Report

nzier
authoritative analysis

Economic impact of Chatham Rock Phosphate

A general equilibrium analysis

Draft NZIER report to Chatham Rock Phosphate Ltd
September 2012

About NZIER

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NZIER was established in 1958.

Authorship

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Key points

Chatham Rock Phosphate is investigating a phosphate-mining project (the CRP project). NZIER have been asked to analyse the impacts of the CRP project on the New Zealand economy. This report documents an initial investigation of the economy-wide, monetary costs and benefits. A companion piece estimating the environmental effects will be completed later in 2012 and will draw on this work for a more complete cost-benefit analysis.

The key findings in this report are:

- New Zealand has over 25 million tonnes of rock phosphate in the Chatham Rise. Unlocking that resource, as Chatham Rock Phosphate Ltd plans to do, will make New Zealand wealthier
- Implementing the mining project over 16 years is equivalent to the country becoming $1.3 billion richer today. At least $800 million of that welfare gain will accrue to people with no ownership interest in Chatham Rock Phosphate Ltd
- The project will remove New Zealand's dependence on imported rock phosphate, of which we currently import at least $185 million worth per year
- It will generate over $300 million of export revenue for the economy in each year of its 16-year lifespan. That will boost GDP by $380 million in each year of the mine's operation
- The economic cost of the operation is primarily in the penalty our exporters pay from an appreciation in the dollar. However, that penalty is small, and the appreciation allows New Zealanders to obtain cheaper goods from overseas. In sum, we expect households to be able to purchase an extra $170 million of imports in each year of operation
- The scenario assessed here does not include the investment or environmental costs of the project, and assumes that the increase in domestic production does not reduce the price of rock phosphate
- These results are highly sensitive to the world demand for rock phosphate
- The final version of this economic report should be read in conjunction with the environmental analysis (to be completed by NZIER in December 2012).

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1. Objective

Chatham Rock Phosphate is investigating a phosphate-mining project (the CRP project) that will considerably increase New Zealand's domestic supply of phosphate. NZIER have been asked to analyse the impacts of the CRP project on the New Zealand economy. This report documents an initial investigation of the economy-wide, monetary costs and benefits. A companion piece estimating the environmental effects will be completed later in 2012 and will draw on this work for a more complete cost-benefit analysis.

The CRP project will make New Zealand fundamentally wealthier. New Zealand has an abundance of rock phosphate on the Chatham Rise and CRP's project will use a previously unused resource. When that resource is unlocked, New Zealand will enjoy a positive wealth shock.

In this report, we investigate how the wealth shock is transferred to the rest of the New Zealand economy, as the mining of rock phosphate reduces imports and increases exports of phosphate.

2. Context of the project

The CRP project intends to mine rock phosphate from the Chatham Rise in order to supply phosphate to the fertiliser industry. The rock phosphate will be both exported and sold to New Zealand fertiliser manufacturers.

2.1 The fertiliser industry

The use of phosphatic fertilisers in New Zealand agriculture is extremely widespread. Super-phosphate alone accounts for a third of fertiliser used in New Zealand by tonnage. In total, phosphatic fertilisers account for over 40% of the fertiliser used in New Zealand.[1]

Of the important agricultural sectors of the New Zealand economy, all have a high usage of fertiliser: fertiliser is over 15% of dairy farming's intermediate inputs; 8% for horticulture and sheep and beef farming.[2]

Production of super-phosphate and other phosphatic fertilisers relies largely on imported rock phosphate. Statistics New Zealand's data shows highly volatile import volumes over the last few years, ranging from 320,000 tonnes in 2009 to 890,000 tonnes in 2010. Since we are modelling a long-run change in the economy the volatility is not important but only the long-run projection of import volumes and values. As a crude estimate of that we have averaged the past two years' imports to 770,000 tonnes of rock phosphate.

CRP's estimates of import volumes, derived from discussions with industry sources, suggest that Statistics New Zealand's numbers are low and the true volume is closer to 1 million tonnes. We have been unable to reconcile the two estimates so we use Statistics New Zealand's data in our central estimate and later test the effect of a larger baseline import volume.

[1] Statistics New Zealand, Agricultural Production Census/Survey

[2] NZIER CGE database, based on Statistics New Zealand Input-Output tables, 1996 Supply and Use tables 2003.

2.2 The Chatham Rock Phosphate project

The following projections of the impact of the CRP projects are drawn largely from Chatham Rock Phosphate Ltd's investment prospectus and related materials. We have not verified the plausibility of the projections.

The CRP project is expected to produce 1.5 million tons of rock phosphate per year, with two-thirds expected to be exported to South East Asia and Australia, and the remainder to substitute for domestic imports.

CRP expects extraction and shipping of the rock phosphate to cost US$130/tonne and the sale price to be about US$170/tonne. World prices have varied from US$40/tonne to US$500/tonne over the past decade but CRP expects them to average around US$245/tonne during the period of production for Moroccan rock containing 32% phosphate.[3] At an exchange rate of about US$0.80 per NZ$1 that implies a world price of about $300/tonne in domestic currency. CRP's rock contains only 22% phosphate so is expected to sell at the correspondingly lower price of $210/tonne.

Statistics New Zealand's import data implies an average import price of $240/tonne, which is substantially below CRP's estimates. At that price the value of 770,000 tonnes of rock phosphate imports is about $185 million, which is what we assume for current production in the baseline scenario. Variation in the world price is later considered as a sensitivity test on the results, given the uncertainty over future prices.

Production is expected to commence in 2015, continuing for 16-17 years.

2.2.1 Sales projections

Once in commercial production, CRP expects to sell US$270 million worth of rock phosphate per year. Assuming an exchange rate of about US$0.80 per NZ$1, that equates to approximately $340 million of revenue per year.[4] Using CRP's projected proportion of exports indicates export revenues of $230 million and domestic import substitution of over $110 million worth of rock phosphate. The projected level of import substitution accounts for nearly two-thirds of the total value of New Zealand's rock phosphate imports.

We assume CRP will sell rock phosphate at the world price. That means there is no change in the domestic fertiliser production industry, save for the fact that it now purchases rock phosphate locally, rather than from overseas. Any saving that CRP make from reduced shipping costs are assumed to be retained as profits.

Local production may imply some increase in the security of supply but we have not quantified any such effect. The assumption that local producers will switch from imported rock phosphate to CRP's product is not itself tested in our modelling. However, the preference of most businesses to deal with their compatriots suggests that there is no reason to doubt CRP's projection.[5]

2.2.2 Cost structure

The cost structure of CRP is expected to be slightly unusual because CRP will contract out the mining to a Dutch firm. Consequently, a large proportion of their inputs to production will be imported. The domestic operation will consist only of a lightly staffed

[3] Import prices quoted here include insurance and freight charges. 2008 is an outlier with extremely high world prices.

[4] We use the convention that a bare dollar sign denotes New Zealand currency.

[5] J. McCallum, "National Borders Matter: Canada-US Regional Trade Patterns," *The American Economic Review* 85, no. 3 (1995): 615–623.

administrative unit. Domestic intermediate purchases are dominated by fuel for the mining ships.

Also notable is the high shipping cost of rock phosphate. Being a bulky commodity, it costs about $38/tonne to export, which means an annual shipping cost of around $38 million, given export projections.

A detailed breakdown of expected operating expenses was not available at the time of writing. We have used rough estimates by CRP along with Statistics New Zealand's data on mining operations in New Zealand to estimate a cost structure for CRP's operations (Table 1).

Table 1 Cost structure of CRP

Estimated annual costs of operation

Cost category	Approximate annual cost	Percentage of total costs
Domestic intermediates	$30 million	13%
Imported intermediates	$160 million	55%
Transport costs	$38 million	17%
Taxes[6]	$32 million	14%
Labour and overheads	$5 million	2%
Total cost	**$265 million**	
Profit	**$75 million**	

Source: Chatham Rock Phosphate Ltd, NZIER

Note that the taxes in the above cost estimates include a provision of 1% of revenue for royalties on the recovered rock.

2.2.3 Ownership structure of CRP

An important question for the allocation of surplus is the ownership of the organisation. CRP expects to be about 50% overseas owned so we need to model half of the profits being owned offshore. A complication is that we are not modelling the investment phase of the project, but only the production phase. That means we would capture the outflow of profits in our model, but not the corresponding inward flow of investment. To deal with that problem we assume that the outward flow in the production phase is equal in net present value to the inward flow in the investment phase as CRP raises equity. Consequently, these two cancel out as long as the original CRP ownership lies in New Zealand, which it does.[7]

[6] Assuming profits are taxed at the company rate of 28%.

[7] Note that this also assumes no supernormal profits go offshore.

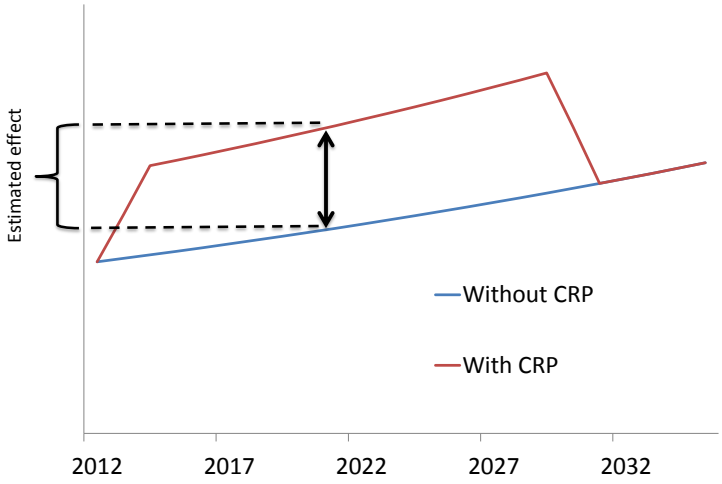
3. National impact of the CRP project

3.1 Interpreting the results

We use a computable general equilibrium model to estimate the likely long-run, annual impact of CRP's operations on the New Zealand economy. The benefit of a CGE model is that it considers both the first round effects of the project — increased production and increased returns to capital in the phosphate mining industry — as well as the impact that this first round effect has on other prices, and demand and production, in the rest of the New Zealand economy.

The effect we estimate will persist as long as CRP is operational, although we might expect the economy to return to its previous state once CRP ceases operations in around twenty years' time (Figure 1).

Figure 1 Estimation strategy



Source: NZIER

We assess the scenario as if the operation was suddenly here tomorrow, fully functioning. Our analysis is not dynamic and does not represent an analysis of the total benefits over the lifetime of the project, from consenting to decommissioning. However, we do sum the effects over the operating period to give an idea of the overall magnitude of effects.

3.1.1 Direct, indirect and induced effects

To explain the modelling results we track the impacts as they flow through the economy, beginning with the direct impacts on the rock phosphate industry. We then analyse the flow-on, or indirect, and induced impacts. It can aid understanding to split indirectly affected industries into the following categories:

- **Downstream industries** – super-phosphate fertilizer is a large intermediate input for agricultural industries. Those industries may benefit from a more

developed local fertiliser sector. However, if they face the same fertiliser price then the benefits will not be quantified in this analysis.

- **Household expenditure industries** – industries that households spend money on are likely to benefit from increased incomes through wages and returns to capital from increasing phosphate production and exports. Those industries include hospitality and the retail trade.
- **Competing export industries** – these industries suffer from CRP's growth as they compete for resources, which are now more expensive, and face a stronger New Zealand dollar. Typically these industries are the agricultural and manufacturing export industries.[8] In this case, many downstream industries will also be the competing export industries.

Finally, the national results flow logically from the direct and indirect impacts. We focus on key macroeconomic variables such as employment and gross domestic product (GDP).

We also report the change in economic welfare (how 'well off' we are). The welfare change is a better measure of the project's impact than GDP. It shows the amount of money that New Zealanders would need to receive in order to make them as well-off as the CRP project.[9]

3.2 Direct impact

The direct impact of the project is twofold:

- New Zealand's exports of rock phosphate increase by $230 million per year
- New Zealand's imports of rock phosphate from decline by $110 million per year.

The price of rock phosphate is assumed not to change because of the CRP project. That means there is no growth in the fertiliser industry induced by the project.

3.3 Flow-on impacts

The flow-on results how the effect of increased wealth in New Zealand from the rise in export earnings. They also show how the consequent appreciation of the exchange rate dampens export earnings for competing exporters.

The **downstream agricultural industries**, which use fertiliser as an intermediate input, are barely affected through their super-phosphate use. That is because we assumed that the CRP project does not lower the price of phosphate to these downstream sectors. If the project does in fact reduce prices to farmers (perhaps during periods of high spikes), there will be tangible benefits to the sector, although they may be offset by lower profits for CRP.

[8] In a dynamic analysis, we would also consider the impacts on investment-related industries such as business construction and infrastructure sectors. Due to the specifics of this analysis, in which we analyse the plant as if it was suddenly here, we do not consider the effects of the CRP project on construction and related investment industries.

[9] The measure we calculate is referred to by economists as the 'equivalent variation'. It is also regularly used in cost-benefit analyses to measure the net benefit of a project.

Table 2 Flow-on effects

Percentage change in value-added relative to business-as-usual, selected industries

Industry	Category	Percentage change in activity
Dairy cattle	Downstream and export competing industry	-0.019%
Horticulture	Downstream and export competing industry	-0.027%
Retail goods	Household expenditure industry	0.152%
Hospitality	Household expenditure industry	0.500%
Textiles	Competing export industry	-0.073%

Source: NZIER

However in this analysis, because the downstream industries are also **competing exporting industries**, they are hurt by the increase in demand for the New Zealand dollar caused by increased rock phosphate exports. The appreciation of the exchange rate results in them being slightly less competitive internationally, which reduces their revenues.

By contrast, the flow-on impacts for **household expenditure industries** are clearly positive. Higher returns to capital and labour, and export earnings boost national income, leading to increased spending in industries such as retail and hospitality.

3.4 National results

Table 3 summarises the results at the national level. The economy benefits from the wealth shock of utilising a previously dormant resource. Exports rise and, consequently, there is an increase in wealth, which generates increased consumption spending. Higher incomes and the stronger $NZ result in more imports in aggregate, despite declining imports of fertiliser.

The two major contributors to the welfare effect are the newfound wealth of CRP's owners and the increased purchasing power of households due to the appreciation of the exchange rate. Overall, that creates an extra $180 million worth of welfare for New Zealanders in each year of CRP's operation. Summed over the sixteen operating years, that amounts to almost $1.3 billion in net present value.

The appreciation of the exchange rate causes imports to be cheaper, which increases the purchasing power of households' income. Their increased wealth also contributes to an additional $240 million of domestic spending each year.

In sum, the output of the national economy rises by $380 million in each year of CRP's operation.

Table 3 National results

Annual change from business-as-usual, per year

Indicator	Percentage change	Indicative dollar value
Welfare (EV)		$180 million
Real GDP	0.20%	$380 million
Consumption[10]	0.16%	$240 million
Exports	0.55%	$310 million
Imports	0.43%	$230 million
Real exchange rate	0.03%	

Source: NZIER

3.4.1 Distribution of impacts

While Table 3 shows a clear national benefit, it is important to understand the distribution of the costs and benefits. Exports have risen by $310 million nationally, but CRP alone is exporting an additional $230 million. That means other exporters across New Zealand have gained $80 million of revenue.

Similarly, imports have risen by $230 million despite CRP directly causing only a $50 million increase in import value.[11] The increase in household incomes generated by the extra wealth, in concert with the improvement in our terms of trade, causes imports to rise by $170 million over and above the direct impact of CRP.

The annual welfare gain is $180 million in each year that CRP operates. Suppose that the owners of CRP glean the full welfare benefit of their $75 million profits.[12] The remaining $115 million of welfare gain accrues to people not directly associated with CRP. If CRP operates for 16 years from 2015 then that stream of benefits to the wider New Zealand public is worth over $800 million today, excluding the benefit to CRP's owners.[13]

[10] Includes public and private consumption spending.

[11] CRP substitutes their production for $110 million of rock phosphate imports. They also import $160 million of intermediate imports. The total direct effect on imports is an increase of $50 million.

[12] This is a simplification for the purposes of exposition but a more technical breakdown yields qualitatively similar results.

[13] Net present value of the stream of welfare gains calculated at an 8% discount rate.

4. Varying the assumptions

Numerous assumptions were made in the course of the modelling work detailed above. In this section we test the sensitivity of the results to variations in those assumptions. The aim is to understand whether the results are an artefact of the data that we are least certain of.

Three tests are performed:

- a change in the size of the baseline market for rock phosphate in New Zealand
- a change in the profitability of the CRP project
- a variation in the extraction period.

For each of these tests we compute the macroeconomic results and compare them with the baseline.

4.1 Scenarios

4.1.1 Larger baseline market

For our baseline scenario we used Statistics New Zealand's import data to estimate the value of New Zealand's rock phosphate imports at $185 million per year for 770,000 tonnes. CRP suggested that the true volume may be closer to 1 million tonnes per year at $280/tonne. It is not possible to reconcile the two data sources but we can test whether the size of pre-existing imports would make a difference to the impact that CRP will have upon the New Zealand economy.

For this scenario we conduct the same simulation but on a database with pre-existing rock phosphate imports worth $280 million. The assumptions around CRP's rock volume and price remain the same as in the baseline.

4.1.2 Varying profitability

The second test is of the impact that CRP's profitability has on the national results. The profitability depends crucially upon the US$/euro exchange rate, since inputs are bought in euros but outputs are sold in US dollars. Exchange rates are notoriously fickle and difficult to forecast so that presents a significant risk to CRP's profitability.

To estimate the effect that a fall in profitability would have upon the national results we decrease the price of CRP's rock phosphate by 10% in the simulation. That reduces the export price received by CRP, but does not affect the import price of the remainder of the rock phosphate used in New Zealand. That seems unrealistic, and is, but the goal of the simulation is to estimate the effect of a change in CRP's profitability, not of a pure world price change. Consequently, it is preferable to avoid muddying the results by also allowing domestic firms cheaper imports.

4.1.3 Different extraction period

The final sensitivity test investigates the difference in national impact if CRP were able to extract for only ten years, rather than sixteen. This test is different from the other two because it does not change the annual results, only the net present value of the project.

4.2 Results of sensitivity testing

The headline numbers from the sensitivity testing are shown in Table 4.

Table 4 Results of sensitivity test

Percentage change from business-as-usual, per year

Indicator	Baseline	Larger baseline	Lower profitability
Welfare (EV)	$180 million	$180 million	$110 million
Real GDP	$380 million	$380 million	$320 million
Consumption[14]	$240 million	$240 million	$140 million
Exports	$310 million	$300 million	$200 million
Imports	$230 million	$240 million	$40 million
Real exchange rate	0.03%	0.03%	-0.01%

Source: NZIER

4.2.1 Larger baseline market

The size of the current market has very little impact on the effect of CRP. The welfare gain remains the same and the macroeconomic effects are minimal.

This result demonstrates that the uncertainty surrounding our estimates of the market size is unimportant to the results.

4.2.2 Varying profitability

Reducing the market price of CRP's exports by 10% has a marked impact on the overall results. It shaves over $100 million from aggregate exports and, while the change in the exchange rate compensates to some extent, GDP still falls by $60 million.

More importantly, the welfare due to CRP falls by $70 million, which is almost 40% of the total. This result illustrates the importance of our assumptions about the export market for CRP's products. Small changes in the assumptions surrounding the world demand for rock phosphate can have large impacts on the estimates of New Zealand's welfare gain.

4.2.3 Different extraction period

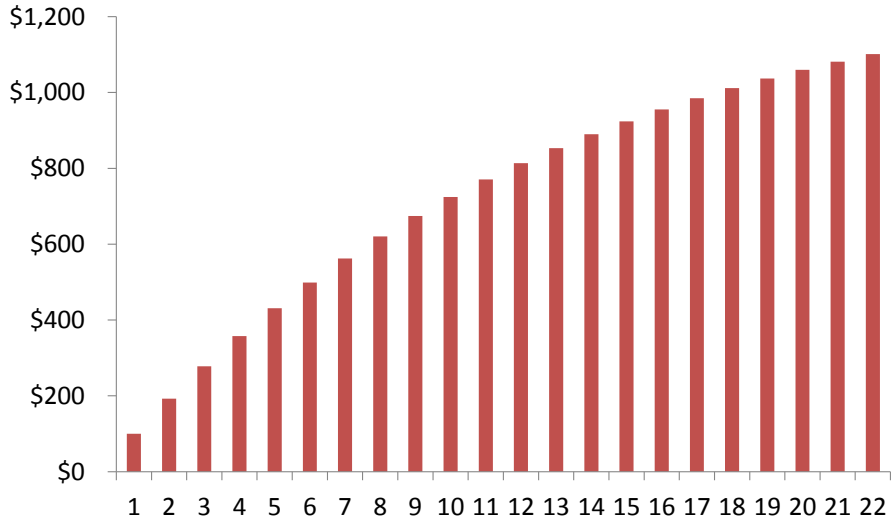
With a sixteen year extraction period, as in our baseline case, the net present value of the increase in welfare is close to $1 billion. As that extraction period falls, the NPV falls rapidly, due to the exponential discounting. Figure 2 shows the NPV of welfare as the number of years of extraction grows.

The implication of the chart is that, as the estimated extraction period lengthens, the NPV becomes less sensitive to small changes in the extraction period.

[14] Includes public and private consumption spending.

Figure 2 Change in welfare effect as extraction period lengthens

Dollar value of NPV of welfare ($ millions) vs years of extraction, 8% discount rate



Source: NZIER

Appendix A Approach to estimating the national impact

A.1 The NZIER CGE model

We analyse the likely national impact of the CRP project using a static Computational General Equilibrium (CGE) model of the New Zealand economy. CGE modelling is a highly-respected and well-developed technique that has a rich history for assessing policy, and industry questions. Our model was developed in close collaboration with Monash University, a global leader in building and applying CGE models.

The model allows us to capture the flow-on effects from the CRP project on the rest of the New Zealand economy. We can show the effect it has on various industries, as well as key macroeconomic variables such as GDP and household incomes.

The model is based on a large database containing the value flows of the economy. The database defines the initial structure of the economy, which is assumed to be in equilibrium in all markets. The structure of the database is broadly similar to traditional input-output tables; for example commodities may be used as intermediate input for further production, used in investment, exported, or consumed by households and the government. Industry costs include the cost of intermediates, margins, taxes, and primary factor costs for labour, land, and capital. As per the accounting identities in input-output tables, the total value sum of producers' input costs (including margins, taxes, returns to factors and other costs) equates to the total value of output production (the 'MAKE' matrix in the database).

The ORANI-NZ model consists of:

- 131 industries
- 210 commodities
- 1 household

The database has been sourced initially from Statistics New Zealand 1995/96 Inter-Industry tables, updated using the subsequently released 2003 Supply and Use tables, and finally 'up-scaled' to 2011 levels using latest Statistics New Zealand macroeconomic data.

A.2 Including rock phosphate in the model

We modified our database to include rock phosphate production for the purposes of this simulation. Data on the industry's imports was taken from the Ministry of Foreign Affairs and Trade's statistics. We used that data, along with information on the industry, provided by Chatham Rock Phosphate Ltd, to calibrate our database to the current size of the industry in New Zealand and the current level of imports.

We then built a new sector in to the model to represent Chatham Rock Phosphate Ltd's operations. The cost and sales structures of that sector were built to the specifications described in the main text (see Section 2.2).

A.3 The modelled scenario

We translated the project's outputs into 'shocks' (or scenarios) that the CGE model can evaluate.

The first shock that we model is the increase in rock phosphate export quantities. That was achieved by bringing up the value of the CRP 'sector's' exports to the required level while holding the export price constant. To bring up the export levels we allowed land productivity to rise in the CRP sector, representing the increased value from the seabed when it is dredged.

The second shock is the import substitution towards the new domestic supply of rock phosphate. That was required to be cost neutral so we assumed a shift in preferences in the fertiliser industry that favoured domestic production over imports. Note that neither of these shocks directly affect the domestic price of rock phosphate, but only the source and quantity.

A.4 Modelling caveats

As with any economic modelling approach, the technique we have employed has its limitations. These caveats include:

- We have used a simple productivity shock to deliver the increased wealth that the CRP project will generate. This is a simplification of how the project will operate.
- The analysis is static, looking at the impacts of the project on the New Zealand economy if it were running tomorrow. In reality, the project's benefits will be spread across the life of the project, initially with investment increasing demand for research and building; operational expenses including demand for intermediate inputs and labour; supply of fuel after the facility is running; and taxation revenue varying across the project lifetime. The results generated by our model do not estimate all of these impacts over the lifetime of the project. Rather, we estimate the impact during the years of operation.
- While the model database is highly disaggregated, it still invariably suffers from aggregation bias. It is quite possible that some of the industry effects we have estimated are a consequence of aggregation problems, rather than genuine links to the rock phosphate industry. However, given the large impact on household consumption in this simulation, and limited downstream effect, that is unlikely to be a significant problem.
- Model structure. The CGE model is based on Statistics New Zealand Input Output tables, with decisions based on neoclassical economics. Structural changes to the economy from the project are therefore not captured in the modelling, nor are any non-competitive market structures. This means the distributional elements of the results may differ in reality if firms with market power do not pass on benefits.