbol{t}}{t} \quad (18)$$

Where: $\boldsymbol{a}$ - proportion of total users base who are connected; p – total Internet access price, c - cost of traditional technology (postal service) and $\boldsymbol{t}$ - slope parameter of consumers' willingness to pay. Compared to Cremer (2000), I expand the parameter $\boldsymbol{t}$ to account for differences in income level in a country, for education and for the factors, which, in theory, could influence customers' willingness to pay for Internet services. For the purpose of estimation the model is setup as follows:

$$1-\boldsymbol{a} = \boldsymbol{g}_0 + \frac{1}{t}p - \boldsymbol{b}_1 GDP - \boldsymbol{b}_2 Ed - \boldsymbol{b}_3 PC - \boldsymbol{l} \quad (24)$$

Here. *GDP* — country GDP per capita income as a proxy for level of income in a country;

Ed - average # of years schooling (as proxy for education level);

PC — proportion of citizens who own computers.

l — fixed-effect dummy variable to account for national language with $l = 1$ for English and $l = 0$ otherwise.

At this stage, it is also useful to include a variable effect dummy variable for the difference of slope coefficient for Ukraine. The estimated model is finally:

$$1 - a = g_0 + \frac{1}{t} p + r * p - b_1 GDP - b_2 Ed - b_3 PC - l \quad (25)$$

Where r =1 for Ukraine and r =0 otherwise. Obtained value of coefficient t is then used to make further inquires and fitted into the theoretical model to evaluate the size of required consumer subsidy.

The Data and Results

In this study I use cross-sectional data on 46 countries including Ukraine for the year 2000. The data set includes: the number of Internet users, population, price of Internet connection including phone charge and line rental fees, the number of personal computers privately owned by country citizens, GDP per capita in US dollars, domestic country tariff for sending a cheapest letter or flyer calculated in US dollars, education level measured as average number of years schooling. In few exceptions, namely for Argentina, South Africa, China and Venezuela the data for year 2000 GDP per capita was calculated from 1999 GDP per capita by adding the growth rate for the year 2000 based on IMF data. The required series where then calculated from the data to fit the model. The following table summarizes the data which have entered the regressions:

Table 1: Data series and sources

Variable (model)	Variable (EViews)	Description	Source
$1-a$	prop_n_c	Proportion of non-connected population as difference between 1 and proportions of population connected	International Telecommunications Union (ITU), 2000
p	p_net_line	Price of internet connection including phone charge and line rental. Calculated for 20 hours of access per month or for unlimited access if such is cheaper	International Telecommunications Union (ITU), 2000
GDP	gdp_cap	GDP per capita	IMF, Worl Bank, United Nations (1999, 2000)
Ed	edu	Education measured by average number of schooling per person.	United Nations (2000)
PC	prop_pcs	Proportion of people who own personal computers	Calculated based on the data from ITU (2000).
r	ukr_t	Dummy variable for difference in searched coefficient 1/t for Ukraine.	Ukraine = 1, 0 – otherwise.
l	lambda	Dummy variable for English speaking	English speaking = 1, 0 – otherwise.

I now estimate the model according to the equation (25):

PROP_N_C = C(1) + C(2)*P_NET_LINE + C(3)*GDP_CAP + C(4)*EDU + C(5)*PROP_PCS + C(6)*UKR_T + C(7)*LAMBDA

Which results in:

PROP_N_C = 1.093023 + 0.001497*P_NET_LINE - 4.27e-06*GDP_CAP - 0.019866*EDU - 0.208958*PROP_PCS + 0.005102*UKR_T - 0.050336*LAMBDA

The R^2 = 0.7698, which is sufficiently high for the purposes of the current study. The coefficient $c(2) = \frac{1}{t}$ is significant at 9% level. The estimation results are presented in Table 2.

Table 2: Main estimation results

Dependent Variable: PROP_N_C
Method: Least Squares
Date: 05/12/01 Time: 16:32
Sample: 1 46
Included observations: 46

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.093023	0.094228	11.59977	0.0000
P_NET_LINE	0.001497	0.000862	1.735878	0.0901
GDP_CAP	-4.27E-06	1.37E-06	-3.116656	0.0034
EDU	-0.019866	0.007165	-2.772619	0.0084
PROP_PCS	-0.208958	0.092491	-2.259238	0.0295
UKR_T	0.005102	0.003875	1.316601	0.1957
LAMBDA	-0.050336	0.026119	-1.927179	0.0613

R-squared	0.769790	Mean dependent var	0.853268
Adjusted R-squared	0.734373	S.D. dependent var	0.137451
S.E. of regression	0.070841	Akaike info criterion	-2.317492
Sum squared resid	0.195719	Schwarz criterion	-2.039221
Log likelihood	60.30232	F-statistic	21.73509
Durbin-Watson stat	2.042262	Prob(F-statistic)	0.000000

I then perform the main tests to ensure the consistency of estimation. The expected problem is heteroscedasticity due to cross-sectional type of data. The White heteroscedasticity test is conducted to test for its presence in the regression. The test shows that no significant heteroscedasticity is present in the estimation (Appendix 2). I also perform routine tests for presence of multicollinearity by estimating covariance matrix (Appendix 2). Although, there is positive correlation in the order of 70% between proportion of population who own personal computer and GDP per-capita, the theory suggest that this should significantly influence estimation outcome. I also conduct routine check for autocorrelation by looking at reported Durbin-Watson statistics, which does not indicate autocorrelation. So, there are no statistically significant violations of main OLS assumptions and the estimated results are consistent and efficient (Appendix 2).

Meaning of the Results and Policy Implications

The main result is the value of the parameter $\frac{1}{t} = 0.001497$, obtained from the regression, which that allows me to calculate the required parameter $t = 668.0$. The coefficient for Ukraine is statistically insignificant as confirmed both by low t-statistics and likelihood ratio test for redundant variables (Appendix 2). Thus, the null-hypothesis that Ukraine is not different from the rest of the sampled countries cannot be rejected at reasonable significance level, meaning that consumer preferences towards Internet in Ukraine are similar to those for consumers from different countries.

As empirical results sugest, the important parameter $t = 668.0$. Getting back to theory, the size of the needed subsidy may be compared now. With the case when government decided to subsidize ISPs or customers to reduce price of connection the size of subsidy from identity (22) is:

$$S_{cons} = \boldsymbol{d} * t = 668.0 * \boldsymbol{d}$$

The size of the subsidy is determined from:

$$S_{firm} = \boldsymbol{d} * cN \quad (16)$$

It now depends on the size of the target audience of recipients and on the size of relevant postal charge. For Ukraine, I take as an audience all the personal computer users who are still not connected. According to ITU (2000) data, the total number of personal computers in Ukraine is estimated as 900,000 of which 230,000 were connected in the year 2000. Given the postal tariffs in the year 2000, the cost of sending a flyer is 0.129 USD at the time of observation (due to variability of exchange rate this cost fluctuates). This estimates the size of the subsidy as:

$$S_{firm} = \boldsymbol{d} * cN = 0.129 * (900000 - 230000) * \boldsymbol{d} = 86{,}430 * \boldsymbol{d}$$

Clearly, at the current Ukrainian setting it is cheaper to subsidize through ISPs than though content providers. The theory and empirical results obtained thus justify the choice of the current policies of the Ukrainian government on supporting companies providing Internet connection services, although the size and targeting of these subsidies remains to be answered by further research.

For extremely small postal tariffs like that in China, or a very small target audience, for $N < 5{,}200$, it may prove to be less expensive to provide support for content providers. For example it may make sense if government or a sponsor becomes interested in having a specific minority group connected to the web. My results are also in line with the results obtained by Jacques Cremer (2000) in the sense that if the proportion of connected users is high or approaches 100% it becomes more welfare improving to subsidize content providers.

Table 3: Theory predictions and empirical results[1]

Variable	Expected sign	Estimated sign	Significance level	Coefficient
Income (GDP/per capita)	+	+	0.3%	0,00000427
Education (years schooling)	+	+	0.8%	0.0199
Language (dummy)	+	+	6.1%	0.05

The fact that the settings of the model are consistent across countries and Ukrainian case is not different from the World average affirms the applicability of the model in wide variety of settings. My empirical results are also overall consistent with the theoretical predictions of the Chapter 2, which also adds to their credibility.

[1] Here, the sign of the estimation results is reversed as to be comparable to theoretical predictions, which are made for proportions connected rather than not connected.

Weaknesses, Limitations and Further Research Opportunitites

This thesis answers the main question and well fits the main topic. It provides in consistent way the theoretical justifications and empirically estimates the main parameters of the model. It is not free of certain limitations and weaknesses however.

First, the type of data used does not allow providing precise answers on the size of subsidies required in each discussed case nor it can pretend to provide clear answers in each of the specific policy decision cases. The data set must include far more observations across space and time in order to have greater precision. Generally the model should be estimated by using a time-series dataset. Partially this limitation is evident from only marginal statistical significance of the main coefficients and tests (see Appendices 1-2). Few other variables, to which I do not have access, may be included into the estimations in the future. Among those are the proportions of urban versus rural population in each of the sampled countries, proportions of population who speak English instead of just a dummy variable for official language and probably some indicator of content availability. Unfortunately such data is not free and often does not yet exist. My attempt to include some of these variables has failed because the sample size would then be reduced even further. A new research, based on more sophisticated dataset, can certainly explore the potential of the theoretical model further.

Second, the theory in some sense is modeled as an attempt to use a generalized model for answering a micro-level question on whether to connect or not. In the further research it certainly would be beneficial to conduct a random survey of both Internet users and those not connected to better understand the reasoning behind consumer choices. The utility function form then may be better understood and changed if needed. Such fine-tuning of the utility function may also improve the specification and the significance of the estimated models.

THE SUMMARY OF THE RESULTS

This thesis is among the first attempts to find the solution to the Internet development policy question in Ukraine. It answers the question of desirability and determines the welfare optimal ways to support development of the Internet in Ukraine. As the results suggest, the main obstacle to faster Internet growth in Ukraine is undervaluation by consumers of benefits explained by effect of network related externalities. Private as well as corporate Internet users do not normally take into account the indirect benefits coming from their connection to other network members. This work has provided theoretical justification why Ukrainian Internet market may need government interventions and it suggests the effective ways for possible interventions.

The theoretical part of the paper first investigates the decision behavior of Internet users and web-content providers. Second, it develops a baseline Internet subsidization model. As with most networks, the Internet is subject to positive network effects. This means that benefits from being on-line increase with more and more computers being connected. As almost intuitively follows from the presence of network effects, each new Internet user increases the value of being on-line for all existing users and for the possible newcomers. With extremely few exceptions, the simple utility maximizing decision by individual users does not take into account the network effects. In this sense the Internet development may require governments to intervene.

The empirical work then estimates, using econometric analysis of cross-sectional country data, the current behavioral characteristics of Ukrainian users of the Internet. Then the specific policy measures are derived using forecasts of expected policy costs by fitting the estimated values of the critical parameters into the theoretical model. Mainly the relative cost is predicted for subsidizing web-content providers versus direct connection price subsidy. The main focus of the empirical chapter is on estimation of the relevant parameter values from the cross-sectional data on 46 economies including Ukraine.

The results suggest that under Ukrainian setting it is cheaper to subsidize through ISP prices than though content providers. But for extremely small postal tariffs like that in China, or a smaller selected target audience it may still prove to be less expensive to provide support for content providers. It makes sense when the policymakers' or sponsors' goals focus on a specific limited in size group. The results are mainly in line with those obtained by other researchers, mainly with Jacques Cremer (2000).

The theory and empirical results obtained thus justify the current policy direction chosen by Ukrainian government of supporting companies providing Internet connection services. This support is mainly done through helping to build high speed communication lines and basic network architecture. Still, the size of such subsidies cannot be evaluated within the framework of current research. This question, as well as political economy implications of government interventions into the Internet market in Ukraine, are to be answered by future extensions of the current research.

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APPENDIX 1: LIST OF SAMPLED COUNTRIES

Price of network access[2]:

COUNTRY	PRICE (USD per 20 hours access)	COUNTRY	PRICE (USD per 20 hours access)
Argentina	47,13	Korea	16,85
Australia	27,85	Luxemburg	39,96
Austria	32,43	Malaysia	21,05
Belgium	27,72	Mexico	28,49
Brazil	44,76	Netherlands	31,8
Canada	29,74	New Zealand	29,83
Chile	8,9	Norway	47,84
China	31,75	Philippines	24,92
Czech	23,19	Poland	37,65
Denmark	37,37	Portugal	42,21
Finland	27,71	Russia	5,13
France	35,38	Singapore	32,49
Germany	35,9	S.Africa	24,9
Greece	33,53	Spain	20,98
Hongkong	28,97	Sweden	29,24
Hungary	32,07	Switzerland	37,26
Iceland	34,51	Taiwan	18,35
India	48,53	Thailand	43,39
Indonesia	8,95	Turkey	17,48
Ireland	25,83	Ukraine	22,57
Israel	21,19	UK	29,36
Italy	19,98	USA	16,62
Japan	61,03	Venezuela	75,07

List of countries with high proportion of English-speaking population:

Australia, Canada, Hongkong, India, Ireland, Israel, New Zealand, South Africa, Singapore, Sweden, Taiwan, UK, USA.

[2] Includes telephone connection charge as well as line rental costs.

APPENDIX 2: SPECIFICATION TESTS

White heteroscedasticity test:

F-statistic	1.427690	Probability	0.209069
Obs*R-squared	13.32749	Probability	0.205934

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/12/01 Time: 18:01
Sample: 1 46
Included observations: 46

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.014728	0.067778	0.217304	0.8292
P_NET_LINE	-0.000286	0.000396	-0.723692	0.4741
P_NET_LINE^2	2.66E-06	5.16E-06	0.515397	0.6095
GDP_CAP	2.45E-07	6.90E-07	0.354578	0.7250
GDP_CAP^2	1.16E-11	1.38E-11	0.846197	0.4032
EDU	-0.002923	0.010359	-0.282157	0.7795
EDU^2	0.000194	0.000384	0.505552	0.6163
PROP_PCS	-0.065857	0.048760	-1.350639	0.1855
PROP_PCS^2	0.037207	0.036603	1.016509	0.3164
UKR_T	-0.000894	0.000601	-1.489077	0.1454
LAMBDA	0.006545	0.003917	1.670785	0.1037

R-squared	0.289728	Mean dependent var	0.004255
Adjusted R-squared	0.086793	S.D. dependent var	0.009913
S.E. of regression	0.009473	Akaike info criterion	-6.275781
Sum squared resid	0.003141	Schwarz criterion	-5.838497
Log likelihood	155.3430	F-statistic	1.427690
Durbin-Watson stat	2.150695	Prob(F-statistic)	0.209069

Correlation Matrix (testing for multicollinearity):

	P_C	GDP_CAP	EDU	PROP_PCS	UKR_T
P_C	1.000000	0.076698	-0.055324	-0.036469	-0.085232
GDP_CAP	0.076698	1.000000	0.611402	0.727221	-0.187784
EDU	-0.055324	0.611402	1.000000	0.691286	0.221646
PROP_PCS	-0.036469	0.727221	0.691286	1.000000	-0.149264
UKR_T	-0.085232	-0.187784	0.221646	-0.149264	1.000000

Likelihood Ratio Test output

Redundant Variables: UKR_T

F-statistic	1.733438	Probability	0.195657
Log likelihood ratio	2.000434	Probability	0.157254