The Regulatory Assistance Project

The E3-India Model

Technical model manual, Volume 9:
Frequently Asked Questions

cambridge econometrics
clarity from complexity

This volume (9) is part of a 9-volume series covering the E3-India model

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Contents

1 Frequently asked questions

1.1 Introduction

This volume contains topics which frequently raise questions. The next section describes how the model 'solves', after that the software is described in more detail, and the last section contains a general table of frequently asked questions (FAQ).

This volume is designed primarily to give practical advice to model users.

2 How the model solves

2.1 The basic solution process

This section describes in detail the solution process within the compiled model code. In most instances the user will not need to understand the solution process, but some basic knowledge would be helpful on occasions when the model fails to solve. An outline is therefore provided.

Iteration loops in the solution

As described in Volume 5, there are several simultaneous loops and interactions in E3-India. While theoretically it might be possible to solve all the equations as a system, in practice the model is far too complex and an iterative approach is required.

The method of solution is Gauss-Seidel, in which the different equation sets are solved in a predetermined order[1], starting with the values of the previous year's solution. The equations are solved, then the whole process is repeated (the 'iteration') and the differences in the values of selected variables from one iteration to the next are calculated; they will usually decrease quite quickly between iterations. When these differences are small enough, the solution is deemed to be 'converged'.

Reports are written to a text file[2] during the solution on (1) any very large absolute differences in solutions between iterations, (2) any non-converged values at the end of the solution, (3) the 30 items with the largest absolute differences between iterations at two different points in the solution, and (4) possible multiple solutions.

Problems in the solution

A large, complex, non-linear model such as E3-India inevitably can sometimes have problems of convergence and stability in model solution. Generally, there are two reasons that the model may fail to solve:

- explosive behaviour where a model variable keeps on increasing until it breaches a pre-specified limit
- non-convergence, where the model becomes trapped between two different solutions and is unable to move to a single point

When a model variable goes out of bounds, an error message is displayed telling the user which variable, state and sector has breached its limit (this is also recorded in the output diagnostics file). This is designed to help the user identify the source of the problem as easily as possible, although it should be noted that the error message may identify a symptom rather than a cause.

Cases of non-convergence are shown when the model reaches a maximum limit on the number of iterations (usually set at 50) without reaching a unique solution.

[1] The order is not important in determining results; it was chosen on the basis of solution speed and stability and largely follows the order of the functions shown in Volume 4.

[2] This text file (called the 'verification' file) contains a set of diagnostic outputs that can be relayed back to Cambridge Econometrics when support is required.

Common types of error pre-solution

Expertise has been developed to identify reasons for both causes and to remove the sources wherever possible. Although not necessarily the case, failures in solution often come from errors in the data or in the estimation. The first response is to check for errors and remove any. Indeed, a set of procedures should be followed before any solution of the model is undertaken to ensure that the data, the parameters and the programming is free of certain types of error:

- Data errors: e.g. zero prices, disaggregated energy demand does not add up to aggregated energy demand value, wage payments when employment is zero, current non-zero values when constant-priced values are zero so that implicit unit-prices are infinite.
- Parameter errors: where there are discrepancies between the model variables and the variables used for parameter estimation.

Alternative model specifications

When all these checks have been done, certain extreme values of parameters or combinations of parameter values in different equations may still cause problems in solution. These must be identified and removed.

The approach for doing this is usually by changing the specification from the default econometric equation (as specified in Volume 4), to a simpler specification. Common alternatives are:

- SHAR – The specified model variable changes in line with the same variable for other sectors in the state.
- RATE – The specified model variable changes in line with the same variable for the same sector in other states.
- EXOG – The specified model variable is not allowed to change and is fixed at the value on the databank.

The function specifications are set early in an Excel spreadsheet which gets exported to csv files for the model to read. The Excel file can usually be found in the C:\E3-india\In\Switches directory.

In general, considerable care should be used when changing specifications. For example, the RATE specification would not be appropriate when running the model for a single state. Unless there is a theoretical reason, model variables should usually only be held as exogenous for model testing.

Other alternative specifications are available for the individual equation sets.

Common problems in the solution – when output becomes zero

Many problems in the solution relate to model variables approaching zero. In particular, when output (QR) for a sector approaches zero, certain ratios (e.g. industry prices, labour productivity) can become unstable:

QR = QRY + QRC + QRK + QRG + QRX – QRM + QRR

where the terms on the right-hand side relate to intermediate demand and the components of final demand, plus imports as a negative demand and the calibration residual QRR (see volume 3 section 4). It is quite obvious that fast-growing imports could result in zero or negative output (the model software will not allow negative output).

This can lead to both model collapse and non-convergence. Any one sector can cause problems in the solution so, with a large number of sectors and states, it is not difficult to see how this could lead to instability.

Other solution problems – zero unemployment

Another important reason for non-convergence is when the economy of a state in the model approaches full employment. In this case the effect of the unemployment rate (the log of the rate is used) can change dramatically in several of the equations, leading to sudden changes in solution from one iteration to another. This effect is compounded by a check in the solution to prevent unemployment going negative by forcing a floor on the unemployment rate: the solution can bounce off this floor from one iteration to the next.

user is warned that they are liable to enter such areas if changes are made to the model or its assumptions which increase employment. The modelling problem has its roots in the actual performance of economies, which become more unstable at very low levels of unemployment. A similar warning is also applicable for when output of a sector is heading toward zero.

2.2 Model software

There are now several well-established packages that can be used for model building, each with its own advantages and disadvantages. However, there is no one single package that fits the requirements of the E3-India model, so a combination of software packages is used.

The following software is used:

- Fortran: E3-India source code is written in the Fortran95 programming language. It is compiled using the Intel Fortran compiler. The standard development environment is Microsoft Visual Studio. Users do not interact with the Fortran code.
- IDIOM: This is a programming language which is itself a pre-compiled set of Fortran commands. It provides a user interface for the modeller, for example allowing the user to make certain changes without recompiling the source code. The IDIOM manual (Cambridge Econometrics, 2007) provides further details and is available on request to advanced model users.
- DOS: The model is run from the command line, using cmd batch files. However, the Manager software hides this from the user.
- Python and HTML: The model manager and front end, which allows the model to be run without requiring any programming expertise, is programmed in Python and HTML.
- Ox: The Ox programming language (Doornik, 2007) is used for data processing, parameter estimation and manipulation of results.

3 Frequently asked questions

Practical questions

#	Question	Answer	More information
1	Are there some basic precautions to be aware of during the setup of the baseline?		Volume 2
2	How do I export my E3-India results?		Volume 2 section 1.2
3	When running the model, where do I read a possible error message?		Volume 9
4	How are model variables named?		Volume 3 section 1.3
5	How is coal treated in the model?		Volume 5 section 1.3

Theoretical questions

6	What are the underlying assumptions used in the construction of a CGE and E3-India? Are there any empirical studies that can confirm the relevance of these assumptions?	E3-India is a macro-econometric model based on post-Keynesian economics. The model is a simulation tool that attempts to reproduce real-world behaviour and does not make assumptions about optimising behaviour. Instead, behaviour is assumed to reflect past trends, as derived in the econometric equations that are based on historical time-series data. This means that many features of the economy that cannot always be represented in the CGE model (e.g. the role of institutions and the existence of unemployment, fixed exchange rates. The main weakness of the approach is the reliance on historical data for assessing future behaviour (i.e. Lucas Critique) but our view is that this still gives us a best guess of real-world relationships.	
7	One of the major difficulties of the general equilibrium models is the modelling of the labour market. How do you model this market? Are there any (empirical) studies that can justify your choice?	E3-India is not an equilibrium model and therefore doesn't suffer from many of the limitations of CGE models. There are econometric equations for labour demand and supply, wage rates and average working hours. There is no assumption that wages adjust so that labour markets 'clear' either in the long or short run. Involuntary unemployment therefore exists as part of the difference between labour supply and	

		demand. Changes in unemployment rates in turn affect decisions made on consumption. The main limitation of E3-Indias the absence of a detailed treatment of skills, so the model cannot say which workers can fill which jobs. This is due to data limitations and is something we are looking to improve in future. In general, however, any scenarios with large shifts in labour between sectors needs a separate more qualitative assessment to ensure that workers are able to make the transition.
8	Can you summarise the expected long-term impacts on GDP, the employment and the environment? Can you define the notion of "long term"?	Unlike a standard CGE model, time in E3-India is defined explicitly. The model solves on an annual basis and provides results for both short and long-term outcomes. The dynamic part of the econometric equations provides annual changes, gradually moving towards a long-term steady state outcome. The speed with which the model moves towards a long-term outcome is also determined by the error-correction specification of the equations. Typically, most equations are most of the way to long-term outcomes within 3-5 years. GDP is an accounting identity and the model results reflect changes in the sum of consumption, investment and net trade. Impacts on GDP will therefore depend on what happens to these. Labour is a derived demand, which depends on demand for final products. Typically wages adjust slowly at best, so impacts on labour largely depend on impacts on production levels (although usually a smaller magnitude). Energy is also a derived demand so the level of energy consumption depends on production levels. Economies of scale are accounted for however so the relationship is not one-to-one.
9	What period to the historical data cover?	The historical time series start in 1993 and 1995 is the first year for parameter estimation and full solution. The time series are annual and use the most recent data available. The future baseline projections go out to 2035.
10	What are the units for the output variables?	Most monetary values are expressed as millions of rupees at constant prices (2010 price base). Price indices (2010 = 1.0) are also given to convert to current prices. Employment is measured in thousands of people. Energy consumption is measured in

thousands of tonnes of oil equivalent and emissions in thousands of tonnes of carbon.