International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

D.156

Amendment 2
(09/2012)

SERIES D: GENERAL TARIFF PRINCIPLES

General tariff principles – Charging and accounting in the international telephone service

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Network externalities

Amendment 2: New Annex B – Determination of the network externality premium

Recommendation ITU-T D.156 (2008) – Amendment 2

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ITU-T D-SERIES RECOMMENDATIONS

GENERAL TARIFF PRINCIPLES

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Recommendation ITU-T D.156

Network externalities

Amendment 2

New Annex B – Determination of the network externality premium

Summary

Amendment 2 to ITU-T D.156 (2008) introduces Annex B, which presents a method to calculate the network externality premium.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T D.156	2008-10-30	3
1.1	ITU-T D.156 (2008) Amd. 1	2010-05-21	3
1.2	ITU-T D.156 (2008) Amd. 2	2012-09-07	3

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T D.156

Network externalities

Amendment 2

New Annex B – Determination of the network externality premium

(This annex forms an integral part of this Recommendation.)

B.1 Introduction

The need to take into account network externalities in the development of telecommunications has been under discussion in ITU-T and the regional tariff groups for a number of years. This discussion led in 2008 to the adoption of an appendix to Recommendation ITU-T D.156, the purpose of which is to ensure payment of network "externality" premiums by the developed countries to the developing countries in order to facilitate rapid development of telecommunication networks in the former. The main purpose of these externality premiums is to reduce the digital divide and ensure access for all, as stipulated by Resolution 22 of the ITU Plenipotentiary Conference (Rev. Antalya, 2006). The adoption of Recommendation ITU-T D.156 at the WTSA was conditional on the development of two additional appendices to facilitate implementation. The first of these, concerning prudential measures, was adopted in 2010 at the meeting of ITU-T Study Group 3 in Seoul, Republic of Korea; the second, concerning determination of the premium, on which work has just been completed, is the subject of this amendment.

This amendment focuses on two main points: methodology and an analysis of the results.

B.2 Methodology

Two approaches are considered in this Recommendation. It is necessary first of all to show the existence of network effects by VAR modelling and then to evaluate the associated externality premium.

B.2.1 VAR model

This is done in two stages: unit root tests and Granger tests.

a) Exploring a relationship between the values

The theoretical VAR(p) model used for this operation takes the following matrix form:

$$Y_t = A_0 + \sum_{i=1}^{p} A_i Y_{t-i} + \varepsilon_t$$

where $Y_t = \begin{pmatrix} Inv_t \\ Traf_t \\ Abo_t \end{pmatrix}$ is the vector of the analysis variables, $A_i = \begin{pmatrix} a_{1i}^1 & a_{1i}^2 & a_{1i}^3 \\ a_{2i}^1 & a_{2i}^2 & a_{2i}^3 \\ a_{3i}^1 & a_{3i}^2 & a_{3i}^3 \end{pmatrix}$ is the matrix of the coefficients, $A_0 = \begin{pmatrix} a_1^0 \\ a_2^0 \\ a_3^0 \end{pmatrix}$ is the model constancy vector, $\varepsilon_t = \begin{pmatrix} \varepsilon_t^1 \\ \varepsilon_t^2 \\ \varepsilon_t^3 \end{pmatrix} \sim BB(0, \Sigma)$ is white noise.

In the vector Y, series transformations may be required in the presence of unit roots. The unit root test methodology is set out below.

b) *Unit root test*

A feature of the structure of the telecommunication market in developing countries is the entry of new operators. This brings about a structural break in the economic series used to characterize the sector, particularly investment, traffic and the number of subscribers. This situation is confirmed by the graphical representation of the series (Figure B.1). In the case of structural breaks, conventional unit root tests become unsuitable (Augmented Dickey-Fuller (ADF)) (Perron, 1989). This Recommendation therefore applies the Zivot-Andrews (1992) test, which offers the advantage of incorporating an endogenous breakpoint (structural shift) and testing for the existence of a unit root in the series. Just like the ADF test, this test has three models according to whether the data reflect a break in constancy, in trend or in both. It is the latter model which has been preferred, in other words we base ourselves on the hypothesis that the series may undergo a shift in both trend and constancy. Thus the basic model is written:

$$y_t = \mu + \beta t + \delta y_{t-1} + \theta I_{t>TB} + \gamma(t - TB) I_{t>TB} + \sum_{i=1}^{k} \eta_i \Delta y_{t-i} + \varepsilon_t$$

where TB is the breakpoint date ($1 < TB < T$) and I the indicator function.

The null hypothesis for this test is H_0: $\delta = 1$. When the calculated statistic t is smaller than the tabulated threshold, the null hypothesis is rejected.

B.2.2 Construction of the rule

The known ratios between investment in countries of the South and that in OECD countries are considered. Using the data for these countries, we hypothesize a linear evolution (constant growth rate for the ratio). The equality horizon can thus be determined from the equation:

$$T = \frac{\ln\left(\frac{r_T}{r_0}\right)}{\ln(1+\alpha)}$$

where α is the growth rate assumed to be constant, and r_T is the ratio of investment for the countries of the South and OECD. This expression enables us to determine, for fixed time frames, the growth rate of the ratio r.

Finally, the ratio being equal to 1, the growth rate is obtained as follows:

$$\alpha = \exp\left(\frac{\ln\left(\frac{1}{r_0}\right)}{\mathrm{T}}\right) - 1$$

On the basis of the different ratios obtained, the latter are compared with the actual ratios. The additional investment required to bridge the gap is then estimated. Let r^* be the expected ratio and r_p the predicted ratio (forecast). The additional investment is given by the equation:

$$I_t^* = I_{ocde} \times r^* - I_{sud}$$

The premium is thus estimated as the ratio of additional investment to expected traffic, the underlying assumption being that the additional investment can be funded only by a price increase.

$$\Delta P = \frac{I_t^*}{Trafic_t}$$

B.3 Results

The results are presented in two subsections: we demonstrate, on the one hand, the existence of network effects and, on the other, we attempt to determine the premium.

B.3.1 Existence of network effects

The results of the unit root test are set out in Table B.1. They show that the investment and traffic series underwent a structural break in January 2007 (Figure B.2). The null hypothesis for the existence of a unit root cannot be accepted at the threshold of 1%. However, for the number of network subscribers, the existence of a unit root is admitted at the 1%, 5% and 10% thresholds (the null hypothesis cannot be rejected).

Table B.1 – Unit root test

	Investment		**Traffic**		**Subscribers**	
	ADF (without breakpoint)					
	Trend	No trend	Trend	No trend	Trend	No trend
Level	−2.171	1.787	−3.523	2.808	−2.300	9.334
First diff.	−8.858	−12.200	−11.155	−12.417	−8.107	−7.161
	Zivot-Andrews					
	t-min	Date (break)	t-min	Date (break)	t-min	Date (break)
	−8.397*	Jan. 07	−6.809*	Jan. 07	−3.387	Jan. 06

* 1% significant level

In the final analysis, the investment and traffic series are stationary, taking into account their structural breaks, and the subscriber series (number of subscribers) is integrated order 1 (first-difference ADF test).

Thus, in establishing the vector Y for the VAR model, appropriate transformations have been carried out. The vector Y thus comprises not initial variables but transformed variables.

Before estimating the VAR model, we should first find the optimal lag order (p) in the model postulated. This is done on the basis of the information criteria (AIC, SC, HQ), the likelihood ratio (LR) and the final prediction error (FPE). According to the results (Table B.4), we can estimate the model with $p = 15$. The results of the Granger test (Table B.5) and the first estimates of the model show that we may consider the variable "subscriber growth rate" as exogenous, thereby reducing our model to two endogenous variables.

The VAR model estimates show that an increase in investment has a positive effect on traffic (with a minimum time lag of two months). However, when the traffic in the network increases, this tends to reduce the volume of investment (negative investment growth before 14 months). At the 14th month, there is a positive investment reaction as a result of the traffic generated at the outset (14 months previously). The sustained and positive growth rate in the number of subscribers has the effect of reducing the volume of traffic and investment. Actually, subscriber growth on the network should increase the number of calls. However, the dimensions of the network being limited, not all calls can be completed to their destination. This means that the reduction stemming from the subscriber growth is in fact a loss of traffic that could have been captured if the network had been big enough to absorb all the traffic.

Shock analysis shows that a unit shock on traffic has the effect of reducing investment during the first two months after the shock, while boosting investment overall. The effect of the shock subsides around the 11th month following the shock.

In the case of an investment shock, traffic shows an upturn only after a one-month time lag. The effect of the shock subsides six months after the shock. However, the effect does not cancel itself out, since it is still positive as from the 13th month.

B.3.2 Determination of the externality premium

Growth rates are calculated for time frames of five to 15 years (Table B.2).

Table B.2 – Growth rate by time frame

Time frame	5	6	7	8	9	10	11	12	13	14	15
Growth rate	1.5590	1.1881	0.9565	0.7991	0.6854	0.5997	0.5328	0.4792	0.4353	0.3987	0.3678

Since the growth rates of the ratio are known, investment forecasts have to be provided for these two groups of countries for a 7 to 15-year time-frame. A time frame of five or six years is unrealistic, since this would require annual growth rates of 118% to 156%.

The additional expected investment (support) to attain the desired growth rate can thus be determined.

A summary (Table B.3) of the calculations shows that the increase in tariffs depends on the time frame. The price increase varies from 16.85% (for seven years) down to 4.9% (15 years). The consequences in terms of prices are also shown.

Table B.3 – Price scenarios according to time frame

Time frame (year)	7	8	9	10	11	12	13	14	15
Rate (%)	16.85	13.66	11.35	9.61	8.25	7.16	6.27	5.53	4.90
Former average price (€)	0.1446	0.1446	0.1446	0.1446	0.1446	0.1446	0.1446	0.1446	0.1446
New average price (€)	0.1690	0.1644	0.1610	0.1585	0.1565	0.1550	0.1537	0.1526	0.1517

B.4 Conclusion

We have estimated the tariff premium that will take into account network externalities for the purpose of developing telecommunications infrastructure in developing countries. To that end, we have developed a method based on economic theory and on statistical and econometric instruments.

The analysis shows that the network externality premium provides for an increase of about five per cent, which allows equilibrium to be achieved in terms of infrastructure development over a time frame of 15 years. For a shorter time frame (seven years), tariffs for incoming international traffic from developed countries will need to be increased by 16.85% in order to attain network maturity by the end of the period in question.

Table B.4 – Selection of p

Lag	LogL	LR	FPE	AIC	SC	HQ
0	179.7652	–	4.50e-07	–6.100553	–5.662590*	–5.931189
1	191.1988	19.95687	4.14e-07	–6.189049	–5.422612	–5.892661
2	196.0177	7.885434	4.85e-07	–6.037008	–4.942099	–5.613598
3	206.7972	16.46321	4.62e-07	–6.101716	–4.678334	–5.551283
4	215.1918	11.90515	4.84e-07	–6.079704	–4.327849	–5.402247
5	218.0988	3.805509	6.27e-07	–5.858139	–3.777812	–5.053660

Table B.4 – Selection of p

Lag	LogL	LR	FPE	AIC	SC	HQ
6	221.7929	4.432884	8.01e-07	–5.665197	–3.256397	–4.733694
7	225.0618	3.566016	1.06e-06	–5.456791	–2.719519	–4.398266
8	234.4310	9.198867	1.16e-06	–5.470217	–2.404472	–4.284669
9	242.7634	7.271919	1.35e-06	–5.445941	–2.051723	–4.133369
10	251.3796	6.579693	1.64e-06	–5.431987	–1.709296	–3.992392
11	266.9492	10.19099	1.63e-06	–5.670881	–1.619717	–4.104263
12	276.8385	5.394141	2.17e-06	–5.703217	–1.323581	–4.009577
13	326.2651	21.56796*	7.69e-07	–7.173275	–2.465166	–5.352611
14	371.0779	14.66604	3.91e-07*	–8.475562	–3.438980	–6.527875
15	398.7258	6.032271	5.28e-07	–9.153667*	–3.788613	–7.078957*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Table B.5 – Exogeneity test

Dependent variable: LINV

Excluded	Chi-sq.	df	Prob.
LTRAFIC	35.73	15	0.002
DAB	27.92	15	0.022
All	75.51	30	0.000

Dependent variable: LTRAFIC

Excluded	Chi-sq.	df	Prob.
LINV	29.30	15	0.015
DAB	18.33	15	0.246
All	50.57	30	0.011

Dependent variable: DAB

Excluded	Chi-sq.	df	Prob.
LINV	15.34	15	0.427
LTRAFIC	23.98	15	0.065
All	45.73	30	0.033

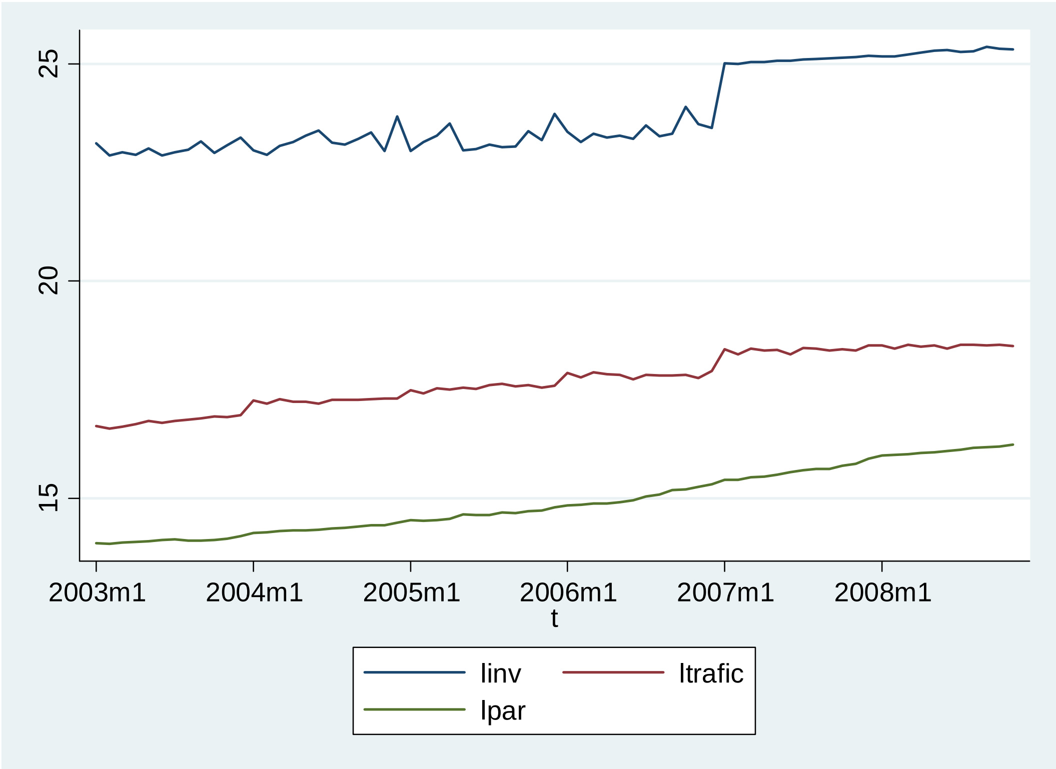

Figure B.1 – Time series of values analysed

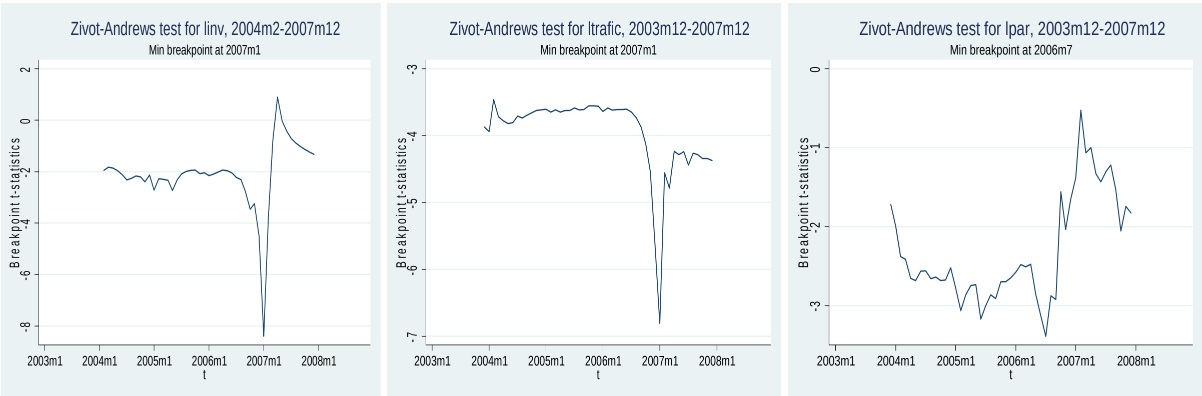

Figure B.2 – Zivot-Andrews test

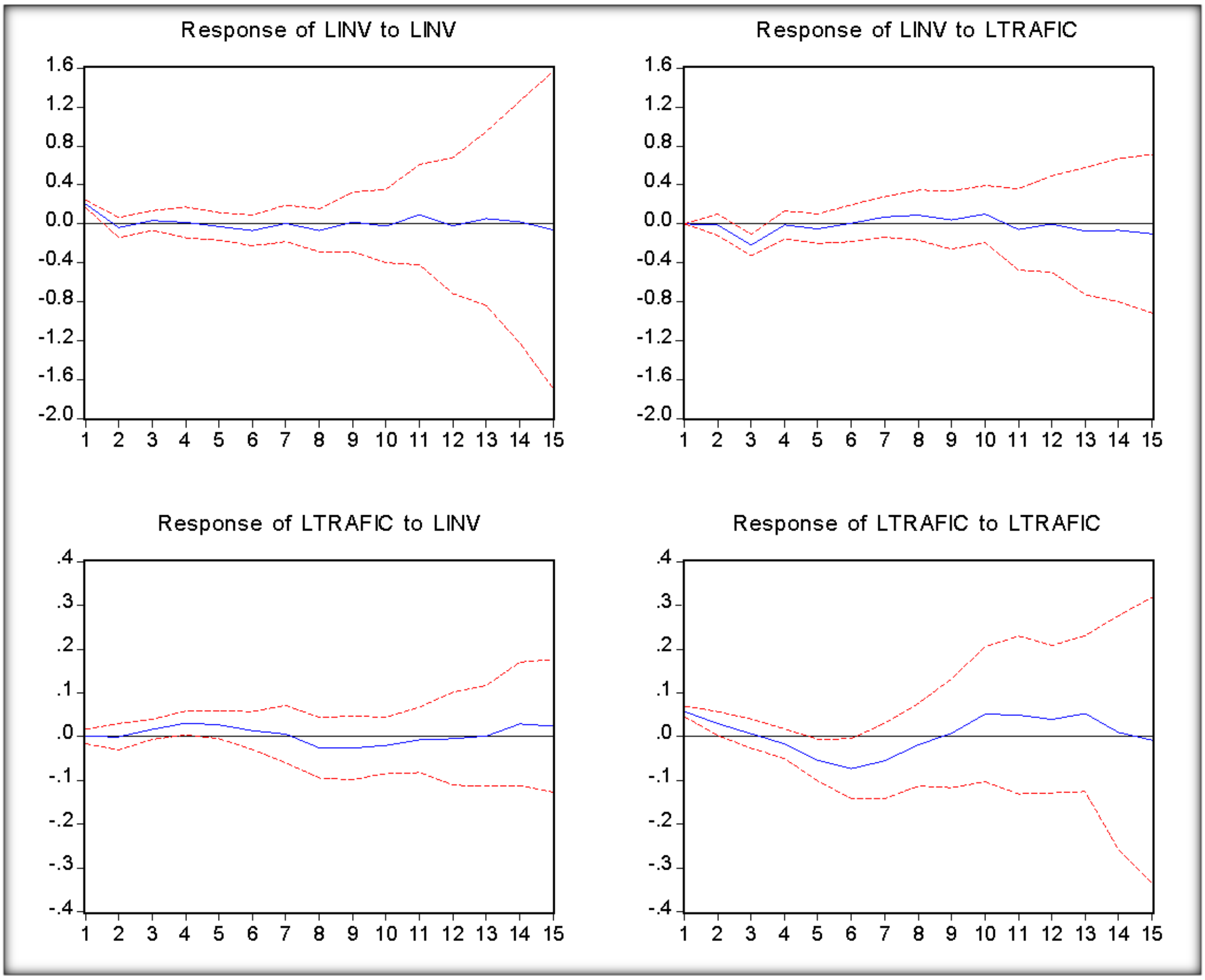

Figure B.3 – Shock analysis

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Series A	Organization of the work of ITU-T
Series D	**General tariff principles**
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
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