

Consultation on amending variable demand modelling advice in WebTAG and for further research into the use of elasticity models

Foreword

The Department has recently released guidance on variable demand modelling as WebTAG 2.9 and 3.10 (June 2006) which indicates, among other things, that simple elasticity models should not be used to estimate variable demand modelling responses. However, it suggests that simple elasticity models may be used to narrow down scheme options before a full variable demand model (VDM) is used to establish more detailed effects of the schemes (WebTAG 3.10.3, Paragraph 1.2.4).

Work was commissioned by the Department in March 2006 to look into the validity of this advice in the context of option sifting. The study investigated whether simple elasticity models could be used as a proxy model when the fully-specified VDM model would take a long time to run, and a large number of exploratory option tests are required. The research concluded that elasticity models may be used to help rank options to assist in scheme selection, with the proviso that sufficient model convergence is achievable. The report also went on to make a number of recommendations in amending the current guidance.

This consultation invites you to comment on the recommendations proposed and the Department's response.

Executive Summary

It has long been acknowledged that elasticity models cannot recreate changes in trip lengths which are forecast by trip distribution models, and will not represent mode shift or time-period choice effects adequately. In light of this, in 2004 prior to publication of the variable demand modelling advice, the Department commissioned TRL to assess, among other things, what impact these shortcomings have on appraisal of schemes and their reliability.

The initial outcomes of the research suggested that simple elasticity models may significantly overestimate the effect of variable demand responses on scheme benefits, giving an overestimate of reductions from fixed trip matrix appraisal benefits. This implies that simple "own-cost" elasticity may not be looked on as a simplification of multi-stage model since the scale and distribution of benefits will be very different where both forms of model have been adjusted to give the same fuel-cost elasticity.

Based on this initial outcome and pending further research, the Department changed its guidance to recommend that a simple elasticity should not be used to model the full effect of variable demand.

In March 2006, the Department commissioned work to establish whether a customised simple elasticity model could, in some situations be safely used as a proxy model when the fully-specified VDM model takes a long time to run and a large number of exploratory option tests are required. The aim was to establish how good elasticity models are in ranking competing/alternative scheme options in order of scheme benefits by demonstrating whether ranking from a fully-specified VDM model is reproduced by the simple elasticity model.

The main conclusion was that whilst the economic benefits calculated using elasticity models are reasonably close to those using VDM, it cannot be concluded that they always mimic the same ranking of scheme benefits. The work concluded that where benefits of options differ by less than 30%, it would be difficult to use elasticity models to sift options. It was recommended that the exponential should be used over the power function for option sifting as they give a closer result to VDM in terms of economic benefits than the power elasticity model. The study also confirmed that scheme benefits depend highly on levels of convergence achieved in the demand-supply modelling. Difficulties were encountered in achieving WebTAG (TAG Unit 3.10.4) convergence criteria in terms of %Gap and Stability Ratio with respect to levels of user benefits. Based on some of the difficulties that arose from the study, a number of recommendations were also made to amend the guidance to aid in the development of variable demand models.

Following the completion of the study, the Department is now formally seeking any views on the recommendations made in the report and the Department's response to these recommendations.

A copy of the final elasticity report (Use of Elasticity Models to Model Variable Demand) can be found on the Department's website.

How to Respond

The consultation period will run until Friday 21st September 2007, please ensure that your response reaches us by that date. If you would like further copies of this consultation document it can be found on the WebTAG website or you can contact Frederic Oladeinde. Please send consultation responses to

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When responding please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of a larger organisation please make it clear who the organisation represents, and where applicable, how the views of members were assembled. The information you send us may need to be passed to colleagues within the Department for Transport, and published in a summary of responses received in response to this consultation

Freedom of Information

According to the requirements of the Freedom of Information Act (2000), all information contained in your response to the consultation may be subject to publication or disclosure. This may include personal information such as your name and address. If you want your response or your name and address to remain confidential, you should explain why confidentiality is necessary. Your request will be granted only if it is consistent with Freedom of Information obligations. An automatic confidentiality disclaimer generated by your email system will not be regarded as binding on the Department.

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The proposals

Introduction

The Department has recently released guidance on variable demand modelling as WebTAG 2.9 and 3.10 (June 2006) which indicates, among other things, that simple elasticity models should not be used to estimate variable demand modelling responses. However, it suggests that simple elasticity models may be used to narrow down scheme options before a full variable demand model (VDM) is used to establish more detailed effects of the schemes (WebTAG 3.10.3 Paragraph 1.2.4).

Simple elasticity models assume that travel demand for each OD-pair depends on the cost for only that OD-pair. The change in cost can take a number of forms, the most common of which are the power and exponential formulations. DMRB 12.2.2 (now withdrawn) recommended the use of the power formulation (when it is acceptable to use simple elasticity models) because it is considered well-behaved and simple. A key property of the power function is that it assumes that a proportionate change in trips is related to a proportionate change in costs.

For the exponential formulation on the other hand, the effective elasticity increases with increasing trip cost, which results in a range of elasticities where there is a wide variety of trip lengths. Consequently, DMRB 12.2.2 recommended that this should only be used where the study area is small and urban and where an elasticity approach is being combined with a logit choice mechanism to jointly represent individual demand mechanisms.

However, it has long been acknowledged that elasticity models cannot recreate changes in trip lengths which are forecast by trip distribution models, and will not represent mode shift or time-period choice effects adequately. In light of this, in 2004 prior to publication of the variable demand modelling advice, the Department commissioned TRL to assess, among other things, what impact these shortcomings have on appraisal of schemes and their reliability.

The initial results of this research suggest that simple elasticity models may significantly overestimate the effect of variable demand responses on scheme benefits, giving an overestimate of reductions from fixed trip matrix appraisal benefits. In summary, simple "own-cost" elasticity may not be looked on as a simplification of multi-stage model since the scale and distribution of benefits will be very different where both forms of model have been adjusted to give the same fuel-cost elasticity.

Based on the initial outcome of the work by TRL and pending further research, the Department recommended that simple elasticity should not be used to model the full effect of variable demand.

The Elasticity modelling research findings

In March 2006, further work was commissioned to establish whether a customised simple elasticity model could, in some situations, be safely used as a proxy model when the fully-specified VDM model takes a long time to run and a large number of exploratory option tests are required. This should establish how good elasticity models are in ranking competing/alternative scheme options in order of scheme benefits by demonstrating whether ranking from a fully-specified VDM model is reproduced by the simple elasticity model.

The study looked into whether simple elasticity models could be used as a proxy model when the fully-specified VDM model takes a long time to run, and a large number of exploratory option tests are required. The study compared economic scheme user benefits using simple elasticity models with those from fully-specified variable demand models.

Two different models were used in the investigation: a model of an urban area with an average trip length of about 15 km and a much larger model with average trip lengths of about 45 km. The urban model was used with three similar schemes for testing three demand modelling regimes: full variable demand, power elasticity and exponential elasticity. The larger model was used with six different schemes and the same demand modelling regimes. The variable demand models and the elasticity models were all calibrated to a fuel cost (veh km) elasticity of approximately -0.30. The study demonstrated that elasticity models may be used to help rank options to assist in scheme selection, with the proviso that sufficient model convergence is achievable. The report also stated that guidance should recommend a range of accuracy for benefits from elasticity models, compared with VDM, of say $\pm 30\%$.

The main conclusion was that whilst the economic benefits calculated using elasticity models are reasonably close to those using VDM, it cannot be concluded that they always mimic the same ranking of scheme benefits.

During the work it has been acknowledged that good convergence of both assignment and demand models is required to achieve accurate results, and hence robust conclusions. With both models a large amount of effort was spent achieving convergence levels that exceed targets set out in DMRB 12.2.1 for assignment and in WebTAG (TAG Unit 3.10.4) for demand models. The convergence achieved for assignment was more than ten times smaller than the DMRB recommended assignment gap of 1% and demand model convergence gap, were at most half of the WebTAG target and in many cases much lower. These convergence levels were achieved by running the models for many more iterations than would be usual for typical scheme appraisal projects and many runs took a number of days to complete.

Despite the effort put into achieving very tight convergence levels, the stability ratios (% network benefits / % gap) did not always achieve the target of 10 recommended in WebTAG (TAG Unit 3.10.4) This experience is being commonly found as scheme benefits are likely to comprise a small proportion of network costs where the network needs to cover sufficient geographical area to encompass reassignment and variable demand responses. Benefits as a proportion of network costs may be well below 1%. The work has demonstrated that in real scheme / model applications it may be very difficult or impractical to achieve the WebTAG stability ratio target.

During the course of the work some model runs were set up to run to a certain convergence level, and then extended for improved convergence levels. The

changes in benefits were examined and found to be small even though the WebTAG stability ratio target was not met.

It was also concluded that a large geographical area has implications for the calibration of elasticity models in particular (especially the exponential model), as the sensitivity of traffic to fuel cost varies according to trip length. It was concluded that the approach adopted in the research to calibrate elasticity models to VDMs be reviewed and the following questions considered in further depth: (a) When using vehicle kilometres as a calibration measure, should more emphasis be placed upon the fuel cost elasticity in the scheme corridor rather than across the entire network? (b) How should the fuel cost elasticity (which is calibrated on NTS trip length and purpose data) reflect differences between NTS trip length distribution and purpose mixes and model trip length and trip purpose mixes?

Implications for Guidance

The report stated that with the proviso that sufficient convergence is achievable, elasticity models may be used to help rank options to assist in scheme selection. The report proposed that the guidance should recommend a range of accuracy for benefits from elasticity models, compared with VDM, of say $\pm 30\%$. It stated that within this range it would be wrong to assume that the ranking of benefits using elasticity and VDM models would be the same, and thus wrong to exclude an option based on economic benefits alone.

The report also stated that the current guidance on assignment convergence in DMRB 12.2.1 is too lax. As a well converged assignment model is a pre-requisite for producing accurate scheme benefits, the report proposed that the convergence targets should be tighter, with a target % gap of about ten times lower than currently recommended and correspondingly more stringent targets for model stability.

It was agreed that the existing targets for demand model convergence (0.2% gap) should be achievable in practical applications (with tighter assignment convergence). However, exceeding a target of 0.1% requires long model run times which may be impractical in scheme applications. A firmer target of 0.15% gap was proposed, though the guidance should still encourage users to exceed this.

The target for stability ratio of relative benefits / convergence gap was claimed to be unachievable in many practical applications. It was concluded that a new method needs to be developed for monitoring the difference in benefits with increments in convergence so that the accuracy of the results can be assessed.

Recommendations to be considered

There is a need to update the Variable Demand Modelling Advice (TAG Units 3.10) and to commission further work to ascertain how elasticity models should be used. The following have been recommended with the DfT's proposed action in italics.

1. The consultants suggested that the guidance should recommend a range of accuracy for benefits from elasticity models, compared with VDM, of say $\pm 30\%$. *The DfT as a result of the elasticity work concluded that where benefits of options differs by less than 30%, it would be difficult to use elasticity models to sift options. However, where the benefits differ by more than 30% elasticity models could be used. The DfT will give this recommendation some further thought and consider how to reflect this in the guidance.*

2. It was concluded that further work is required to review the WebTAG guidance on convergence and stability ratios, with practical methods found to demonstrate that sufficient convergence levels are achieved. *The DfT will drop the guidance on the stability ratio target of 10 as other measures such as the gap percentage and assignment convergence should be sufficient to ensure robustness of VDM results. However, the Department will carry out further research to find a better way of monitoring the difference in benefits with increments in convergence so that the accuracy of the results can be assessed.*
3. It was suggested that the convergence target in the assignment should be tighter, with a target percentage gap of 0.1% minimum. *The Department will amend the advice on assignment convergence in DMRB 12.2.1 to reflect a gap value of 0.1% minimum. This is based on the findings of the Motts/F-M and other work, that 0.1% is desirable to get good demand-supply convergence. Evidence also suggests that, while the target is challenging, it is within reach of most models.*
4. It was also suggested that the existing targets for demand/supply model convergence should be moved to 0.15% as exceeding the target of 0.1% sometimes requires long model run times which may be impractical in some scheme applications. *The Department will change the demand convergence to 0.15%. The range of 0.1 - 0.2% acceptance gap value will be removed from the VADMA guidance.*
5. It is expected that guidance will continue to recommend VDM for the preferred scheme option. Given this, it will always be a requirement to set up a VDM model of the do minimum network. The consultants suggested that the application of elasticity models could then use this as reference and may thus achieve a much closer match with VDM models for testing scheme options. *The Department concluded that more research is needed to conclude whether elasticity models should be used in this way as this was not part of the test carried out in the research work. This area will be explored in the medium to long term.*
6. It is recommended that further consideration should be given to how elasticity models could be calibrated to better reproduce the VDM effects in the part of the models that are most relevant, namely the scheme corridors, and the traffic passing through them. *This is a reasonable assumption which the Department has no problem with.*
7. Consideration should be given to establish how to calibrate VDM models where the mix of trip purposes and trip lengths are different from the NTS mix on which the fuel elasticity research has concentrated. *The Department feels that no action is required as it is felt that the guidance covers the range of elasticities by trip purpose which can be used as a guide to calculating the overall fuel cost elasticity of the model.*
8. The consultants raised the question as to whether we need to worry about calibrating VDM time-only assignment models as it cannot be calibrated in the manner done in this research work. *The Department's view is that as time only assignment does not work properly with VDM as it will be difficult to validate the assignment model and secondly, there is the risk of underestimating the impact of vehicle operating cost on choice of routes. Hence time only assignment may not be adequate for modelling variable demand. We will clarify this in the guidance. The issue of time only assignment and fixed trip modelling will be further considered.*

9. It was recommended that the exponential should be used over the power function for option sifting. *The Department agrees that it should give guidance on the use of exponential models, with a health warning when applied to long distance trips. Advice will also be developed on the treatment of long distance trips in VDM with some emphasis placed on cost dampening effect. However, further research will be undertaken to determine how the advice should be structured.*
10. It was agreed that further work should be carried out to ascertain whether elasticity models can be used for the assessment of medium scale schemes such as local transport plan schemes. *The Department will consider how this might be taken forward.*

What will happen next

A summary of responses, including the next steps will be published by the end of October 2007 on the WebTAG website at www.webtag.org.uk.

Further Information

Further information on the proposal is available from Frederic Oladeinde at the above address. Any general inquiries regarding the elasticity modelling report can be directed to the ITEA helpline at 02079446176

List of those consulted

All those registered on WebTAG.