

Telzed Limited

Bottom Up Cost Models

Issues and options – a discussion paper

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Bottom Up Cost Models

Issues and options

October 2014

A discussion of some issues that are related to Bottom Up cost models

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Important note

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1 What are BU cost models used for?

1.1 Background to the paper

Bottom Up (BU) cost models have been widely used in the telecoms industry to help define the costs of services. The first such models were made well over 10 years ago and BU methods have developed over time. The use of BU models has also increased: many regulators now use or have considered using BU models. Some operators have also made BU models, but the prime driver for BU has been the telecom regulators.

This Telzed report discusses the use of BU models and highlights some issues with BU models. The report does not discuss BU methods in detail nor does it discuss other cost analysis methods – an introduction to these alternative methods can be obtained from the Telzed paper “Options to evaluate telecom products’ costs and profits - Guidance for selecting and building systems” This is available on the Telzed web site.

The purpose of this report is to stimulate debate and action in the cost-modelling community to ensure that appropriate cost models are developed and some of the potential mistakes are avoided. To achieve this aim, some of the key issues are highlighted below and some dangers of improper modelling are discussed. The approach is intended to be slightly provocative. The paper covers only some of the issues, and even then only in brief; it is not a comprehensive discussion of BU models.

For more understandings of BU models and how they may be used along with or instead of other cost model approaches, then please refer to regulatory papers on cost models or (even better) contact Telzed.

1.2 Defining a Bottom Up model

BU models are analysis tools that build up the total costs of a telecoms business or telecoms services based on many inputs of different cost elements. The number of these cost elements are defined by algorithms within the model that specify how many cables, the capacity of transmission systems, the number of switches needed etc. These numbers vary with customer or service volumes and so they usually vary over time. The costs of the systems are defined by the equipment numbers and their prices (both of which may change over time). Additional costs are added for operational staff, network planning staff, for repairs, for power, for building space and for supporting staff costs. Business management costs are also usually added in.

The total costs are then assigned to the services, based on the cost drivers – access service drive up the number of access copper or fibre cables, but voice calls do not. Voice calls drive up the costs of switches and transmission. This enables the costs of each service to be calculated based on a cost-causation principle.

BU models can be made flexible: volumes and cost data can be adjusted to reflect different technologies and network designs. This allows alternatives to be analysed and optimal solutions to be analysed.

The costs are processed so that the economic average costs of one-off capital and on-going costs are combined. This can show the average costs of a service over time or else the evolution of costs in each year over time.

Most BU models are made in Excel spreadsheets though some parts of the analysis may use other IT systems. The model combines the small inputs and so builds, “bottom-up,” the total cost.

BU model cost data is typically used for assessing other cost data or to help set prices that are cost oriented: cost plus an X% margin.

BU models have many benefits and also some inherent weaknesses.

The economic output from a BU model is similar to that provided in discount cash flow models, though the processing used in the model usually looks quite different.

1.3 Top Down models are often considered as an alternative

BU models are often contrasted to models that start with accounts data. Accounts have the actual costs incurred in a past period, and the values can be audited. A top down (TD) model allocates the account costs to the services. The rules for this are well developed and service costing methods are similar the methods used in BU models. However the input costs are not built up from small inputs and algorithms, but are derived by cost-splits and allocations from accounts data.

Capital costs are annualised and combined with and on-going costs to give the average cost per service in a specific time period.

By definition a TD model uses the costs in a past period and so they might be questionable for forward looking business decisions: what are the costs next year or the year after? The values can still be of use and TD models *are* used for defining service costs and for pricing services, in much the same way as BU models results are used. Many methods can be used to adjust the TD data to reflect average future costs or to help inform price decisions. Capital asset values can be adjusted to reflect current or future values, volumes can be adjusted, costs can be changed to reflect better operations, costs may be directly varied by the volumes (this leads to incremental cost calculations) etc., and such adjustments make the values more valid for decisions.

TD models are also central to Regulatory Accounts that show the performance of the business. These Accounts show the margins met by services, sub-markets within the overall telecoms industry or the margins of operational business units. These provide useful insights to the markets and regulators commonly specify them to help assess market outcomes or to help with price controls.

TD models have strengths and weaknesses. These are mostly different to those of BU models.

1.4 Choice of model and the use of BU models

There is no one model type (BU or TD or combined BU/TD methods) that provides a solution for every requirement. One is not inherently better than the other. The choice depends in the situation and the types of insights and data that are required. Sometimes BU is preferred and

at other times TD. Sometimes both are used or combined. Sometimes other cost analysis methods might be used. Price setting might use neither method.

The choice depends on (amongst other things) the questions to be answered, the required accuracy, the existence of source data, skills available, and the time and resources (budget).

It is noted that the use of BU models seems to have increased over time. This is partly because more skills are available to make the models and also there is some evidence that regulators have recently tended to choose these models more often and recently seem to have taken less interest in using TD models, even when they already exist. A further incentive to use BU models was provided by the EC 2009 Recommendation for call termination calculations that specified a BU model that defines the pure LRIC¹ of call termination. This gives a type of marginal cost analysis that has led to lower voice call termination prices compared to the “full LRIC methods” used in the past². Other countries outside the EU have considered the use of pure LRIC and/or the use of BU models for call termination and for other services.

The proliferation of BU models, and some issues that seem to arise from their use, mean that it is timely to examine how BU models are used and made, with an accent on the issues and problems.

¹ Long Run Incremental Costs – the average cost over time caused by the service's volume or “increment”

² It is probable that many EU mobile terminations were then not really LRIC based as the values varied so much - the variations could not be clearly explained by national cost-factor differences

2 What are the questions to be answered?

2.1 What model (if any) is needed?

BU models are useful but they are only useful for some questions and in some situations. A key issue that seems to be sometimes forgotten is: what are the overall aims and what are the key questions to be answered? Regulators (and operators) need to stop and think carefully about the overall aims. What is the strategy and what are the ways to achieve the desired outcomes. This leads to considerations of the information required for decisions and *then* modelling options can be considered. Quite possibly cost models are not needed at all. If cost analysis is required, then; is a BU model the best approach?

Unless the aims and directions are clear then “any” model might be a good approach.

The best approach depends on many factors. A country with limited competition or emerging markets will have different needs to a highly competitive and mature market such as in Western Europe. What is good in the short term might not be the best solution in the longer term. What is best depends on the view taken by the parties – incumbent, alternative operators, fixed versus mobile operators, consumers, investors, and governments.

This means that copying what was done elsewhere, without a full consideration, might lead the wrong approach.

2.2 Is a BU model the best approach?

Assuming cost analysis is required (and this does not necessarily mean cost-based price controls) then, is a BU model the best approach? Many analysis methods are possible. TD models may exist – could they be used? Are they better or adequate in the local situation?

The best approach is not easy to decide upon and needs a comprehensive review. This paper cannot cover all of the decision issues and the options. It is noted that perhaps full considerations are sometimes not being given and “simply” choosing a BU model is being taken as a first option in some situations. There are some dangers in this approach and these that might not become apparent until the model is being developed. However telecom regulators wish to be seen as authoritative and knowledgeable, so any later changes to another method or any admissions that BU was not the optimum solution, might not occur.

Choosing BU models along with other methods or on its own, requires a full understanding of the wider issues and also an understanding of the alternative approaches: how else can BU models be chosen (instead of TD for example) unless the strengths and weaknesses of each are understood? What are the links between both?

Once a BU choice is made then other choices are required on the detailed BU methods and how the BU model fits with the wider aims.

2.3 Keep politics and modelling separate but know how they are linked

Cost models are open to bias. Some rules can be specified in advance and these economic criteria provide a guideline. If very well defined, then two separate modelling teams ought to produce roughly similar outcomes. In practice many assumptions can be adjusted that will vary the outputs. The assumptions used depend on the situation and these can be linked back to wider political or strategic requirements.

Wider national issues and politics may encourage high or low prices the help encourage one outcome or another. This is quite legitimate: e.g.:

- In some countries maintaining high wholesale leased line prices encouraged alternative operators to build networks and not lease capacity
- The EC specified 8-10€ per month for wholesale copper costs in the 2012 NGA non-discrimination Recommendation
- In the 2009 EC call termination Recommendation, the desired outcome was a low price, as a possible stepping stone to bill and keep.

These outcomes do not really require a cost model at all – the prices could be set in other ways, and in the case of call termination, pure LRIC BU models were not really required to give a low value³. A similar outcome (similar price and similar economic results) could have been obtained without a BU model. In addition, arguably the BU models in the EU might not have been used independently. Observations of the results suggest that some results might have been “chosen” or “adjusted” – how else could they give such a consistent Mobile termination Rate (MTR) outcome (see footnote)?

These discussions do not mean that political or other economic biases are not legitimate. They are useful and can be legitimate. However using a BU model to give such a pre-defined outcome tries to wrap the outcome in a “cost-model legitimacy.” This is a questionable approach.

If a type of cost is deemed to be good for economic reasons, then the recommended approach is to define that cost using sound methods (BU, TD or other), and not to then bias the calculation to give the answer that was preferred in the first place.

³ At the risk of being provocative, it is unlikely that all the pure LRIC cost models and resulting mobile call termination rates (MTR) are really being set independently. The BEREC MTR Snapshot report for 2014 shows some tendency for many countries to have a MTR close to 1.1€c. It should stretch the credulity of most observers that so many highly diverse countries can really have the same cost base. Are UK costs really almost the same as Bulgarian costs? That said, *perhaps* an outcome of ~1.1€c *is reasonable* from an economic or political view, but this is very different from believing the costs are all so similar

3 Doing a BU model properly

Assuming a BU model is a good approach then it is only sensible to do it properly and to also make use of other data, if available, to make the BU model as good as possible *for the intended purpose*⁴. As noted above, having the aims and also economic criteria specified in advance are sensible. Public consultations and the involvement of all parties is recommended. If the purpose is just to “get general insights” or else to encourage some action by operators then a different BU model is required to one that is to be used for critical price controls.

In the following, a number of insights and comments are made to help BU developments. These are not exhaustive – they are just some examples. Some are also included to provoke further thought. The order is not related to the importance.

Include the industry

Few things give confusion and lack of support more than not being clear about what the model is for, how it is to be made and how it is to be used. Deciding on how the model will be used “once the results are obtained and examined,” is clearly an unsatisfactory statement. Consult openly from as early as possible. The discussions have to explain if and why other models or methods are not to be used. For example, “Accounts include inefficiencies” is not a satisfactory/sufficient answer for excluding TD models or other TD derived data⁵.

Define the criteria at the outset

Define the type of costs and the economic methods. A BU model should be a principled approach, not a model that “simply” aims to come up with a high or low value.

Do not simply copy a model or the approach from elsewhere

Though most models are derived from others, a model that is for one country or to meet one regulator’s needs probably does not fit with another’s. This is most apparent when special aspects are to be included: islands, desert areas, mountains, local staff obligations etc. Most models need to have a lot of bespoke factors that are unique to the country and the operator.

Just because a model was used successfully in another country, it does not mean it was a good model and a good outcome. This is not something that will be easy to validate – BU projects are unlikely to be openly admitted to be flawed, at least by a regulator.

⁴ Some purposes do not require a very thorough or robust model. Some purposes do require a very thorough approach

⁵ Historic accounts naturally will include past inefficiencies, if they existed. It should also be clear that this may or may not be a problem

Know when to use or not use BU models

If the service does not exist or it is very detailed (such as colocation services) then BU models are more obvious solutions. However TD models can still be used in such calculations⁶ to provide some values. TD cost allocations to small services are fraught with problems⁷.

Know the limitations and risks

Services such as interconnect are two way services and most traffic partly or mostly balances. The net impact of too high or too low a cost calculation is not too severe. Of course there is cash flow involved, but the overall outcome of huge mobile traffic growth and penetration is seen globally no matter if MTR is zero, very low, roughly LRIC+ based or very high. There *is an optimum* MTR (or fixed termination rate) but the exact value is not clearly at the peak of a rapidly changing function. A full LRIC value is a default value that, even if not optimum, will rarely cause major harm compared to a more optimal value. Of course the optimum from a *cash flow viewpoint*, for each party in the industry, is not the same.

The contrast to two way services is when the services are one way – wholesale access services such as unbundled local loop, leased lines and broadband access. There is no reverse market of similar services bought back in. In this situation it is critical that the costs are recovered and/or prices are set sensibly. 10% errors in a model could lead to 10% under-recovery. 40% too much costs could bias the market development in other ways.

With broadband fibre costs being an emerging service, this leads to a belief that BU is the best or only way to approach the price controls. After all, the costs are not yet in the accounts with any realistic level of volumes. The risks from any calculations (BU or TD derived), should be obvious. Huge risks exist and these means the whole national market outcome pivots on a “few pages of Excel modelling” and some consultants’ assumptions. BU models may have a role to play but this needs very careful thought. The EC NGA non-discrimination Recommendation noted alternative approaches. Cost models are not always the best solution or need to be combined with other analysis.

Do not use a BU model for purposes it was not intended for

A model might be developed for LRIC+ costs based around 2013/14 volumes. Using the same model for marginal costs or for volumes that are three times greater, has risks. A load of adjustments are required. The design algorithms are only “some Excel formulae” and cannot compensate for a team of engineers who each have 10+ years’ experience. Engineers design real networks. For example:

- Are system modularities properly modelled? The required accuracy in a full average service LRIC model and to measure small cost changes are different
- If volumes increase a small amount then new investments might be suddenly required. This can create anomalies if the model is not used as intended.

⁶ If that is not obvious, then please contact Telzed

⁷ “Heroic” allocation splits are needed. Contact Telzed for further explanations if required

Many factors need to be adjusted if the model is used for other purposes, in other countries and with operators other than originally intended.

Know what really matters

BU models of Next Generation Access are arguably the most critical current application. Certainly all of the cost elements need to be carefully defined. The huge uncertainties are the take up of customers and the roll out (coverage and availability) of the FTTx. If these are uncertain (and they usually are) then it makes other details somewhat specious. Evidence from the EU data⁸ (and other countries) shows that NGA take up significantly lags the availability. The net impact on costs and cost-based prices is huge.

There are ways that this can be dealt with, but the thinking required moves beyond “simple” BU modelling and details like “getting manhole numbers and costs accurate” become almost irrelevant.

This does not mean that BU models can ignore the accuracy of smaller assumptions on the grounds that only a few major assumptions dominate. In most models the many details *do* matter and need to be addressed. A due perspective is required in other models and when making decisions: the risks and the “error bars” on the results must be understood.

Beware of any model that is not released to operators and other parties

A BU model is complex. They are error prone. If there is not the confidence to give copies to the operators or to publish it fully (e.g. Sweden), then this raises questions. If you cannot trust a review by the operators, other consultants and other parties, then perhaps the model is not solid enough to be used at all.

Opex costs are notoriously difficult in BU models

Many BU models include operational costs as a percentage of the capital equipment values. This is a convenient calculation method. The real issue is how to define the opex value in the first place and hence specify the percentage accurately (and adjust this if the equipment price alters since the opex probably does not change much as a result). If a data request to operators is: “Please define the opex of a hand-over distribution frame as percentage of the capital value” or “Please define the opex of fibre cable as percentage of the capital value,” then probably something is wrong. Defining opex this way is almost meaningless to most operators. It also shows the modelling team do not understand the issues and have not specified opex properly. It is complex to define and needs careful definitions. Once this is done, then eventually this can be defined as a percentage to use in a model.

Operational costs need very careful specifications and calculations. A number of approaches are possible.

⁸ E.g Digital Agenda 2014 trends in broadband markets: <https://ec.europa.eu/digital-agenda/en/news/scoreboard-2014-trends-european-broadband-markets-2014>

Asking “What is the average annual cost of a technician” is also a sign that the BU approach is flawed. It might be a useful input to a model, but the question is more like: how long is a piece of string? *Much* more definitions are required in the opex specification.

It is insufficient to ignore actual costs *just* because an operator might be inefficient

Efficient costs are a desired outcome from many BU models. Data from an operator might include some inefficient operations (no business is perfect). In itself, this not a sufficient reason for totally ignoring the values. The onus is probably on the modelling team to show/prove the levels of inefficiency. Unless this is possible then there is no way to justify any other value. Furthermore the efficient cost value to use must be achievable. Many countries have legal, social, or historic-legacy related obligations that cannot be avoided. Perhaps they must employ former government civil servants from when the company was nationalised. Clearly these are not efficient operations, but if they cannot be avoided should such costs be deleted from the BU model?

Efficient costs are a major area for discussion and analysis. A simplistic view is insufficient. More subtle thinking and more analysis is required. What is efficient in another country is highly likely not to be relevant to another. More complex stochastic frontier analysis etc. may be possible (in theory) but in practice it is not possible for many (most?) countries.

Avoid a make-it-up model

BU models are so flexible, it is possible to model anything from close the actual systems and network structures through to totally theoretical network and organisational designs. This is a key benefit. It however opens up the possibility to modify costs further and further way from the reality of what exists or what is realistically possible for the operator to comply with. This may form a totally unrealistic make-it-up model. Where does a model veer from reasonable adjustments to inappropriate make-it-up results? This is not a clear threshold.

Modified scorched node approaches and network optimisation is fair, up to a point. Somewhere this can cross into fantasy model levels. Some very critical thinking, appreciation of what a model is doing and appreciation of the realities are required. Furthermore there is a transition cost to move from the current to the optimal structure cost – is this relevant and how is it defined?

Consultants versus a team of engineers

BU models are usually made by external consultants, because the skills are specialised. Few regulators or operators have the skills. The modelling has to be compared to the realities of real networks that were designed, built and operated by engineers and technicians. It is a brave consultant to claim the engineering department has grossly over-estimated the network design and made hugely wrong decisions. Networks are never perfect, but engineers’ network designs are unlikely to very far from wrong⁹, especially given the time

⁹ Some exceptions to this can exist

and circumstances when the decisions were made. Arguably the onus is on the modelling team to prove they themselves know more about networks before all of the engineering data is dismissed.

This does not mean modelling the actual network exactly. However BU models have to be careful when changes are made. The changes have to be justified. The author of this paper responded to a BU model of the smallest mobile operator in one country. The BU modelling team could find no justification for believing that the small operator (with strong competitive pressure) could have installed excess equipment or staff, so almost all of the network and cost data from the operator had to be used in the BU model and/or the BU was calibrated so that the totals were similar. The initially unrealistic BU model was adjusted. Certainly more adjustments might be considered for a government-owned fixed incumbent without much competition, but it is still noted that: the engineers were probably not stupid, so BU modelling should be careful when dismissing the submissions.

Calibrate

Unless a BU model fairly reflects what has happened in the past (system numbers and traffic, perhaps subject to some legitimate adjustments), then it cannot predict the future with confidence. This seems obvious but do all BU models do this? What are the justifications from variances from the actual values today?

This matters most for services and equipment numbers that are changing over time.

Are the results realistic?

If a BU model has costs of circa 30% of the actual costs (TD or otherwise derived). Then perhaps a new modelling team is required.

Stories of such outcomes (cost values very far from actual ones derived from the accounts) exist.

Are data submissions realistic?

Ideally many operators should be asked for cost data in order to get a realistic view of the costs in the country/region of the country. If one submission is perhaps 50% or less of another, then:

- Are the values biased by a deliberate desire of the submitter to influence the outcome in a certain way? This can be probed into
- Maybe the data request is not clear. A simple request for; “the average cost of a field technician,” is not sufficient. The costs have to be much more clearly specified or results will not be comparable.

Large variations in submitted values quite possibly mean that something is wrong with the data request. Taking the lowest value or even the average then opens up obvious risks.

Bottom up models are really top down and most top down models are bottom up

It is emphasised that most BU models use (or should use) huge amounts of TD-derived data. Asking for the cost of a radio mast could be met by using a sample price list from a vendor, but this is prone to major errors in the BU results. Looking at 100 actual installations and adding all the additional cabin and land costs that vary by site, will give a more accurate average result. This is really a TD allocation process, derived from accounts.

The cost of a technician is best derived from looking at the full costs of the 500 staff in the field and deriving a realistic average. This is a TD approach. Looking at a single “typical” salary will probably give huge errors. Adding in support (IT and HR) to give a full cost view might be yet more realistic (depending on the BU model approach). This requires some Activity Based Costing and so it is really a TD type of approach, though that calculation is not within the BU model.

Many TD models use Current Cost Accounting. CCA has various approaches, but a common one is to define the current average price of an item and then define how many are in existence. This is then used to adjust the historic accounting values. The adjustments can consider alternative vendors or technologies. This is really a BU model: it uses equipment numbers multiplied by a price.

This accentuates the fact that BU models and TD models are not in opposition, and good versions of each really can and should use many aspects from the other. Also, as both approaches are developed then the results of both can (and should) converge. The gaps must be understood; though they will probably never produce exactly the same result.

Explain the differences

If there is a TD model (FAC, CCA etc) then the onus is on the modelling team to know why the BU model produces different results. The results will be different, but unless proper understandings exist for why values differ, then the BU results cannot be trusted. Efficiencies and optimisations or technology assumptions certainly do have an effect (it is noted that these could be also included to some degree in the TD models), but proper quantifications and analysis of differences are required before BU results can be used with confidence.

Beware of BU complexity

BU models can seem like Excel alchemy. This may be impressive. It also means understanding the approach and carrying out reviews are difficult in some cases. Sophistication might mask weak design assumptions.

4 Conclusions and how to move forward

This report highlights a number of areas that BU modelling needs to address. With the proliferation of BU models and their more widespread use, there are now more “off the shelf models” being offered by specialised consulting firms. Regulators naturally look to other countries, and this increases the use of BU models – if country Y has done this, then it cannot be bad for us. This does not mean that BU is necessarily the best solution nor does it mean it is truly wrong. What is required is a proper approach that addresses the key issues. Doing a poor model is surely a bad outcome.

To address the issues and do an appropriate model requires proper consultations, analyses and interpretation of the results. Saving money by using an off-the shelf model that consultants want to re-sell from another project, might seem attractive. It is recommended that if a BU model is done then it should be done properly¹⁰. Model re-use is good but it has dangers.

There are many types of cost analysis and regulatory controls. Certainly BU models have a role to play. Other approaches also have a role. TD modelling is one option among many. The other models should not be considered to be in opposition and inherently wrong, just as BU models are not inherently better (or worse!) than others such as TD. Full appreciation of the different approaches is required.

BU models may be something of a current fashion in the regulatory world. It is recommended that additional care is taken before choosing BU models and even more care is taken in the BU development.

Telzed is available to help with any aspect of BU or other modelling or to assist with regulatory strategies and decisions.

¹⁰ A simple/quick model is certainly suitable for some *insights*, but if the future wholesale or retail prices for FTTx are to be set, then a more complex approach is required

5 Next steps and notes about the author

All parties involved in BU models should consider how the models are developed and what the requirements really are: step back and consider if a BU model is appropriate and then to move forward in a more measured manner. This might avoid some of the problems that seem to arise.

Informed discussions should help the process. Telzed is available for such discussions. Telzed is also able to help build BU models or respond to a BU project. Telzed can also build and analyse TD models and regulatory accounts. Telzed can help with the consultations and to define the strategies and required decisions.

The author of this paper has worked in many BU model projects. R Steele has led BU model teams, including the team that built the initial versions of the Swedish fixed model. This has evolved, but after over 11 years, the current version is still structurally similar to the original version. The approaches used there have surely been adopted into many other BU models. The Swedish approach included the industry and the publication of the model, and this can reasonably be considered a practice that others should try to emulate.

R Steele has reviewed other BU models. He has also helped operators respond to BU data requests and public consultations. He has developed regulatory accounts and many TD models (FAC, CCA and LRIC) for fixed and mobile operators. He has run training courses and workshops on costing and cost models.

The author has an unusual background. As well as BU modelling and economic experience he has also extensive regulatory accounting and TD modelling experience. Furthermore he is a Chartered Engineer and has worked as a telecoms engineer.

Telzed welcomes any enquiry. This need not be limited to BU or TD models. Please see the Telzed web site for more information about the Telzed services and skills areas.

