Economic impacts of dietary improvements in New Zealand

Computable general equilibrium modelling

NZIER report to the University of Otago

April 2025

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Key points

We estimated the economic impacts of healthier diets

The economic impacts of unhealthy diets – and the potential economic benefits from improved diets – are not fully clear. NZIER worked with researchers at the University of Otago to estimate changes in consumer welfare and economic activity from changes toward healthier diets in New Zealand.

We modelled several 'what if?' scenarios based on dietary modelling from the University of Otago

Dietary modelling considered the potential health benefits in New Zealand of several changes to the country's diet. These changes are aligned with public health nutrition evidence and include the following known risk and protective factors: increased consumption of fruits and vegetables, and reduced consumption of processed meats and sugar sweetened beverages.

The economic modelling is an initial attempt to quantify linkages between dietary change, food and agricultural policies, and economic productivity.

Economic theory explains whether impacts are positive or negative

We estimated the impact of making changes to the New Zealand diet. By assumption, this causes an initial economic loss because it involves moving consumers away from their most-preferred dietary choices.

We also estimated the impacts of import controls to promote domestic food production. Again, this produces a loss by assumption because it tampers with optimal trade patterns.

We also introduced an economic benefit to compare to these costs: a small productivity gain. It was positive by definition.

The economic impacts were all small

Although we knew the direction of economic impacts before we started, we didn't know how big they would be. They all turned out to be small: less than one percent changes in gross domestic product and household consumption for each change and all the combinations modelled.

This result suggests that improving diets at the national level is economically feasible in New Zealand; it will not disrupt the economy.

Dietary improvements are probably economically worthwhile

We could not find a number in the literature that quantified the economic benefit from better diets. We therefore modelled a small change in productivity that seemed aligned with the literature on diet, absenteeism, presenteeism, and disease-related mortality.

That small increase in productivity was more than sufficient to pay for an improved diet.

Some policies may not be economically beneficial

Just on our initial modelling, we found that import control policies might produce economic losses that are not offset by productivity gains. These results depended on how policies were modelled and the size of the assumed shocks, so they need further investigation. They do suggest that economic analysis should be part of any national food policy.

Interdisciplinary research produced new, valuable insights

This research also demonstrated the value of interdisciplinary research and combined modelling exercises. The results produced here, and the new knowledge created, were only possible by working across specialisations in respectful collaboration.

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1 Introduction

Unhealthy diets have been identified as a public health concern and a burden to the economy (Horton et al. 2024). For high-income countries, the main concerns are the prevalence of overweight and obesity and the contribution of unhealthy diets to non-communicable diseases. Impacts are measured in premature deaths as well lost economic production. However, the World Bank argues that there is still work to be done to understand unhealthy diets comprehensively and produce economic estimates of their impacts (Horton et al. 2024).

Research at the University of Otago is attempting to understand and measure the impacts of diet on health. A key tool in that research is a model that connects dietary intake to health, allowing researchers to estimate the impact of improvements in the average diet in New Zealand to impacts on disease incidence. NZIER is contributing to that research by modelling economic impacts. Changes in the average New Zealand diet would have macroeconomic consequences as people changed their consumption bundles and businesses reacted by changing their production.

To measure economic impacts, NZIER used a computable general equilibrium (CGE) model of the economy, TERM-NZ. Using this model has some implication for the results of the analysis. By assumption, the CGE model treats the current state of the economy – including food consumptions and production – as optimal given the available resources. Making an exogenous change to the national diet therefore entails a move away from optimality and has an economic cost by assumption. The question is not whether there is a cost, but how much and who bears it. The same is true of other changes imposed on the model. For example, restricting imports to promote domestic food supply entails a shift away from the optimal equilibrium and therefore imposes a cost on the economy. Again, it is the size and pattern of the costs that are interesting to assess.

Modelling the benefits of these changes is more difficult. TERM-NZ, a model of the macroeconomy, does not include a measure of individual or public health. Any improvement in wellbeing or reduction in disease is not an automatic output of the model. Including these benefits involves translating them into economic metrics and then including them in model scenarios. In this report, we discuss some potential measures of benefits. The important point, however, is that an economic assessment of dietary changes should consider both the costs and benefits of those changes.

This study was not intended to be a comprehensive economic evaluation of dietary impacts. It is not a study of the burden of disease, either in terms of fiscal costs for the public health system or the wider costs on New Zealand people and society. It would be possible to expand the research in that direction in the future. This work is also not an evaluation of the effectiveness of interventions at a programme level.

The rest of this report presents NZIER's contribution to this research programme on diet and health. It starts by discussing the economic costs and benefits of dietary changes, relying on theory and prior literature. It then presents the method used in this analysis, CGE modelling. It next provides results from several model scenarios with different dietary changes and other economic impacts and then discusses the implications of the results. A short conclusion ends this report.

2 Cost and benefits of dietary changes

2.1 Economic costs

A key concept in neoclassical economics, going back to Walras, Jevons, Pigou and Marshall, is market equilibrium (Heilbroner 1986; Robinson 1964). The economy is described as a collection of markets for different goods and services. In each market, some quantity is transacted between suppliers and consumers at some price, with the quantity and price representing an equilibrium. If the price in a market is too high, it would drive away consumers while enticing too many suppliers. If a price is too low, demand would be too high for the amount that sellers are willing to supply. A critical implication is that the economy is not in equilibrium until all the markets are; an imbalance somewhere implies imbalances everywhere.

The current demand for foodstuffs that produces the national diet of New Zealand operates within this system of markets. The diet could be notionally divided into healthy choices and unhealthy choices. The demand for both of them reflects the tastes and preferences of New Zealand consumers as well as the costs of supply for businesses. The balance between healthy and unhealthy choices reflects the ratio of prices between the two, which in turn reflects the combination of how people want to spend their money and what it costs to produce these items. Therefore, imposing a different diet on consumers by shifting it toward more healthy choices – even if it is good for reasons of individual or public health – involves creating a cost for them. They are no longer purchasing the most enjoyment (*utility* is the economic term) for the lowest spending. Instead, they are now getting a basket of foodstuffs that is no longer exactly what they want at current prices, but something a little different and a little deficient.

This economic thinking does assume that consumers are freely choosing their most preferred foods, while research in public health nutrition evidence shows that dietary intake is affected by food availability (Myers 2023) and is influenced by the food industry employing strategies such as food marketing (Arrona-Cardoza et al. 2023) to drive sales of their products, alongside food preferences. The impact of these external pressures on the underlying economic assumption will be explored in future work.

Economic theory also describes a similar mechanic for producers or suppliers. The equilibrium at which they supply each market is a point at which their costs are minimised. If they are compelled to change what they supply, by assumption the change involves an increase in their costs per unit. Even if they sell more in total, they experience a decline in profits. An exogenous change in diets therefore creates losses for suppliers.

The scenarios considered in this research include restrictions on imports. These restrictions are modelled to analyse the potential impacts of prioritising domestic supply for healthy foods. The CGE model includes both imported and domestic supplies of products, and by assumption the balance between the two is optimal. Restricting imports leads to more supply being met from domestic sources. However, changing the ratio of imports to domestic supply creates additional costs for the economy.

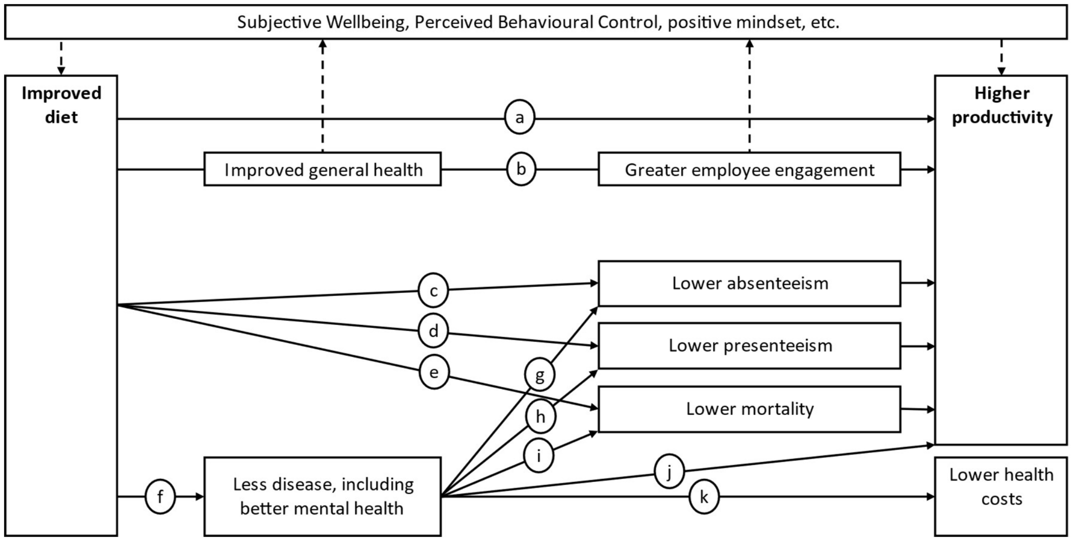
The scenarios modelled in this research involve exogenously changing the aggregate diet in New Zealand, which changes the commodities demanded, supplied and imported. When assessed only for their market value – rather than for health or wellbeing – these changes produce economic losses in the model by assumption. Using the model helps our understanding, however, by estimating the magnitude of those losses and demonstrating how other parts of the economy adjust in response. The model helps answer questions like 'what would it cost to…?' or 'is it economically feasible to …?'

2.2 Economic benefits

Changes to the average diet in New Zealand should also produce benefits. Otherwise, it would not be economically rational to undertake them. From a health perspective, the aim of a healthy diet is to improve health, especially by reducing the incidence of non-communicable disease and premature mortality. However, health, disease and mortality are not included in a typical CGE model. They are simply not part of the parameters or equations in a macroeconomic model. For the wider project, these benefits, including impacts on health system costs or cost savings, will be modelled by the University of Otago, using multi-state life-table modelling (Cleghorn, Nghiem, and Ni Mhurchu 2022). For CGE modelling, the benefits of a healthy diet need to be translated into economic impacts and added to the scenarios modelled. Otherwise, a transition to a healthier diet is all cost and no benefit, from a CGE modelling perspective. To understand whether a healthier diet is worthwhile or passes a benefit-cost test, the benefits need to be specified in the modelling scenarios.

For the purposes of this research, the CGE model needs a single parameter that expresses the positive impact on economic production from a healthier diet. This number does not appear to be available in the literature, for New Zealand or for any other country. The literature linking diet, health and disease with economic productivity is fragmented. To relate the available literature to the current modelling, the framework shown in Figure 1 was developed. The framework provides a way to classify or locate each study in the literature for its contribution to understanding the connection between diet and productivity. In the figure, the lettered circles refer to relationships, correlations or causal links that can be used to classify the literature. The CGE model needs a single parameter that quantifies the improvement in productivity that results from a healthy diet, which is indicated by the single line *a* connecting *Improved diet* with *Higher productivity*. The figure also includes more-complex causal chains. Improved diet can lead to less disease (*f*), which in turn leads to lower absenteeism (*g*) and higher productivity. The figure also includes the possibility of lower health care costs, which were not investigated in the modelling. Not included in the framework are long-term productivity gains produced by improvements in educational outcomes resulting from improved student diets.

Figure 1 Framework linking improved diet with economic productivity



N.B.: Framework focuses on elements and relationships considered in the literature and is not a complete description of physical or economic processes.
Source: NZIER

Table 1 indicates the coverage of different topics in the framework by studies available in the literature. The studies were identified by searching several academic databases, starting with a few key publications with which the research team was familiar. The literature search was not intended to be comprehensive or systematic. In the table, the first column contains letters that refer to linkages in the framework. The second column lists studies that have examined those linkages. The studies may or may not have found statistically significant relationships; they are included if they examined the specific linkage. In addition, it is important to note that the framework was developed from the examples in the literature. It is intended to classify the pathways described in the research, not to describe the actual processes in the economy.

Table 1 Research on relationships linking diet and productivity

With reference to the framework in Figure 1

Framework reference	Literature reference
a	Shi et al. (2013)
b	Amano et al. (2020) (with opposite causation); Brecko & Grum (2022); Isham et al. (2020; 2021)
c	Boles et al. (2004); Brecko & Grum (2022); Hafner et al. (2015); Isham et al. (2020); Shi et al. (2013)
d	Boles et al. (2004); Hafner et al. (2015); Isham et al. (2020); Shi et al. (2013)
e	n/a
f	Cleghorn et al. (2022); Drew et al. (2020); Herman et al. (2022); Kandel (2019)
g	Boles et al. (2004); de Oliveira et al. (2023); Hafner et al. (2015); Kirsten (2010); MacLeod et al. (2021); Shi et al. (2013)
h	Boles et al. (2004); de Oliveira et al. (2023); Hafner et al. (2015); Kirsten (2010); MacLeod et al. (2021); Shi et al. (2013)
i	Carter et al. (2017); Herman et al. (2022); MacLeod et al. (2021)
j	Blakely et al. (2021); Schofield et al. (2015); Shi et al. (2013)
k	Cleghorn et al. (2022); Drew et al. (2020); Herman et al. (2022)
Subjective Wellbeing, etc.	Amano et al. (2020); Isham et al. (2020; 2021); Shi et al. (2013)

Source: NZIER

Direct linkages

Linkage *a* is the simple connection that is required for the present modelling. There does not appear to be an estimate of this parameter in the literature. An example of a relevant study is Shi et al. (2013), which used data on 19,000 employees of five employers to analyse baseline and post-intervention relationships between unhealthy diet and self-reported job performance. It is not clear how the reported results could be transformed into the required model parameter, but the research did show that an improved diet improved job performance.

Linkage *b* connects diet and productivity, but with the addition of other factors such as general health or greater employee engagement. In a study of Japanese workers, Amano et al. (2020) found that better work engagement was associated with a healthier diet. The authors did discuss the possibility that causality could run in the opposite direction or in both directions, but focused on how better engagement at work produced a better diet. They hypothesised that feelings of wellbeing and self-efficacy might be involved, thus connecting linkage *b* to the factors Subjective Wellbeing, Perceived Behavioural Control, positive mindset, etc. at the top of Figure 1. By contrast, Brecko & Grum (2022) conducted survey research with 230 participants in Slovenia, and found that good diet leads to more productive work behaviours. They did not consider causality in the opposite direction or the possibility that healthy diet and good productivity are produced by a common third factor, such as high perceived behavioural control (PBC). Isham et al. (2020; 2021) summarised the literature on wellbeing and productivity, noting that the relationship between productivity growth and wellbeing is complex and involves many moderating or mediating factors (Isham, Mair, and Jackson 2020, 1) and identifying good diet as one of those factors.

More indirect linkages

With linkages *c* and *d*, the connection between diet and productivity in the framework becomes indirect. Several studies connected the quality of the diet to absenteeism (not being at work) and presenteeism (being at work but not fully effective), and then used them as metrics for productivity. Boles et al. (2004) was an earlier study and commonly referenced in later studies. They included a conceptual model of health and productivity that links modifiable health risks such as diet to performance and thence to productivity. Using data from 2,264 United States employees who used corporate-sponsored fitness centres, they found that poor diet increased presenteeism from 4.71 percent to 6.95 percent. The study by Brecko & Grum (2022) mentioned earlier included a metric for absenteeism but not presenteeism; they did not find a significant correlation between nutrition and absenteeism. Hafner et al. (2015) analysed data from about 22,000 employees in Britain and investigated the impact of specific dietary practices. Consumption of fruits and vegetables did not have an impact on absenteeism or presenteeism, while added fats and sugary drinks were related to the latter but not the former.

In their review, Isham et al. (2020) linked unhealthy diets to absenteeism and presenteeism, citing Boles et al. (2004) and Hafner et al. (2015). However, they did not appear to cite additional empirical studies for the linkage beyond those two studies. Instead, poor diet was included as one of several risk factors or risky health behaviours, which in turn were collectively connected to job performance metrics. Finally, the Shi et al. (2013) study, described previously, also used absenteeism and presenteeism as measures of productivity outcomes. They assessed 19 modifiable risks grouped into 5 dimensions. For the dimensions, improvements were linked to improvements in all productivity metrics compared to a baseline of no change. For the individual risks, the impacts were more varied: an increase in unhealthy diet, for example, affected presenteeism but not absenteeism.

These studies show, first, that absenteeism and presenteeism are more common metrics for job performance than any direct measure of productivity. Second, the results suggest that unhealthy diet as a direct cause tends to affect presenteeism – that is, ability to perform the job while being at work – but not absenteeism.

Linkage *e* is included in the framework for theoretical completeness. Studies on disease link it to absenteeism, presenteeism and mortality as measures of productivity, but we did not find research linking diet directly to mortality and productivity.

Linkages through disease impacts

A more indirect causal chain between diet and productivity links healthy diet to reduced incidence of disease, and then this lower incidence to measures of productivity. This causal chain starts with the link between diet and disease (linkage *f*). This is a large area of research and our review has not attempted to cover it fully. One example of this research was Herman et al. (2022), which was a microsimulation modelling exercise to link diet to chronic conditions and economic outcomes in the United States. They stated, *Diets closer aligned with nutritional guidelines could lower the risk of several chronic conditions and improve economic outcomes, such as employment and healthcare costs. However, little is known about the range, order of magnitude and timing of these potential effects* (Herman, Nguyen, and Sturm 2022, 1265). They found that improving diets could reduce diabetes by 11.5 percent and heart disease by 7.2 percent. These are two chronic health conditions that other research has linked to poorer job performance and productivity. Another example from the literature was Kandel (2019), a review of three studies on the effect of diet on coronary artery disease and stroke. According to the review, healthier diets can lead to lower blood pressure and reduced incidence of type 2 diabetes, although the research did not quantify the total size of the changes. Research of the type shown in these two studies can help quantify the linkage between improved diet and better productivity. In the New Zealand context, Cleghorn et al. (2022) optimised diets across the population so that they met recommended daily intakes for either all nutrients, micronutrients or key nutrients. They then calculated changes in disease risk from the dietary changes, and the result was a health improvement of 1.1 million to 1. 6 million quality-adjusted life-years (QALYs) over the lifetime of the cohort modelled. Similarly, Drew et al. (2020) modelled the update of diets conforming to the New Zealand dietary guidelines and found that the population had health gains of 1.0 million to 1.5 million QALYs. The association between dietary risk factors and disease incidence used in these New Zealand studies comes from the Global Burden of Disease studies (Forouzanfar et al. 2015).

The next link in the causal chain connects disease with job performance metrics. There are several studies that have consider linkages *g*, *h* and *i*. Three studies have been mentioned before: Hafner et al. (2015) found that high blood pressure was connected with more absenteeism and presenteeism; Shi et al. (2013) found that high blood pressure increased presenteeism and reduced self-reported job performance; and Boles et al. (2004) found that high blood pressure had no impact on job performance metrics. Kirsten (2010) provided a discussion of the connection between chronic conditions and absenteeism and presenteeism, noting that the focus on the latter was a new trend at the time. MacLeod et al. (2021) connected hypertension to productivity losses, including absences from work, reduced function at work and premature death. They obtained estimates from the literature, and concluded that losses due to absenteeism as a result of hypertension *could amount to more than $11 billion annually* (MacLeod et al. 2021, 304). That estimate appears to be from 2008 to 2011, and it would represent about 0.07 percent of the 2011 United States' gross domestic product of $15 trillion.[1] Finally, de Oliveira et al. (2023) considered the connection between mental health and job performance with a review of 38 studies. They found that poor mental health led to absenteeism and presenteeism. Across these studies, specific conditions are linked to certain metrics of job performance, and they indicate that reductions in chronic conditions or disease would improve economic productivity. However, there are few fully quantified relationships like the result from MacLeod et al. (2021), and even it is for only one condition.

Impact of mortality

Linkage *i* considers the connection between disease and mortality, because premature death can remove workers from the economy. It should be mentioned that the economic ramifications are unclear. Premature death can remove both a worker and a consumer, so the net impact on a per capita basis is complex. In addition, economic productivity is a ratio of outputs to inputs, with inputs including both labour and capital investment. Again, the impact of removing workers is complex and depends on technology and investment.

[1] https://fred.stlouisfed.org/data/gdp

Nevertheless, the literature provides evidence about the loss of lives or loss of productive years.

Overall impact of disease

Linkage *j* involves research that directly assesses the economic impact of disease. In the New Zealand context, Blakely et al. (2021) estimated the loss of income to working-age people from multiple diseases. They found that the *combined annual income loss from all diseases among 25- to 64-year-olds was US $2.72 billion or 4.3% of total income* (Blakely et al. 2021, 1). Mental illness contributed the largest portion of the loss, with cardiovascular disease in second place at 15.6 percent of the loss. This work did not discuss the contribution of nutrition or dietary factors to disease or economic loss. In the Australian context, Schofield et al. (2015) conducted microsimulation modelling to estimate the impact of chronic illness on productive life years (PLYs) for older workers. They converted the PLYs into dollar values, finding that the *national impact of this lost labour force participation on GDP was estimated to be $37.79 billion in 2010, increasing to $63.73 billion in 2030* (Schofield et al. 2015, 1). Nominal GDP in 2010 was AU$1.4 trillion,[2] so the impact that year was approximately 2.7 percent of GDP. The impact of a dietary behaviours was not discussed in the article. Shi et al. (2013), discussed above, directly linked disease to job performance. One of the five wellbeing dimensions was physical health, which included high blood pressure and high cholesterol as *modifiable well-being risks* (Shi et al. 2013, 355). They found that these two risks did not statistically affect job performance. These studies suggest that the total impact of disease on economic productivity can be valued at several percentage points of GDP, although the mechanisms by disease may be difficult to pinpoint.

Subjective Wellbeing, etc.

Several studies included some consideration of the subjective state of workers. In the framework in Figure 1, this element is included as an additional element outside the direct pathway between improved diet and better productivity. It includes Subjective Wellbeing (SWB), as mentioned in several studies, Perceived Behavioural Control (PBC) (Ajzen 1991), positive mindset or mental attitude, and other descriptors. It is not clear from the research whether the direction of causation is from work success to high subjective wellbeing to healthy diet, as suggested by Amano et al. (2020), or in the opposite direction as suggested by Isham et al. (2020; 2021) and Shi et al. (2013). Another possibility, less prominent in the literature discussed, is that health diet and economic productivity are correlated because they are both the result of higher SWB, PBC, or feelings of self-efficacy. In that case, healthy diet would be a useful indicator of individuals who are likely to be more productive but not a tool for economic intervention.

Impact on health care costs

A final economic impact of diet is directly on health care costs (*k*). An example of research on the topic is Herman et al. (2022), microsimulation modelling discussed previously that linked diet to disease as well as health care costs. They found that after 30 years of healthy dietary behaviours, reductions in diabetes, heart disease and stroke would result in healthcare cost savings in the United States of $144 billion annually. It is unclear what base year they used for that estimate, but the GDP in 2019 (the base year for the modelling) was

[2] https://www.rba.gov.au/statistics/tables/csv/h1-data.csv: Nominal GDP at current price, seasonally adjusted, for the quarters March, June, September and December 2010 (AU$1,364,469 million).

approximately US$22 trillion,[3] making the savings 0.7 percent of GDP. This economic impact was not included in the present modelling exercise but was an impact noted in the literature. Another example is the modelling by Cleghorn et al. (2022). They estimated that the improvement in health due to improved diet in New Zealand would result in savings to the health system of $20 billion (2011 NZ$) over the lifetime of the cohort modelled. Drew et al. (2020) similarly valued the health care system cost savings from the New Zealand population following dietary guidelines at $14 billion to $20 billion (2011 NZ$).

Summary of economic benefits

The literature relevant to the connection between healthy diet and economic productivity considers many potential linkages, which have been assembled into the framework in Figure 1. For the CGE modelling, one approach is to assume that an improved diet leads to improved productivity and summarise that relationship in a single parameter. However, the research does not provide that parameter. Instead, prior research provides many different results – most partial, some conflicting – that could be used to create a causal chain and calculate the productivity gain from improved diet. The aim would be to understand the contribution of diet to disease, then the impact of disease on job performance metrics, and finally the relationship between those metrics and economic productivity. The studies of the overall impact of disease on productivity provide an upper bound, because they indicate total losses but not the portion of the loss that could be avoided with an improved diet. Those studies suggest the overall impact is a few percentage points of GDP. The economic benefit achievable by modifying diets would be some fraction of that amount.

3 Method

This section sets out the methods used to estimate the economic impact of changing diets. This section covers what CGE is and what scenarios have been modelled.

3.1 What is CGE

CGE models are data-driven and used to capture the effects of a new policy or technology or other external shocks affecting economic activity. They **capture the economy-wide effects of changes** ('shocks' in modelling jargon) directly on the affected industry, as well as indirectly on supplying industries, competing industries, and factor markets (labour and capital). CGE models show the full effect of a change which includes impacts from indirect effects which aren't immediately obvious. The cumulative impact of indirect effects can outweigh the direct effect of a change.

CGE models also estimate the effect of a shock on macroeconomic variables such as GDP, employment, wages and trade.

CGE models are a powerful tool, allowing economists to explore empirically many issues on which econometrics or multiplier analysis would be unusable. For these reasons, CGE models have become widely used internationally (e.g. by OECD, IMF, World Bank) for economic impact analysis.

3 https://fred.stlouisfed.org/data/gdp

3.2 How do they work?

A CGE model consists of equations which describe model variables. It also uses detailed data on the structure of the economy that is consistent with these model equations.

This data provides a snapshot of the economy in a particular year, which is used as a starting point for a baseline (or business as usual (BAU)) against which to compare policy simulations or economic changes.

The model data is linked together through a set of equations which capture how the economy evolves over time in response to a shock. These equations, which are based on the economic theory of general equilibrium, ensure supply and demand for goods, services and factors of production in the economy are balanced, and determine how firms and households react in response to changes in incentives.

In any CGE model, we must choose what is to be determined within the model (the endogenous variables) and what is to be considered external to the model (the exogenous variables). A CGE model is just a way of explaining the endogenous variables in terms of the exogenous variables.

Where we draw the line between endogenous and exogenous variables, and which ones can vary or must remain fixed, depends on several factors, including the purpose for which the model simulations are to be used. The choice that we make is called the model closure.

3.2.1 Model closure

CGE models require researchers to make a few assumptions about how the economy operates. Essentially, there are too many moving parts for the amount of economic data we have, so we have to nail down a few of those parts to allow the model to find a solution. These assumptions are called *closure conditions*. They typically concern labour markets, capital markets, government behaviour, and foreign exchange.

Determining the closure is a key part of any modelling exercise and it is very important that the modeller be transparent about what is a result of the modelling and what has been imposed by assumption via the closure.

We investigated several sets of closure conditions to select one in which the model behaved in a way that reflected medium-term adjustments in the economy: enough flexibility to represent the choices and changes that businesses and consumers might make, but with some constraints on their options.

The closure conditions used for this modelling are that:

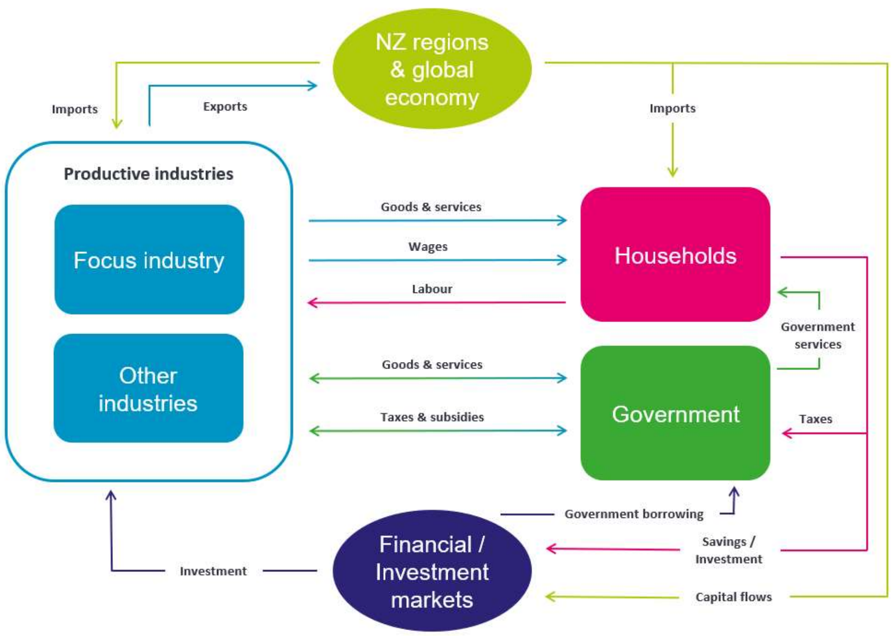
- Aggregate employment is fixed but the real wage varies, so that changes in the macroeconomy have an impact on the average household
- Capital is flexible but the rate of return is fixed, which provides investment capital for changes in business activities as long as the changes are sufficiently profitable
- Real government consumption follows household consumption, so that government spending is constant as a percentage of the whole economy.

3.2.2 Flows in the economy

The difference between the initial and the new equilibrium can then be analysed to determine the effect of the shock on a range of economic indicators, such as GDP, employment, wages and living standards.

Figure 2 provides a stylistic representation of the relationships between different parts of the model.

Figure 2 Our CGE model represents the circular flows in the economy



Source: NZIER

3.3 Scenarios modelled

This section sets out the different scenarios modelled. Each modelled scenario is characterised by different changes ('shocks') to the economy that occur from changing consumption, increasing productivity, and/or import controls. Table 2 shows the combination of the different shocks and how each scenario is comprised.

Table 2 Modelled scenarios

Shock/scenario	1	2	3	4	5	6	7	8	9	10	11
Fruit consumption increased	x				x	x	x	x	x	x	x
Vegetable consumption increased		x			x	x	x	x	x	x	x
Processed meat consumption decreased				x	x	x				x	x
Sugar sweetened beverages consumption decreased			x		x	x				x	x
Import prices increased								x	x	x	x
Productivity increased						x			x		x

Source: NZIER.

The details on the size of the shocks (regardless of the scenarios to which they were applied) are described below.

Consumption shocks

- 101.7 percent increase in household fruit consumption, which was calculated as the amount the average New Zealander needed to increase fruit intake to meet the new dietary guidelines
- 172 percent increase in household vegetable consumption, which was calculated as the amount the average New Zealander needed to increase vegetable intake to meet the new dietary guidelines
- 13.3 percent decrease in household beer and soft drink consumption, which is the consumption category that includes sugar sweetened beverages. This decrease was calculated by subtracting all estimated spending on sugar sweetened beverages (SSBs) from the household expenditure category 'Soft drinks, waters and juices' (Statistics NZ 2024a) based on Eyles, et al. (2024), and then calculating the net impact on beer and soft drink consumption in TERM-NZ based on household expenditure data (Statistics NZ 2024a). The calculation is shown in Table 3
- 90 percent decrease in processed meat consumption, which limits such consumption in keeping with new dietary guidelines.[4]

Table 3 Calculation of SSBs consumption shock

Beverages in TERM-NZ 'Beer and soft drink' industry	Weekly spend[a] ($)	Percentage for sugar sweetened drinks[b]	Reduced spend ($)
Coffee, tea and other hot drinks	5.10		5.10
Soft drinks, waters and juices	10.40	29.9%	7.29
Beer	7.90		7.90
Total	**23.40**		**20.29**
Percentage of all beverages[c]		**13.3%**	

[a] Average weekly household expenditure (over all households), year ended June 2023 (Statistics NZ 2024a)
[b] Fraction based on Sugar sweetened drinks: Soft drinks (15.7%) + Electrolyte drinks, energy drinks, and flavoured water (2.3%) + Fruit and vegetable juices and drinks (11.9%) (Eyles et al. 2024)
[c] Calculation is 1 – (20.29 ÷ 23.40)
Source: NZIER

Import prices

- An increase in the price of imports of by 100 percent for the relevant commodity with changed, which simulates a policy focus on food security that prioritises domestic production.

Productivity increase

- A 0.1 percent increase in total factor productivity.

[4] The 90 percent decrease in processed meat consumption is intended to represent a 100 percent decrease, i.e., removal from the diet, but the model struggles with zero consumption of an existing commodity.

More information on each scenario is provided in the subsections below. To apply these to Table 2 we can use scenario 10 as an example. This scenario models a 101.7 percent increase in fruit consumption, a 172 percent increase in vegetable consumption, a 100 percent increase in the price of fruit and vegetable imports, and a 0.1 percent (one-tenth of one percent) increase in total factor productivity.

4 Results

4.1 Economic theory in action

Overall, changes in diet leads to a small decrease in the size of the economy with a fall in real (inflation-adjusted) gross domestic product (GDP). Household consumption and government spending fall as GDP contracts, and there is also a small increase in exports.

The basic explanation for the decline is that the model is based on the assumption that households maximise their welfare or wellbeing at current prices with their current basket of consumption. Forcing a change to that consumption creates a loss in welfare. The fact that the change creates a loss comes from underlying theory; the size of the loss is an informative result from the model.

When the consumption basket changes, commodities for which the demand has risen increase in production and imports or reduce exports to meet higher domestic demand. Higher output requires more employment and is met by increasing prices.

Losses in real GDP and household consumption are greater once import price rises are added into the model. When this happens more resource is shifted within New Zealand to fill the production gap that was previously being sourced as imports. The reduction of imports is also met with more exports being redirected to domestic consumption than before the import price increase.

When health benefits are included in the model in the form of a 0.1 percent productivity increase, overall GDP increases. Household consumption rises in scenarios in which there is the increase in productivity and no import constraints; that combination leads to a rising average real wage. No other levels of productivity growth were tested, so the modelling does not fully quantify the trade-off between health benefits and import constraints.

4.2 Key results

Key economic indicators of interest are GDP, household consumption (as a measure of consumer welfare), and trade. This section discusses the scenarios with the largest changes in key macroeconomic variables. Table 4 provides the key economic indicators from the CGE modelling for all scenarios. More key indicators are provided in Table 5 in the appendix, as are more detail modelling results in other tables.

Real GDP

- The largest increase in real GDP was 0.19 percent in scenario 6 when all the dietary changes were coupled with an increase in productivity from better health. The growth in real GDP was only 0.11 percent when import controls were added in scenario 11.

- The largest decrease in real GDP was in scenario 10 where the dietary changes are combined with increased import prices but without productivity gains, which caused real GDP to fall by 0.21 percent.

Real Household consumption

- As with real GDP, the largest increase in real household consumption was in scenario 6 where it increased by 0.13 percent because of the higher average real wage.
- The largest fall in real household consumption was in scenario 10 which caused a 0.60 percent decrease in real household consumption.

Exports

- The largest increase in exports was in scenario 6 where export quantities increased by 0.41 percent. This is a result of sectors being more productive because of improved health outcomes.
- The largest fall in exports was scenario 10, in which the consumption increase for fruits and vegetables was combined with the import price shock (compare with scenario 5: all dietary changes and no import controls). This caused exports to be redirected to domestic consumption.

Imports

- Import volumes increased by the largest amount in scenario 6, by 0.15 percent to support additional demand from fruit and vegetable consumption and broader goods across the economy as well as to support higher production.
- Import volumes decreased by the largest amount in scenario 10, which saw increased import prices but did not include a productivity increase. Import volumes fell by 2.10 percent.

Table 4 Selected macroeconomic results by scenario number (percent change)

Key indicators for each scenario listed in section 1.

	Scenario										
Variable	1	2	3	4	5	6	7	8	9	10	11
Real GDP	-0.04	-0.08	0.00	-0.01	-0.12	0.19	-0.12	-0.19	0.13	-0.21	0.11
Real Household Consumption	-0.07	-0.10	0.00	-0.01	-0.18	0.13	-0.17	-0.53	-0.22	-0.60	-0.29
Export Volume	0.12	-0.06	0.02	0.09	0.16	0.41	0.05	-0.86	-0.61	-1.18	-0.94
Import Volume	0.06	-0.16	0.02	0.10	0.02	0.15	-0.10	-1.68	-1.55	-2.1	-1.97
Average real wage	-0.12	-0.11	0.00	0.01	-0.21	0.20	-0.22	-0.65	-0.24	-0.71	-0.30
CPI	-0.08	0.04	0.00	0.01	-0.03	-0.04	-0.04	0.31	0.31	0.35	0.34

Source: NZIER.

4.3 Results tables

Full data tables are available in the appendix and show the following:

- Table 5 shows the main macroeconomic results.

- Table 6 shows the change in export quantities by sector
- Table 7 shows the change in import quantities by sector
- Table 8 shows the change in production quantities by sector
- Table 9 changes the production price by sector.

5 Discussion

5.1 Starting point for the research

The modelling reported here was focused on understanding the magnitude of macroeconomic impacts from changes in diets in New Zealand. The improved diet involved four specific changes: increased vegetable intake, increased fruit intake, (nearly) total removal of processed meat, and reduction in sugar sweetened beverages. These changes were modelled individual and in combination. An additional food policy was modelled: large increases in import prices as a proxy for policies to promote food sovereignty and local food production. Finally, the modelling included one shock that represented an economic benefit: a generalised increase in productivity.

As discussed above, the direction of impacts on the CGE model from the modelled shocks were known *a priori* because of assumptions underpinning the model. An exogenous (external) change to diets that is caused by policy rather than changes in consumer preferences by assumption creates a loss in consumer welfare. Similarly, constraints on imports by assumption produce economic losses. The productivity increase was similar: the direction of the impacts was known in advance. Productivity gains by definition create economic gains.

5.2 Lessons from the modelling

The two questions explored in this modelling were therefore the size of the economic impacts and the results from interacting the different shocks. The sizes of the individual diet shocks were small. The largest was the shock for vegetables, which produced a 0.10 percent decrease in consumer welfare to achieve the recommended level of vegetable consumption. Said differently, households maintained 99.9 percent of their pre-policy consumption level while also getting all their vegetables. The change in fruit consumption reduced consumer welfare by 0.07 percent, the reduction in sugar sweetened beverages reduced it by 0.01 percent, and the reduction in processed meat had no impact on consumer welfare. These impacts were additive in the modelling: the loss in consumer welfare from all four changes simultaneously was equal to the sum of the individual impacts. Making these four changes for healthier diets produced a 0.18 loss in consumer welfare. Again, looking at the impact differently, the consumer welfare level was 99.8 percent of its original level after the dietary changes.

Changes to GDP were slightly smaller than changes to consumer welfare. For example, the change from the four dietary changes together was a 0.12 percent reduction in GDP. The impacts again appeared essentially additive: the full set was nearly equal to the sum of the individual impacts.

The modelling also investigated the potential impacts from a diet-related policy: import controls meant to increase reliance on domestic food sources. This was modelled as a 100 percent increase in import prices for fruit and vegetables. This shock was not modelled in isolation, but only alongside other shocks. When it was combined with the dietary changes, the result was the largest negative impacts on the economy. The dietary changes pushed consumers away from their optimal basket of consumption and the import policy increased consumer prices. The worst combination created a 0.60 percent loss in consumer welfare. While this impact was more than three times the impact of the dietary changes alone, it also amounted to less than a one percent loss in consumer welfare, as well as loss of one-fifth of one percent of GDP.

All of the above model scenarios involved shocks that *a priori* were costs to the economy. A better diet should also produce benefits. The literature connecting healthy diet with economic productivity is complex, so it is difficult to quantify the direct impact. A better diet has been shown to increase self-reported job performance (Shi et al. 2013). When the impact of diet on presenteeism and absenteeism was investigated, the results were mixed. Modelling of the impact of disease-related mortality on income in New Zealand found a loss of a few percent points (Blakely et al. 2021), but the relevant causal chain could not be isolated for this modelling. The present modelling therefore assumed a benefit of 0.1 percent increase in productivity to examine the impact of that magnitude of change on net economic results. For context, a full-time employee in New Zealand would generally have 12 statutory holidays and 20 days of annual leave per year, leaving 228 days at work for the 260 weekdays in a year. The 0.1 percent increase in productivity could be achieved by decreasing absenteeism by 1 day per year for every 4 employees. At that level, all the negative impacts of the dietary changes are reversed and there is a small economic gain, both in terms of consumer welfare and GDP. This level of productivity gain is not, however, sufficient to counteract losses due to import price controls.

5.3 Answers to some questions

These results provide some indications about the answers to three questions. One question concerns the extent of economic disruption from improving diets. The modelling suggests that the New Zealand economy can supply all the food necessary for an improved diet for the population, especially if the supply is a combination of domestically produced and imported, with minimal macroeconomic impact. In fact, the 1 percent drop in GDP for the September 2024 quarter (Statistics NZ 2024b) was a bigger economic loss than anything produced by the modelled dietary changes.

A second question is whether dietary improvements are worthwhile considering the balance of costs and benefits. These initial results suggest that improved diets are worthwhile because the negative economic impacts are offset at low levels of productivity gains. These gains need to be investigated and quantified because existing literature does not provide them. However, the relative orders of magnitude suggest a positive benefit-cost ratio.

A third question concerns the relative benefits of different approaches. There have been calls for a national food policy in New Zealand, such as a 2023 call from several National Science Challenge (Building Better Homes, Towns and Cities et al. 2023). Suggested changes include more equitable access to nutritious food, optimised local food production, and a food system that balances domestic needs and trade benefits. This modelling showed that changes in the food system can have both positive and negative impacts. Some negative impacts, while always under one percent of household consumption, are larger than the positive impacts modelled here. The results suggest that some policies will be more worthwhile than others, and some might even not be worthwhile if measured only by net economic benefit.

6 Conclusion

Unhealthy diets are a public health concern in industrialised, Western countries. The economic impacts of unhealthy diets – and the potential economic benefits from improved diets – are not fully clear. Researchers at the University of Otago are approaching these topics with interdisciplinary methods. NZIER is contributing to that research by using changes in dietary intake, which are inputs to diet Multistate Lifetable (MSLT) modelling to estimate health impacts, as inputs to its macroeconomic CGE model, TERM-NZ. The aim is to understand changes in consumer welfare and economic activity from potential changes in diet.

Several scenarios were modelled to estimate potential impacts on consumer welfare and GDP in New Zealand. These scenarios were built up from a combination of specific changes to New Zealand diets, import price controls and productivity gains. The results from the modelling suggest several conclusions. First, New Zealand could support healthier diets with minimal disruption to consumption bundles, production, consumer welfare and GDP. Any modelled economic losses are minor compared to the usual quarterly movements in macroeconomic indicators. Better diets at the national scale are economically feasible. Second, the potential productivity gains are probability sufficient to offset any losses. This is less certain, because the required input data are not available in the data. However, the level of productivity gain required is small compared to some of the figures reported in the literature. Third, some policies will be better than other for improving the New Zealand national food system. This result suggests that economic modelling should happen alongside the development of any such initiative to prioritise better policies.

This research also demonstrated the value of interdisciplinary research and combined modelling exercises. The results produced here, and the new knowledge created, were only possible by working across specialisations in respectful collaboration.

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Appendix A CGE results

Table 5 Macroeconomic results by scenario number (percent change)

Key headline indicators for each scenario listed in section 1

	Scenario										
Variable	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Real Household Consumption	-0.07	-0.1	0.00	-0.01	-0.18	0.13	-0.17	-0.53	-0.22	-0.60	-0.29
Real Investment	-0.03	-0.11	0.00	0.03	-0.11	0.08	-0.14	-0.14	0.06	-0.13	0.06
Real Government Expenditure	-0.07	-0.1	0.00	-0.01	-0.18	0.13	-0.17	-0.53	-0.22	-0.60	-0.29
Export Volume	0.12	-0.06	0.02	0.09	0.16	0.41	0.05	-0.86	-0.61	-1.18	-0.94
Import Volume Used	0.06	-0.16	0.02	0.10	0.02	0.15	-0.10	-1.68	-1.55	-2.10	-1.97
Imports Landed	0.06	-0.16	0.02	0.10	0.02	0.15	-0.10	-1.68	-1.55	-2.10	-1.97
Real GDP	-0.04	-0.08	0.00	-0.01	-0.12	0.19	-0.12	-0.19	0.13	-0.21	0.11
Aggregate Employment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average real wage	-0.12	-0.11	0.00	0.01	-0.21	0.20	-0.22	-0.65	-0.24	-0.71	-0.30
Capital Stock	-0.04	-0.08	0.00	0.02	-0.10	0.09	-0.12	-0.14	0.06	-0.14	0.05
GDPPI	-0.10	0.01	-0.01	0.00	-0.09	-0.10	-0.08	-0.03	-0.05	-0.05	-0.06
CPI	-0.08	0.04	0.00	0.01	-0.03	-0.04	-0.04	0.31	0.31	0.35	0.34
Export Price Index	-0.02	0.01	0.00	-0.02	-0.03	-0.08	-0.01	0.17	0.12	0.24	0.19
Imports Landed Price index	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.68	0.87	0.87

Source: NZIER.

Table 6 Change in export quantities by sector (percent change)

Trade impacts for each scenario listed in section 1

	Scenario										
Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Trade	0.64	0.14	0.03	-0.06	0.74	0.58	0.76	0.76	0.6	0.71	0.55
Living plant	-0.07	-1.88	0.00	-0.11	-2.05	-2.03	-1.94	-3.18	-3.16	-3.29	-3.27
Vegetables	**0.53**	**-17.12**	**0.01**	**-0.08**	**-16.65**	**-16.65**	**-16.52**	**-22.78**	**-22.78**	**-22.95**	**-22.95**
Fruit	**-10.13**	**0.05**	**0.12**	**-0.08**	**-9.93**	**-9.87**	**-9.91**	**-21.52**	**-21.48**	**-21.78**	**-21.74**
Forage	0.09	-0.23	0.11	0.38	0.32	0.49	-0.15	-0.39	-0.23	-0.11	0.06
Arable	0.16	-2.90	0.00	0.65	-2.13	-1.94	-2.73	-3.32	-3.13	-2.70	-2.51
Meat	0.29	0.14	-0.01	0.80	1.19	1.33	0.42	0.52	0.67	1.37	1.52
Wool	0.27	0.21	0.00	0.04	0.51	0.81	0.47	0.53	0.83	0.57	0.86
Forestry	0.60	0.17	0.03	-0.06	0.73	1.04	0.75	0.85	1.17	0.84	1.15
Fisheries	0.56	0.11	0.03	-0.05	0.63	0.83	0.66	0.65	0.84	0.64	0.83
Forest and fisheries supporting services	0.62	0.18	0.03	-0.05	0.77	0.77	0.79	0.93	0.93	0.95	0.95
Other manufacturing	0.53	0.14	0.03	-0.04	0.65	0.75	0.66	0.72	0.83	0.71	0.82
Meat production	0.48	0.15	0.01	0.33	0.96	1.17	0.62	0.73	0.94	1.12	1.33
Processed meat	**0.50**	**0.14**	**0.01**	**0.29**	**0.94**	**1.11**	**0.64**	**0.73**	**0.90**	**1.08**	**1.25**
Fisheries production	0.60	-0.36	0.03	-0.06	0.21	0.32	0.23	-0.80	-0.68	-0.80	-0.68
Dairy production	0.41	0.15	0.01	0.46	1.01	1.39	0.55	0.54	0.92	1.00	1.39
Other Food and Drink production	0.26	-0.38	0.03	-0.01	-0.12	-0.01	-0.13	-3.87	-3.77	-4.03	-3.93
Beer and soft drink production	**0.01**	**0.14**	**0.03**	**-0.05**	**0.13**	**0.23**	**0.15**	**-3.60**	**-3.50**	**-4.05**	**-3.95**
Textiles clothes and fabrics	0.57	0.18	0.03	-0.05	0.72	0.75	0.74	0.86	0.88	0.85	0.88
Wood production	0.62	0.18	0.03	-0.06	0.77	0.93	0.79	0.93	1.09	0.92	1.08
Pulp and paper	0.59	0.17	0.03	-0.06	0.72	0.96	0.74	0.86	1.09	0.85	1.08

Industry	Scenario 1	2	3	4	5	6	7	8	9	10	11
Printing	0.63	0.18	0.03	-0.06	0.77	0.66	0.8	0.93	0.82	0.92	0.81
Utilities	0.63	0.19	0.03	-0.06	0.78	1.35	0.81	0.92	1.49	0.90	1.47
Other service	0.64	0.18	0.03	-0.06	0.78	0.71	0.80	0.87	0.81	0.82	0.76
Holiday	0.47	0.04	0.02	-0.02	0.51	1.04	0.50	-0.43	0.10	-2.16	-1.64

Source: NZIER.

Table 7 Change in import quantities by sector (percent change)

For each scenario listed in section 1

	Scenario										
Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Trade	-0.35	-0.15	0.02	0.06	-0.43	-0.28	-0.5	-0.6	-0.45	-0.59	-0.44
Living plant	1.23	4.57	0.06	0.16	5.98	6.03	5.74	8.71	8.77	8.97	9.02
Vegetables	**-0.50**	**102.17**	**0.08**	**0.24**	**101.23**	**101.52**	**100.33**	**-60.47**	**-60.41**	**-60.32**	**-60.27**
Fruit	**65.9**	**0.25**	**-0.35**	**0.29**	**65.20**	**65.36**	**64.96**	**-53.76**	**-53.72**	**-53.40**	**-53.36**
Forage	0.49	0.60	-0.24	-0.79	0.08	0.02	1.09	1.69	1.62	1.19	1.12
Arable	0.23	5.50	0.01	-1.12	4.61	4.59	5.69	6.86	6.84	5.75	5.73
Meat	-0.37	-0.52	0.07	-0.50	-1.31	-1.21	-0.88	-0.91	-0.81	-1.38	-1.29
Wool	-0.14	-0.51	0.03	-0.02	-0.64	-1.03	-0.65	-0.78	-1.17	-0.73	-1.13
Forestry	0.19	0.17	-0.03	-0.01	0.32	0.20	0.35	0.56	0.44	0.60	0.48
Fisheries	-0.19	-0.77	0.05	0.10	-0.80	-0.76	-0.94	-1.46	-1.43	-1.38	-1.34
Forest and fisheries supporting services	1.58	1.79	-0.04	-0.25	3.06	3.10	3.33	5.51	5.55	5.34	5.39
Other manufacturing	-0.29	-0.39	0.02	0.09	-0.57	-0.47	-0.67	-0.71	-0.61	-0.60	-0.50
Meat production	-0.59	-0.04	0.06	-0.35	-0.90	-0.88	-0.62	-0.84	-0.82	-1.37	-1.35
Processed meat	**-0.69**	**-1.06**	**0.08**	**-35.58**	**-36.19**	**-36.09**	**-1.73**	**-2.19**	**-2.07**	**-103.21**	**-101.18**
Fisheries production	-0.50	-0.75	0.07	0.13	-1.05	-0.99	-1.24	-1.14	-1.09	-1.10	-1.04
Dairy production	-0.73	-0.57	0.09	-0.07	-1.26	-1.33	-1.28	-1.46	-1.52	-1.69	-1.76
Other Food and Drink production	-0.51	0.32	-0.04	0.17	-0.07	0.04	-0.19	1.23	1.34	1.48	1.59
Beer and soft drink production	**-0.10**	**-0.61**	**-0.09**	**0.14**	**-0.66**	**-0.44**	**-0.70**	**0.96**	**1.18**	**-86.44**	**-86.42**
Textiles clothes and fabrics	-0.87	-1.47	0.11	0.29	-1.93	-1.82	-2.31	-2.52	-2.40	-2.15	-2.04
Wood production	-0.03	0.17	-0.01	0.07	0.19	0.16	0.13	0.53	0.49	0.57	0.54
Pulp and paper	0.17	1.35	-0.45	-0.08	1.00	0.92	1.50	1.95	1.87	2.41	2.33

	Scenario										
Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Printing	-0.88	-1.37	0.10	0.29	-1.85	-1.68	-2.22	-2.40	-2.22	-2.06	-1.89
Utilities	-0.61	-0.83	0.05	0.16	-1.21	-1.31	-1.42	-1.58	-1.67	-1.39	-1.49
Other service	-0.43	-0.49	0.00	0.11	-0.81	-0.60	-0.91	-1.15	-0.94	-1.14	-0.93
Holiday	-0.82	-1.38	0.10	0.27	-1.82	-1.58	-2.17	-2.49	-2.26	-2.23	-1.99

Source: NZIER.

Table 8 Change in production quantity by sector (percent change)

Key headline indicators for each scenario listed in section 1.

	Scenario										
Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Trade	0.04	0.33	-0.05	-0.06	0.26	0.41	0.36	-0.08	0.08	-0.1	0.06
Living plant	0.94	2.75	0.04	0.07	3.77	3.83	3.64	5.38	5.44	5.53	5.59
Vegetables	**-0.14**	**67.99**	**0.07**	**0.16**	**67.73**	**67.98**	**67.22**	**86.06**	**86.32**	**86.53**	**86.79**
Fruit	**14.09**	**-0.1**	**-0.11**	**0.04**	**13.75**	**13.87**	**13.75**	**29.31**	**29.44**	**29.75**	**29.88**
Forage	0.43	0.34	-0.08	-0.32	0.38	0.49	0.76	1.06	1.17	0.89	1
Arable	0.29	2.57	0.02	-0.49	2.4	2.57	2.83	3.37	3.55	2.96	3.14
Meat	0.17	-0.02	0.03	-0.58	-0.39	-0.19	0.15	0.1	0.3	-0.49	-0.29
Wool	0.18	-0.08	0.02	0.04	0.15	0.26	0.09	0.08	0.19	0.15	0.27
Forestry	0.5	0.19	0.01	-0.04	0.65	0.82	0.68	0.86	1.03	0.87	1.04
Fisheries	0.24	-0.32	0.05	0.02	-0.02	0.13	-0.08	-0.33	-0.18	-0.29	-0.14
Forest and fisheries supporting services	2	2.13	-0.08	-0.32	3.7	3.76	4.08	6.7	6.75	6.57	6.62
Other manufacturing	0.22	-0.04	0.01	0.03	0.21	0.38	0.17	0.25	0.43	0.31	0.48
Meat production	0.09	-0.06	0.04	0.21	0.27	0.49	0.03	0.01	0.23	0.2	0.42
Processed meat	**-0.34**	**-0.91**	**0.08**	**-44.82**	**-44.83**	**-44.72**	**-1.24**	**-1.42**	**-1.2**	**-44.61**	**-44.47**
Fisheries production	0.28	-0.64	0.05	0.01	-0.3	-0.14	-0.36	-1.26	-1.11	-1.27	-1.12
Dairy production	0.22	-0.03	0.02	0.42	0.62	0.99	0.19	0.11	0.47	0.45	0.82
Other Food and Drink production	-0.17	-0.24	0.05	0.12	-0.25	-0.08	-0.41	-2.95	-2.77	-3	-2.82
Beer and soft drink production	**-0.54**	**-0.99**	**-5.91**	**0.2**	**-7.09**	**-6.9**	**-1.51**	**-2.6**	**-2.39**	**4.97**	**5.19**
Textiles clothes and fabrics	0.13	-0.28	0.03	0.04	-0.09	-0.01	-0.16	-0.21	-0.12	-0.11	-0.02
Wood production	0.27	0.06	0.01	0	0.34	0.45	0.33	0.47	0.58	0.49	0.6
Pulp and paper	0.56	0.95	-0.25	-0.09	1.16	1.33	1.49	1.86	2.03	2.14	2.31

	Scenario										
Industry	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Printing	0.02	-0.49	0.07	0.1	-0.31	-0.27	-0.47	-0.41	-0.38	-0.26	-0.23
Utilities	-0.25	-0.45	0.04	0.07	-0.59	-0.5	-0.7	-0.79	-0.7	-0.69	-0.6
Other service	-0.23	-0.46	0.03	0.08	-0.58	-0.37	-0.69	-0.91	-0.7	-0.89	-0.68
Holiday	-0.13	-0.71	0.07	0.13	-0.64	-0.17	-0.83	-1.6	-1.13	-2.58	-2.11

Source: NZIER.

Table 9 Change in production prices by sector (percent change)

For each scenario listed in section 1

Industry	Scenario										
	1	2	3	4	5	6	7	8	9	10	11
Trade	-0.13	-0.03	-0.01	0.01	-0.15	-0.12	-0.15	-0.15	-0.12	-0.14	-0.11
Living plant	0.05	0.48	0.00	0.02	0.56	0.54	0.53	0.85	0.84	0.87	0.86
Vegetables	**-0.10**	**4.92**	**0.00**	**0.02**	**4.80**	**4.79**	**4.76**	**6.85**	**6.85**	**6.91**	**6.90**
Fruit	**2.47**	**-0.01**	**-0.03**	**0.02**	**2.42**	**2.40**	**2.42**	**5.66**	**5.64**	**5.74**	**5.72**
Forage	0.00	0.06	-0.02	-0.09	-0.05	-0.09	0.05	0.11	0.07	0.04	0.00
Arable	-0.02	0.68	0.00	-0.15	0.51	0.46	0.65	0.80	0.75	0.65	0.6
Meat	-0.05	-0.03	0.00	-0.17	-0.24	-0.27	-0.08	-0.10	-0.13	-0.28	-0.31
Wool	-0.05	-0.04	0.00	-0.01	-0.10	-0.16	-0.09	-0.10	-0.17	-0.11	-0.18
Forestry	-0.12	-0.03	-0.01	0.01	-0.14	-0.22	-0.15	-0.17	-0.25	-0.17	-0.24
Fisheries	-0.11	-0.02	-0.01	0.01	-0.12	-0.17	-0.13	-0.13	-0.17	-0.12	-0.17
Forest and fisheries supporting services	-0.12	-0.04	-0.01	0.01	-0.15	-0.15	-0.16	-0.19	-0.19	-0.19	-0.19
Other manufacturing	-0.10	-0.03	0.00	0.01	-0.12	-0.16	-0.13	-0.14	-0.17	-0.14	-0.17
Meat production	-0.09	-0.03	0.00	-0.08	-0.20	-0.25	-0.12	-0.14	-0.20	-0.24	-0.29
Processed meat	**-0.09**	**-0.03**	**0.00**	**-0.08**	**-0.20**	**-0.25**	**-0.12**	**-0.14**	**-0.20**	**-0.23**	**-0.28**
Fisheries production	-0.12	0.08	-0.01	0.01	-0.03	-0.06	-0.03	0.20	0.17	0.20	0.17
Dairy production	-0.08	-0.03	0.00	-0.10	-0.20	-0.29	-0.11	-0.10	-0.19	-0.20	-0.29
Other Food and Drink production	-0.04	0.10	-0.01	0.00	0.06	0.03	0.06	0.98	0.94	1.02	0.98
Beer and soft drink production	**0.04**	**-0.03**	**-0.01**	**0.01**	**0.02**	**-0.02**	**0.01**	**1.06**	**1.02**	**1.18**	**1.14**
Textiles clothes and fabrics	-0.11	-0.04	-0.01	0.01	-0.14	-0.15	-0.15	-0.17	-0.18	-0.17	-0.18
Wood production	-0.12	-0.04	-0.01	0.01	-0.15	-0.19	-0.16	-0.19	-0.23	-0.19	-0.23
Pulp and paper	-0.12	-0.03	-0.01	0.01	-0.14	-0.20	-0.15	-0.17	-0.23	-0.17	-0.23

Industry	Scenario										
	1	2	3	4	5	6	7	8	9	10	11
Printing	-0.13	-0.04	-0.01	0.01	-0.16	-0.13	-0.16	-0.19	-0.17	-0.19	-0.17
Utilities	-0.13	-0.04	-0.01	0.01	-0.16	-0.27	-0.16	-0.18	-0.30	-0.18	-0.29
Other service	-0.13	-0.04	-0.01	0.01	-0.15	-0.14	-0.16	-0.17	-0.16	-0.16	-0.15
Holiday	-0.09	-0.01	0.00	0.00	-0.10	-0.21	-0.10	0.09	-0.02	0.44	0.33

Source: NZIER.