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A System Dynamics Pricing Model for Stabilizing Prices for Telecommunication Products and Services in Uganda

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This study involved the use of systems dynamics approach to develop a pricing model for telecommunication goods and services in Uganda. Primary data were collected from four telecommunication service providers and Uganda Communications Commission, a regulatory body of telecommunications in Uganda. Descriptive statistics and factor analysis with principal component and varimax rotation methods were used to determine the most important factors that affected the pricing decisions made by telecommunication firms. These factors were further analyzed and modeled using Vensim PLE simulation and modeling software, to develop a new pricing model for telecommunications goods and services. The findings indicate that demand and market based pricing approaches are the significant approaches used to set prices for telecommunication products and services in Uganda. The main factors affecting prices of telecommunication goods and service include operating costs, forces of demand and supply, foreign exchange rate, inflation and excessive competition. This paper presents four policy strategies for stable telecommunication prices as Taxation, Liberalization, Government incentives and Wealth maximization.

Key Words: System dynamics, telecom prices, pricing methods, developing countries, Uganda

Introduction

Although the telecommunications sub-sector of Uganda is relatively young, it has been growing rapidly and consistently over the past decade. For instance there was only one telecommunications service provider in 1996 with a total number of 3000 mobile subscribers (UCC, 2003). This number was very low. In contrast, the call rates were so high at Ush600 per minute. The use of telecommunication services thus became a big challenge to the majority of Ugandans who lived on less than US$1 a day (Nasasira, 2003). Today, there are over five registered telecommunication service providers covering

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the entire country with approximately 11,000,000 subscribers. Notably however is that the average call rate has been standing at USh380, until recently when Warid Telecom introduced cheaper call rates at Ush3 per second. Even with all these developments, the telecommunication rates in Uganda are far higher than the rates in all other East African countries. This has continued to happen despite the establishment of the Uganda Communications Commission (UCC), a body mandated to monitor and harmonize telecommunication prices in the country.

A number of approaches such as cost-based pricing (Kelly, 1999; Sharkey, 2003) and Capital Assets Pricing (Michailidis at el. 2006) have been used to set and stabilize prices. These approaches however are based on assumptions that there is of a fully competitive market and also that long-term marginal cost pricing often provides optimal economic efficiency (Nichols et al. 2006). Ryan at el. (2008) designed a spectrum pricing model based mainly on spectrum management algorithms. This model, to a certain extent, addressed the problem of dynamic spectrum pricing. Notably however is that cost based pricing has been the predominant pricing approach in Uganda and the world over due to its popularity in achieving break-even for both investors and customers. This approach has largely benefited the investors at the expense of customers who very often complain about high call rates in Uganda. There is a lot of public outcry against exorbitant prices. The government has always been blamed for not allowing free entry of new service providers who would help bring the rates down. To make matters worse, the government charges a hefty 30% as Value Added Tax (VAT) on telecommunications products and services. These taxes are directly transferred to the final consumer. The mass media have reported several cases of customer dissatisfaction with the telecommunication rates and other distortions in the sub-sector. For example, operators are suing each other and consumers are also suing service providers over pricing issues (Afedraru, 2010). Many observers argue that the high and unstable telecommunication prices in Uganda are as a result of reluctance, intended or unintended on government's side to play its role of ensuring affordable telecommunications services. This has caused a communication crisis in the country (The New Vision, May 25th, 2010). The pricing methods used are obsolete and inappropriate as they heavily rely on a single variable "cost" and are assumed to operate under a free market economy. Alleman at el. (2009) argue that the artificial assumptions of a free market economy allow the policymakers to avoid their responsibility of monitoring telecom rates through established regulatory frameworks and standards.

According to Forrester (1992), a system dynamics approach to problem solving presents exceptional capabilities of representing "the real world by accepting the complexity, nonlinearity and feedback loop structures that are inherent in social, economic and physical business systems". In other words, system dynamics looks at problem solving from a holistic angle, where by all factors affecting a given area are examined. Their influence is then modeled into feedback loops to give a clear picture of real-world scenarios. System dynamics is a mature, proven and well tested approach that has been used to solve many operations research problems. For example, Kirkwood (1998) argues that system dynamics facilitates decision making through the use of computers to model the human decision making process into real life processes. Thus, simulating the pricing decisions made by telecom service providers and regulators through creation of models can help a lot, not only in setting but also stabilizing telecommunication prices in Uganda. This study therefore sought to address the pricing problems in telecoms by developing a systems dynamics pricing model that can be used to stabilize telecommunication prices in Uganda. The following research questions were used to guide this study:

Are telecommunication prices in Uganda fair and stable?

Can systems dynamics be used to set and stabilize prices for telecommunications products and services in Uganda?

What variables should be used in the system dynamics pricing model?

Research Methods

The study adopted a system dynamics (SD) methodology, whereby a number of factors influencing prices in the telecommunications sub-sector were assessed and modeled using causal-effect loop diagrams. The study population covered four telecommunication operators (Warid Uganda, MTN Uganda, Uganda Telecom and ZAIN Uganda) and the Uganda Communications Commission. Using purposive sampling techniques, the employees of these organizations who participated in pricing of products and services such as marketers, managers, heads of department and regulators were selected. A total of 50 respondents were involved in the study, in line with Roscoe's (1970) rule of thumb that a sample size between 30 and 500 is sufficient. A 90% response rate was registered, however after preliminary data cleaning and sorting, only 41 questionnaires were considered for analysis. Table 1 shows the sample size:

Data collection methods

The study deployed mainly primary data, collected using a questionnaire method. However, some important inferences were made based on review of the available literature on system dynamics, pricing and telecommunications. To test for validity and reliability of our research instrument, Content Validity Index (CVI) was used and a CVI > 0.50 was obtained. To test the questionnaire for reliability, Cronbach Alpha's coefficient was used. A Cronbach Alpha >0.60 for all variables was obtained. Table 2 shows validity and reliability results.

Data analysis

Descriptive statistics and Factor analysis with principal component and varimax rotation methods were used to extract the most important factors influencing prices in the telecommunications sub-

Table 1: Study Sample breakdown

Organization	Sample	Sampling method
MTN Uganda	10	Purposive sampling
Uganda Telecom	10	
ZAIN Uganda	10	
WARID Uganda	10	
Uganda Communications Commission	10	
Total	**50**	

Table 2: Pretest results for validity and reliability

Variable	N of items	Anchor	Cronbach Alpha Coefficient	CVI
Fairness of Telecommunication Prices	2	Yes/No	0.601	0.522
Stability of Telecommunication Prices	2	Yes/No	0.601	0.522
Systems Dynamics as an Appropriate Pricing Method	2	Yes/No	0.601	0.522
Reasons for the Systems Dynamics Approach	5	Yes/No	0.743	0.674
Variables for System Dynamics Pricing Model	7	5 point	0.702	0.578

sector. This was done using SPSS software. On the other hand, Vensim PLE software was used to develop and simulate the new System Dynamics pricing model.

Findings

This section presents the research findings in relation to the research questions afore mentioned.

Fairness of Telecommunication Prices

Descriptive statistics were used to examine the fairness of telecommunication prices in Uganda as seen in table 3:
Results in table 3 indicate that telecommunication prices in Uganda are not fair (68.3%), while only 31.7% of the respondents indicated that prices were fair.

Stability of Telecommunication Prices

Descriptive statistics were also used to examine the stability of telecommunication prices in Uganda as seen in table 4:
Results in table 4 indicate that telecommunication prices in Uganda are not stable (93%). Only 7% of the respondents indicated that the prices were stable.

Systems Dynamics as an Appropriate Pricing Method

Descriptive statistics were used to determine whether systems dynamics approach was an appropriate method for setting and stabilizing prices for telecommunication products and services in Uganda as shown in tables 5:
Results in table 5 indicate that system dynamics was an appropriate method for setting and stabilizing prices for telecommunication products and services in Uganda.

Reasons for Systems Dynamics Approach

Descriptive statistics were also used to examine the reasons why systems dynamics approach was an appropriate pricing method for setting and stabilizing prices for telecommunication products and services in Uganda. Table 6 shows the reasons for system dynamics approach.
The need for system dynamics approach is as result of cheaper call rates (34%), emphasis being more towards end user (20%), flexibility (7%), reality and sincerity (27%), situational and consideration for all factors affecting prices (12%) as shown in table 6.

Variables for System Dynamics Pricing Model

Descriptive statistics and factor analysis were used to determine the variables to be considered in system dynamics pricing model for setting and stabilizing of prices for telecommunication products and services in Uganda. Table 7 shows the various SD model variables:
Results in table7 indicate that the respondents agreed that capital expenditure (Mean=3.4444), inflation (Mean=2.7576), interconnection rates (Mean=3.1515), excessive competition (Mean=3.4634), forces of demand and supply (Mean=3.1053), foreign exchange rate (Mean=3.1951) and operating costs (Mean=3.2439) are

Table 3: Fairness of telecommunication prices in Uganda

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	13	31.7	31.7	31.7
	No	28	68.3	68.3	100.0
	Total	**41**	**100.0**	**100.0**	

Source: Primary data

Table 4: Stability of telecommunication prices in Uganda

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	3	7.3	7.3	7.3
	No	38	92.7	92.7	100.0
	Total	**41**	**100.0**	**100.0**	

Source: Primary data

Table 5: System dynamics as an appropriate prices method

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	41	100.0	100.0	100.0

Source: Primary data

Table 6: Why systems dynamics approach

	Frequency	Percent
It leads to cheaper call rates	14	34.2
It is situational and considers all factors that affect prices of products and services.	5	12.2
It emphasizes the need for end user participation who is the beneficiary.	8	19.5
It is flexible	3	7.3
It is real and sincere in a dynamic small economy like Uganda.	11	26.8
Total	**41**	**100.0**

Source: Primary data

variables to be considered in system dynamics pricing model for setting and stabilizing of prices for telecommunication products and services in Uganda.
Results in table 8 shows that 51.217% of the system dynamics variables for pricing of telecommunication products and services include operating costs, forces of demand and supply, foreign exchange rate, inflation and excessive competition. On the other hand, capital expenditure and interconnection rates were not significant variables as they negatively influenced telecom prices.

Discussion of Findings

Fairness and Stability of Telecommunication Prices

The results shown in table 3 indicated that prices of telecom products and services were not fair in Uganda. The results in table 4 also indicated that prices were not stable. These findings are in line with literature (Afedraru,

Table 7: Variables for SD pricing model

	Mean	**Std. Deviation**	**Analysis N**
Capital Expenditure	3.4444	.81989	41
Inflation	2.7576	.67195	41
Interconnection rates	3.1515	.63723	41
Competition	3.4634	.59572	41
Forces of demand & supply	3.1053	.29912	41
Foreign exchange rate	3.1951	.51086	41
Operating costs	3.2439	.43477	41
Average	**3.1945**		

Source: Primary Data

Table 8: Factor analysis for SD variables

	Component
Operating costs	.879
Forces of demand & supply	.822
Foreign exchange rate	.814
Inflation	.741
Capital Expenditure	-.597
Interconnection rates	-.541
Excessive competition	.525
Eigen value	3.585
% of variance	**51.217**

Source: Primary data

2010; UCC, 2008; The New vision, May 25th, 2010).

System Dynamics Variables

Results in table 5 indicated that system dynamics was an appropriate method for setting and stabilizing prices for telecommunication products and services in Uganda. This is re-affirmed by results in table 6, in which the respondents indicated that system dynamics approach was superior because it led to cheaper calling rates, and that it emphasized end users. The respondents also indicated that system dynamics was a flexible approach, real, sincere and also that it was a situational approach that considered all factors affecting prices. These findings agree with literature (see Radzicki, 2003; Forrester, 1992; Forrester et al. 1996; Dooley, 2002; Sterman at, el. 2003; Rodriguez & Paucar, 2005).

Further to the above, findings in table 7 and table 8 indicated that excessive competition, operating costs, foreign exchange rates, forces of demand & supply and inflation were key variables influencing telecom prices.

This is in agreement with Bank of Uganda (2008); Alleman at, el. (2009); Gans & King, (2009).

Building the System Dynamics Pricing Model

This section presents a step by step description of how the new system dynamics pricing model was built.

Model variables

A number of variables were derived from primary data, while others were borrowed from literature. Table 9 shows the variables that were derived from primary data and those that came from literature:

Variable Relationship Modeling

Table 10 shows the relationship between the identified model variables.

The New System Dynamics Pricing Model

Using the above variables, causal-effect loop diagrams

Table 9: List of derived and adopted variables to be modeled

Pricing approaches	Pricing factors	Pricing goals
Demand-based pricing (Demand) Market-based pricing	Capital Expenditure Inflation Interconnection rates Excessive competition (Competition) Forces of demand & supply (Supply) Foreign exchange rate (Exchange rate) Operating costs Prices Taxation Government incentives Regulation Liberalization	Profit maximization Wealth maximization Market expansion Beat competition (Competition) Break-even

Table 10: Relationship between variables

01)	Break even = A FUNCTION OF(Inflation)
(02)	Capital Expenditure = A FUNCTION OF(Interconnection Rates)
(03)	Competition = A FUNCTION OF(Regulation)
(04)	Demand = A FUNCTION OF(Supply)
(05)	Exchange rate = A FUNCTION OF(Investment)
(06)	Inflation = A FUNCTION OF("Liberalization.", Supply)
(07)	Interconnection Rates = A FUNCTION OF(Competition, Profit maximization)
(08)	Investment = A FUNCTION OF (Demand, "Wealth Maximization.")
(09)	Market expansion = A FUNCTION OF(Exchange rate)
(10)	"Market-Based Pricing" = A FUNCTION OF(Competition)
(11)	Operating Costs = A FUNCTION OF(Capital Expenditure)
(12)	Prices = A FUNCTION OF(Operating Costs)
(13)	Profit maximization = A FUNCTION OF(Prices, Taxation)
(14)	Regulation = A FUNCTION OF("Market-Based Pricing")
(15)	Supply = A FUNCTION OF(Break even, Government Incentive, Market expansion, Operating Costs)
(16)	Taxation = A FUNCTION OF( )
(17)	"Wealth Maximization." = A FUNCTION OF( )

were drawn to show how each variable influenced another based on their relationship in terms changing

prices. figure 1 shows the new system dynamics pricing model:

Interpretation of the New Pricing Model

The model has four loops; 2 positive and 2 negative loops. The first loop has 3 variables i.e. regulation, competition and market based pricing. An increase in regulation of telecommunication goods and services reduces competition in the sector. When competition increases, service providers resort to market-based pricing approaches in order to survive. This leads to a need for increased regulation. This cycle produces a negative loop which implies there is a problem that requires intervention. The problem of excessive competition is manifested in the increased interconnection rates between service providers as seen in the second loop. An increase in interconnection rates leads to a proportionate increase in capital investment by service providers in an effort to setup their own infrastructure. However increasing capital expenditure also increases operating costs, which intern increases prices of goods and services with the aim of maximizing profits. The government taps into high profits by increasing taxes on profits and capital gains.

The high operating costs in the second loop transform into reduced supply of goods and services with the hope of minimizing costs. However, this situation results into an increase in inflation which renders businesses unprofitable as suppliers and service providers fail to break-even. Subsequently, the government intervenes by liberalizing the market in order to allow in other players, with the hope that this will reduce the inflationary situation. The government intervenes into the sector by providing incentives aimed at boosting supply of goods and services, which intern increases supply. With increased supply, demand increases. An increase in demand increases foreign direct investments since investors hope to maximize wealth by exploiting the prevailing market opportunities of high demand. However, an increase in Foreign Direct Investments (FDIs) into the sector reduces the exchange rate, which later reduces the market expansion potential and supply

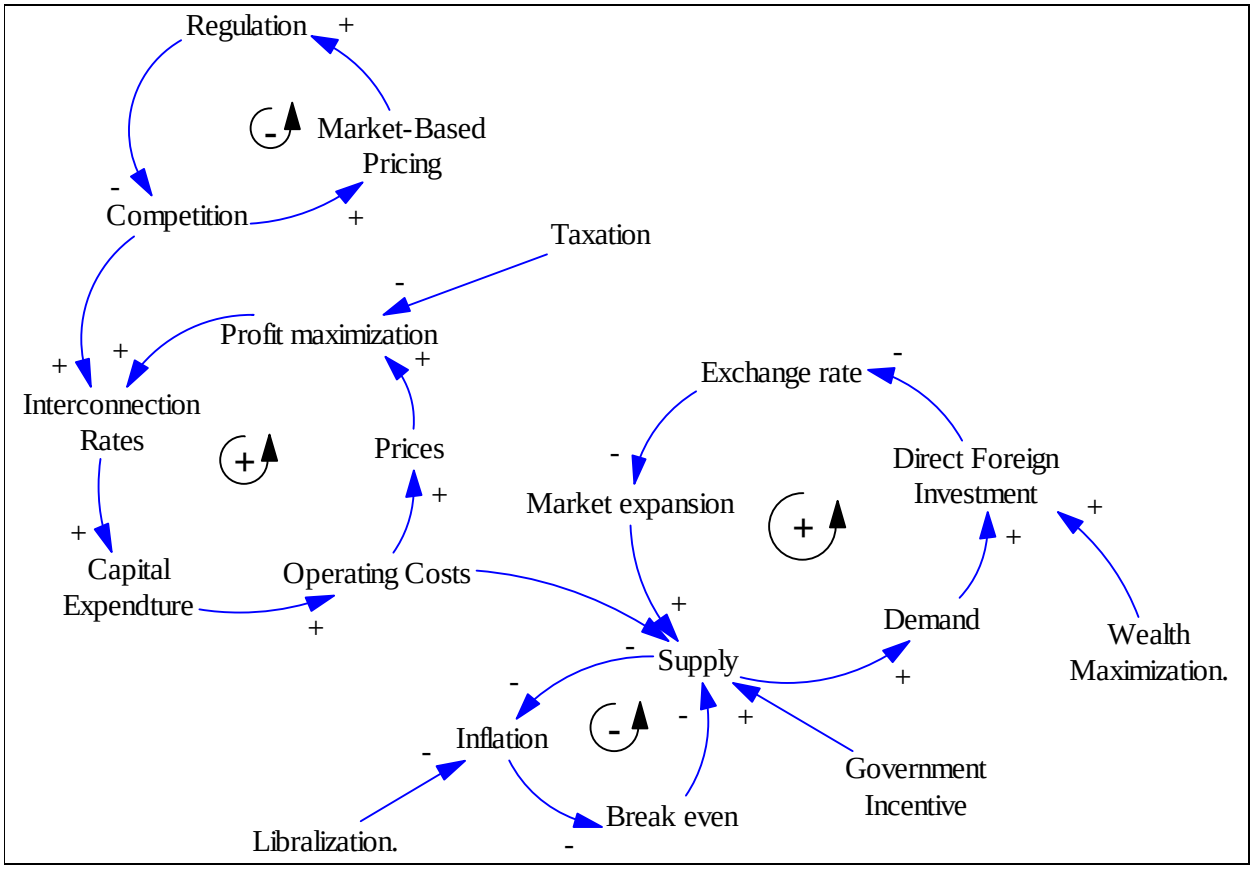

Figure 1: The System Dynamics Pricing Model

of telecom goods and services, hence resulting into a positive loop.

POLICY INTERVENSIONS FOR BETTER PRICES

The model presents four key interventions that can help stabilize prices for telecommunication goods and services. These are 1) Taxation, 2) Liberalization, 3) Government incentives and 4) Wealth maximization as explained below:

Taxation

The government can increase taxes whenever profits go up in a given sector. This is done such that government generates revenues to support other sectors of the economy, and also to provide support for the telecommunication sector through regulation and other administrative issues.

Liberalization

Liberalization is brought into play whenever there is an inflationary situation, where the supply of goods and services is low. The government intervenes by opening up the sector to new entrants who bring in new technologies for improved production and service delivery.

Government Incentives

In addition to liberalization, government can provide investment incentives such as tax holidays, free land among others in order to attract new investors into the sector that is suffering from inflationary situations.

Wealth Maximization

Wealth maximization is the main drive leading to investment in the telecoms sector. When demand increases and with government incentives available, investors are willing to commit their capital into the sector with the aim of accumulating their wealth overtime.

Conclusion and Recommendations

Demand and market based pricing approaches are the significant approaches used to set prices for telecom

munication products and services in Uganda.
Operating costs, forces of demand and supply, foreign exchange rate, inflation and excessive competition are the most important factors that affect pricing of telecommunication products and services in Uganda.
Telecommunication prices in Uganda are not stable, as they are dynamic and therefore need for system dynamic approach.

Governments can apply taxation, liberalization and investment incentive policies in order to check instability and distortions in the prices of telecommunications goods and services, while the key driver for investors is a need to maximize wealth.

Limitations of the Study and Areas for Further Research

This pricing model has been developed from a developing country perspective, where issues such as liberalization, interconnection rates, inflation among others are so prevalent. It may therefore not directly apply in developed countries where some of these variables are not contentious and do not significantly influence consumer and market behavior. It is upon this limitation that we recommend further studies aimed at coming up with similar frameworks and/or models for setting and stabilizing prices in developed countries.

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