Review of 'Economic impact of meeting 2050 emissions targets: Stage 2 modelling' by the New Zealand Institute of Economic Research

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1. Overall assessment

The analysis by the New Zealand Institute of Economic Research (NZIER) uses an appropriate modelling framework that meets global best practice standards in most areas, and the modelling exercises meet the requirements set out by the Ministry for the Environment (MfE). Some assumptions in the analysis likely result in emission reduction costs being overestimated, while other assumptions result in the cost being underestimated. On balance, the costs of meeting emission targets estimated in the study are likely in the high end of the probable range. Although the analysis is appropriate under the time constraint for the study, future modelling exercises could be improved in several ways.

2. Peer review methodology

Background information on NZIER's modelling work was gathered by reviewing available documentation on the model used by NZIER and related models (e.g., the MONASH model, the parent model for the framework used by NZIER). This literature review included Dixon & Rimmer (2002) and Ballingall & Schilling (n.d.). Additional information on assumptions in the model and how the model operates was gathered via personal correspondence with NZIER.

The appropriateness of the study to answer MfE's questions was assessed by comparing the scenarios and assumptions in the modelling exercises to the target options outlined in the MfE memo titled '2050 target options that will be tested in NZIER's CGE modelling' (15 February 2018), and information provided in the 'Purpose and any background information' and 'Specific questions/instructions for provider' sections of 'AoG Consultancy Services Order' used to contract this review.

The validity of the results were assessed using expert judgement and by evaluating whether changes in results across scenarios were plausible. Where possible, results were graphed across scenarios (if not already done so in the report) to check for outliers/unreasonable results.

3. Assessments of the findings

3.1. Technical accuracy of the CGE model runs - Assessment relative to MfE's requirements

The scenarios modelled are appropriate for evaluating the target options outlined in the MfE memo '2050 target options that will be tested in NZIER's CGE modelling' (15 February 2018) and additional scenarios requested by MfE. Refinements to the model and the scenarios considered also meet the specifications requested by MfE for Stage 2 of the modelling analysis, as outlined in the 'Purpose and background information' sections of 'AoG Consultancy Services Order' used to contract this review. Specifically:

- The scenarios implemented in Stage 2 consider (1) alternative pathways to reach net zero long-lived gases, (2) alternative stabilisation targets for short-lived gases, and (3) the potential non-fungibility between short-lived and long-lived gases.
- A scenario is included to assess the impact of purchasing international emission permits (C-Wide-80%-Int-$150).
- Relative to Stage 1, improvements have been made to modelling forestry in the model. Significantly, in scenarios with greater assumed sequestration from forestry, land used for forestry/sequestration is now 'taken away' from other activities (although there is not an endogenous sequestration response to the carbon price).
- Baseline emission projections have been revised so that they are consistent with New Zealand's Seventh National Communication under the United Nations Framework Convention on Climate Change.

3.2. Suitability of the assumptions to determine the economic cost of the target options

Ambitious climate policies will have broad sectoral and macroeconomic impacts, so a computable general equilibrium (CGE) model is an appropriate tool for evaluating these policies. The CGE model used for the analysis meets global best practice standards in most areas. Other countries proposing large reductions in emissions do not face the same challenges and opportunities as New Zealand, so there are many unique aspects to New Zealand-focused models. Consequently, although the analysis is appropriate under the

time constraint for the analysis, future modelling exercises could be improved in several ways (listed below), with appropriate time for model development.

As in all large-scale modelling exercises, many assumptions are needed to operationalize the model used by NZIER. Some assumptions in the analysis likely result in the emission reduction costs being overestimated, while other assumptions result in the cost being underestimated. On one hand, innovations that lower emissions – energy efficiency improvements above long run trends, increased penetration of renewable electricity, increased use of electric vehicles, and the methane vaccine – are assumed to come at no cost, which may result in costs being underestimated. On the other hand, the model has limited scope for producers to reduce the emissions intensity of output, which may result in costs being overestimated. For example, although the scenarios assume that there is more innovation and forestry sequestration in scenarios with more ambitious targets, within each scenario: (1) non-combustion emissions are linked to output in fixed proportions (i.e., non-combustion emissions per unit of output do not respond to the carbon price); (2) sequestration from forestry does not respond to the carbon price, (3) there are no price-induced energy efficiency improvements, and (4) there is no price-induced new low-carbon technologies (for energy or agriculture). On balance, the costs of meeting emission targets estimated by the study are likely in the high end of the probable range.

In comparing the estimates to those from other studies, it is useful to note that, as every action in a CGE model has an opportunity cost, the costs of abating emissions in CGE models are usually higher than those in models with a partial equilibrium structure or a reduced-form representation of the economy. For example, Chen et al. (2016b) show that realistic details of economies represented in CGE models (e.g., sectoral detail with intermediate-input links among sectors, and existing taxes) more than double net present discounted cost estimates relative to those from other models.

In interpreting the results, users should be aware that several input assumptions are varied in each scenario so, in general, it is difficult to infer the individual impact of changes in scenario/input assumptions by comparing results across scenarios. For example, results for the A-Mod (net zero CO_2 emissions) and B-NF-50 (net zero CO_2 emissions and methane stabilization at 50% of the 2016 level) scenarios cannot be used to infer the cost of stabilizing methane emissions, as the innovation assumptions differ in the two scenarios. Similarly, comparing the B-NF-50 (no fungibility between short- and long-lived gases) and B-F-50 (fungibility between short- and long-lived gases) scenarios does not allow direct assessment of the impact of fungibility between short- and long-lived gases, as the assumed rate of forestry sequestration

and innovation assumptions both differ in the two scenarios. Ideally, scenarios in the analysis would be supported by a suite of supplementary scenarios that varied one input assumption at a time, but I acknowledge that this was not feasible given the time constraint for the work.

For future climate policy analyses, the following model developments would be useful.

- Include both price-induced improvements in energy efficiency and price-induced reductions in non-combustion GHG emissions per unit of output, for example, as in the MIT Economic Projection and Policy Analysis (EPPA) model (Paltsev et al., 2005, Chen et al., 2016a) and the European Commission's General Equilibrium Model for Energy-Economy-Environment interactions (GEM-E3) (Vandyck et al., 2016).

- Improve the modelling of international permits to consider the foreign exchange implications of purchasing international permits, and adding the ability to simultaneously impose a domestic emissions cap and a fixed price for international permits – see, for example, Winchester and Reilly (2018).

- Include advanced low-emissions technologies/production methods that are not economic under current prices and policies, but may be profitable in the future, for example, as in the EPPA and GEM-E3 models.

- Include endogenous forestry sequestration responses to the carbon - see, for example, Winchester and Reilly (2015).

- Identify different types of greenhouse gases in the model, for example, as in the EPPA and GEM-E3 models.

References

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