The economic impact of GS1

In retailing and wholesaling industries

NZIER report to GS1

19 March 2019

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NZIER was established in 1958.

Authorship

Key points

GS1 commissioned NZIER to estimate the economic contribution of using GS1 standards in the retail and wholesale industries for the New Zealand economy. The research scope was limited to the macroeconomic effects of cost and labour productivity improvements in these industries.

GS1 standards and associated products have wide-ranging potential; NZIER was commissioned to look at their effect on labour productivity

Global data standards deliver economic improvements in the following areas:

- e-commerce
- e-invoicing
- product compliance
- automating exporting administrative process
- food traceability
- supply-chain management and logistics.

To measure the economic contributions of GS1 standards in these areas would require a multi-year research project. We focused our research on labour cost and labour productivity improvements and we used our CGE model to provide a robust but conservative assessment of the wider economic effects of GS1 data standards on the New Zealand economy.

Our central results are summarised in these key points. The results of additional modelling scenarios are available in the body of the report.

Global data standards affect labour use through the elimination of manual processes, human errors and duplication systems

Data standards affect labour use in two ways, through:

- labour productivity improvements
- labour cost savings.

We have modelled these two impacts separately.

The labour productivity effects of using the GS1 standards increase GDP by $417 million annually

The literature indicates that data standards and associated technologies can improve labour productivity in retail by 5%.

Using GS1 market penetration data we conservatively estimated that the effects of the GS1 standards on labour productivity in the retail and wholesale industries increase GDP by $417 million (0.15%) annually. Other macroeconomic effects of a 5% labour productivity improvement in retail and wholesale industries include:

- an additional $115 million of New Zealand-wide export revenue annually
- households benefiting through higher real wages and increasing their consumption by $236 million annually

- an increase in total industry outputs by $592 million annually, led by the growth in the supermarket and grocery industry ($344 million)

The effects of absolute labour cost savings are larger than the labour productivity effects. Without GS1 in retailing and wholesaling, GDP would be lower by between $1.2 billion and $1.5 billion annually.

Easton (2009) suggested that cost savings from data standards were around 5% of total output, based on an early study into the effect of barcodes on cost savings in the US grocery industry. We found that the effect of the absolute labour cost savings from GS1 standards was larger than the labour productivity effect.

Building on Easton (2009) we estimated that GDP would be lower by between $1.2 billion (-0.42%) and $1.5 billion (-0.53%) annually without the labour cost savings from GS1, after adjusting for market penetration in retail and wholesale.

These estimates are conservative indications of the impact of data standards in the retail and wholesale industries. The overall economic contribution of GS1 will be much larger than the results presented in this report, due to the diverse range of applications for the standards.

We have focused on labour cost and productivity improvements rather than the other efficiency gains.

There are likely to be more opportunities to use data standards to reduce costs and enhance the efficiency of businesses to improve the wellbeing of New Zealanders. It would be worthwhile investing in improving the ability to recognise and capitalise on the opportunities.

Contents

Appendices

Figures

Tables

1. Objectives and scope

GS1 commissioned NZIER to estimate the economic contribution of using GS1 standards in retail and wholesale industries. GS1 explicitly expressed an interest in the impacts of GS1 on retail transactions and labour productivity at the point of sale. This represents part of, but not the entirety of GS1's participation in the supply chain.

1.1. GS1's role in supporting the retail and wholesale is the tip of the iceberg

GS1 is part of a global eco-system of public and private standards. Global standards are relevant to most parts of the global supply chain that includes exporters, third party logistics providers, border agencies, wholesalers, retailers, and consumers (APEC 2017).

GS1 provides global standards, which have wide ranging applications in supply chain logistics. Some examples of their application are beyond the scope of this work include:

- **e-commerce:** GS1 standards support e-commerce through the accurate representation of the specifications, location and origin of products sold online

- **e-Invoicing:** Deloitte Access Economics in Australia[1] estimated that e-Invoicing, using the standards could result in cost savings for the Australian economy of A$28 billion **over ten years**

- **product compliance**: A BRANZ scoping study of electronic tracking of construction materials showed a reduction in the incidence and cost of non-compliance, saving the industry $23 million annually (Dowdell *et al.*, 2017)

- **exporting**: automated information in the export supply chain using GS1 standards reduced manual entry errors resulting in Australian meat exporters saving an estimated A$14 million each year (GS1a, n.d.)

- **food traceability**: GS1 standards can be used to trace the origins of imported food. Some consumers are willing to pay more for traceable food compared to food that is not traceable. Koreans indicated they were willing to pay 39% more for traceable imported beef products compared to non-traceable products (Lee *et al.*, 2011)

- **product recall**: GS1 standards provide a platform for product recall.

A major study would be needed to unpack the wider impacts of GS1. Our scope was limited to the effect of data standards on labour costs and labour productivity. Therefore, the estimates in this report are a conservative indication of the contribution of GS1 to the New Zealand economy.

1.2. Our approach to estimating the impact

We use NZIER's computable general equilibrium (CGE) model of the New Zealand economy to estimate these economic impacts.

CGE modelling is our recommended method for conducting policy analysis or sectoral impact studies, as it delivers more conservative, but more realistic, estimates of net

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[1] https://treasury.gov.au/consultation/e-invoicing/

benefits than commonly-used (and widely criticised) alternatives such as multiplier analysis

CGE shows 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.

Figure 1 shows a schematic of the linkages within the CGE model.

Figure 1 Our CGE model represents the flows between all the agents and activities in the economy

Components of a CGE model
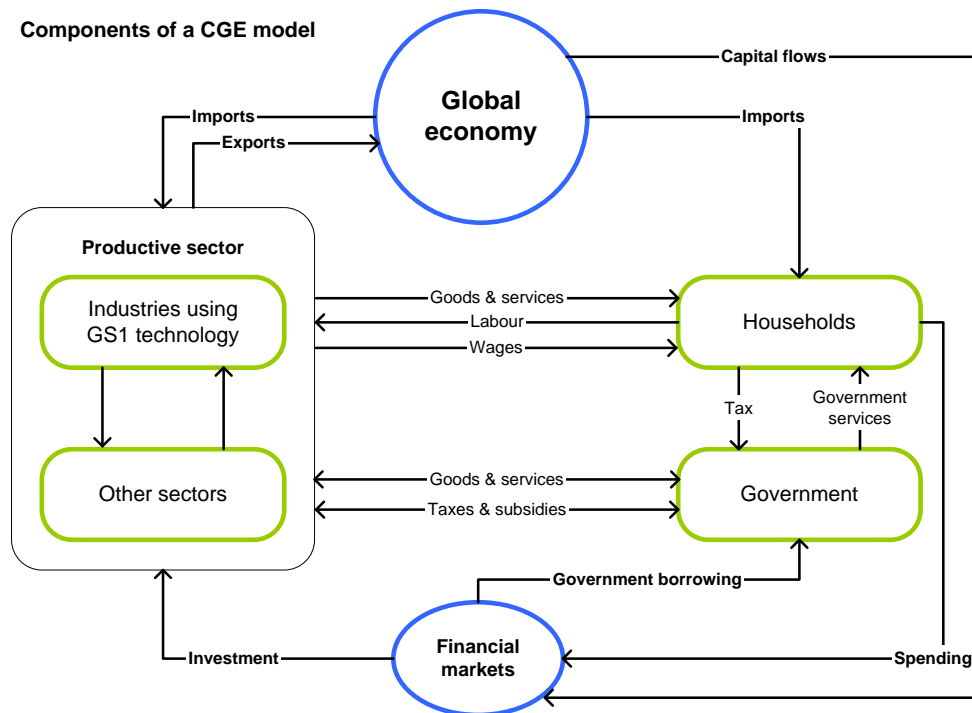
Source: NZIER

Our CGE model contains information on 106 industries and 201 commodities within the economy, incorporates trade and financial linkages to world markets, and estimates price responses to demand or supply shocks. It is described in more detail in Appendix A.

We first examine the effects of GS1 on labour productivity in retail and wholesale industries and the flow-on effects throughout the national economy on GDP, employment, wages, and household spending. This provides a robust assessment of the macroeconomic impacts that GS1 are interested.

In a second set of simulations, we evaluate the effects of a labour cost increase in retail and wholesale industries using GS1 standards. In doing so, we are exploring what would the national economy look like if GS1 standards were *not* used in selected industries, compared to the 2018 baseline. We based our labour cost shock on Easton's (2009) study.

Our modelling also considers how resources (especially labour and capital) shift between retail and wholesale industries and other industries (manufacturing, services, etc.) as retail and wholesale industries become more labour efficient.

This approach involved the following key steps:

- Step 1: determine the penetration of GS1 standards in retail and wholesale industries
- Step 2: scan the literature to determine the effects of data standards on labour productivity
- Step 3: estimate the macroeconomic effects of the labour productivity improvements in the retail and wholesale industries using the CGE model of the New Zealand economy.

An in-depth empirical study of the labour productivity effects of the standards was beyond the scope of the research. Instead we conducted a literature scan to draw on findings from existing research into the same or very similar standards.

Sensitivity scenarios are provided to reflect how the results would change if the productivity effects and/or the market penetration changes.

1.3.   GS1's market penetration

The first step in the research was to determine the penetration of GS1 standards in retail and wholesale industries. NZIER and GS1 worked together to establish estimates of the market penetration that were compatible with the Stats NZ's System of National Accounts, which is the basis for the structure of the CGE model of the New Zealand economy.

GS1 provided NZIER with a range of market penetration shares for retail and wholesale industries at the ANZSIC06 level. This market penetration information is commercially sensitive and was not included in the report.

Market penetration estimates were provided in the form of ranges which reflect the typical uncertainty when producing some estimates. To manage this uncertainty, we divided the market penetration shares into three categories: lower, medium, and upper bounds.

We then used employment count at the industry level from Stats NZ's Linked Employer-Employee Data (LEED), to weight the market penetration shares provided by GS1, for each of the lower, medium and upper bounds. To estimate our shock values, we then multiplied these estimated ratios with the labour productivity improvements based on the findings of the literature review.

2. Productivity is critical

Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.

Paul Krugman, Economist, Noel Laurette

GS1 is in the business of global standards which use a common language to identify capture and share information among all the participants in the supply chain. The benefits of global standards include:

- greatly enhanced supply chain visibility and traceability
- labour cost savings on transactions
- automation of information transfers and processes
- reductions in information input, manual errors and duplication of information
- digital linkages to certification and regulation.

We scanned the literature to ensure an evidence-driven approach for our quantitative analysis. The findings of the literature are summarised in this section of the report.

In summary the literature indicates the data standards affect labour productivity in two ways:

- they increase output per worker by accelerating throughput – an improvement in labour productivity
- they generate labour cost savings from automation, eliminating tasks, reducing manual errors and removing duplication.

Basker (2011), found that the introduction of barcode scanners from 1972-1982 raised a store's labour productivity by 4.5% on average, following the first few years of adoption. Labour productivity is defined as output per unit labour input (OECD, 2002).

Ellickson (2016) describes the barcode scanner and the data standards behind it as a tremendous labour-saving device. But the scanner also supported four additional effects:

- the number of products sold in supermarkets increased by an order of magnitude – from 9,000 to 30,000
- the number of products sold per worker and the number of products per metre of shop floor space
- the expansion of market research capabilities through the visibility of consumer behaviour
- the expansion of the supply and logistics sector and associated technologies to manage the coordination and delivery of an increased product range.

Barcode scanners improved labour productivity in retail but required an expansion of supply chain logistics sector to support the retail sector.

Easton (2009) estimated that the adoption of GS1 standards throughout New Zealand would generate cost savings of around $1 billion annually and represent a productivity

improvement of 0.5% at the national level. Easton's estimate was based on a 5% reduction in the total turnover for New Zealand's supermarkets, groceries, liquor retailing, hardware and chemist retailing. Easton (2009) estimated to be around $20 billion at the time of publication.

The 5% cost saving appears to be based on a report by PWC (1998), which estimated the adoption of the barcode lead to equipment savings of 2.75% and sales savings of 2.89%, for the grocery industry in the US using data from 1997.

We found a similar estimate in a GS1 media information release on the role of GS1 standards in the United Kingdom. According to GS1 (b), (n.d.). The adoption of GS1 standards allows for a 5.69% cost savings in the total revenue of the retail industry, mostly through labour efficiency gains (£650 million per annum) with the automatisation of manual, paper-based processes.

Wider effects of GS1 standards

GS1 standards offer the ability to trace exports from farm to plate. In a case study published on their website (GS1 (a), n.d.). GS1 conducted a pilot to streamline beef exports from Australia to the United States. Results of this case study showed that the use of GS1 standards led to significant cost savings and greater visibility in the supply chain (from 43%-93%).

Similarly, APEC (2017), found that the GS1 global standard increased visibility in the supply chain for commodity exporters to 100%. The benefits of improved visibility included:

- cost savings from a reduction in the time searching for information
- a 20%-50% reduction in the time spent approving loading of cargo
- the elimination of delays approving the release of a cargo on arrival due to incomplete or inconsistent provision of information
- overall reduction in fruit soilage due to delays in exporting
- improved compliance
- improved cold supply chain integrity
- improved detection of fraudulent information
- accelerated delivery times.

The value of using "end to end supply visibility technology" is highlighted in another paper (Elphick-Darling et al., 2017). In that study, pilots were conducted with the adoption of GS1 global standards (GDS) in Australia to identify and share information on various activities of the supply chain, including freight, pick-up storage and locations, traffic congestion and other delays. Results of the study show that the benefits in terms of efficiency, visibility, innovation to the various actors of the supply chain (manufacturers, producers, traders) justify the adoption of a strategy to implement these standards more widely.

Traceability can add value for consumers and can enable price premiums above comparable products without traceability. For example, Koreans indicated they were willing to pay 39% more traceable imported beef products compared to non-traceable products (Lee et al., 2011).

The impact of traceability is out of scope for this work. We refer to it here because it is a clear indication that the standards have wide application that could be considered in future research. The economic contribution of GS1 is much broader than the impact on retail and wholesale industries, which is the focus this report.

The benefits of traceability are not limited to food products. It can also be used to test the compliance of other imports. A BRANZ scoping study of the electronic tracking of construction materials could reduce the incidence and cost of non-compliance, saving the industry $23 million annually (Dowdell et al., 2017).

Data standards can be used for e-Invoicing to reduce the costs of business administration and accounting. Deloitte Access Economics in Australia[2] estimated that e-Invoicing, using common data standards, could result in cost savings for the Australian economy of A$28 billion **over ten years** (Australian Government; Australian Taxation Office & New Zealand 2018).

E-Invoicing creates cost savings by decreasing or eliminating manual input, manual errors and increasing payment time. An inter-governmental discussion paper suggests e-Invoicing could result in benefits to the Australian and New Zealand economies potentially in excess of $30 billion over ten years (Australian Government; Australian Taxation Office & New Zealand Government, 2018).

Data standards can be also used to lower the costs of expediting trade processes. Automated information in the export supply chain using GS1 standards reduced manual entry errors resulting in Australian meat exporters saving an estimated A$14 million each year (GS1 (a), n.d.).

2.1.   Our modelling approach

The combination of the effects of the data standards summarised above indicates that data standards have diverse and transformational effects for information management and supply chain management.

The findings of the literature scan demonstrate the case for a comprehensive study of the role of data standards in:

- generating cost savings throughout supply chain
- increasing labour productivity
- enhancing the visibility, veracity and portability of information.

Nevertheless, the literature scan did not yield results suitable enough for the development of macroeconomic scenarios for all the impacts suggested by other studies. Such further research remains to be done in a much larger project.

Based on our literature scan, we modelled two macro shocks or scenarios, each resulting in the elimination of manual processes, human errors and duplication systems from using GS1 Standards:

- labour productivity improvements
- labour cost savings.

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[2]   https://treasury.gov.au/consultation/e-invoicing/

For the labour productivity scenarios, we used the results of the literature to inform the modelling scenarios. Labour productivity gains in the literature provided estimates to build three scenarios: lower, central and upper, for sensitivity analysis. These are:

- a 2.5% labour productivity increase (lower)
- a 5% labour productivity increase (central)
- a 7.5% labour productivity increase (upper).

For the labour cost savings shock, we used the results from Easton (2009) to simulate a 5% increase in labour costs. That is, we modelled what would be the economic impact on the New Zealand without the labour cost savings resulting from the adoption of GS1 standards. The labour cost saving includes wider cost savings throughout supply chain (in addition to labour productivity) suggested by the literature.

3.   Economic impacts of a labour productivity increase

The macroeconomic impacts for the central scenario are discussed in this section. Results from the sensitivity scenarios can be found in Appendix B.

With a labour productivity increase in GS1 industries, we observe two effects:

- **a supply-side effect:** The productivity improvement leads to labour savings. The direct effect of an increase in labour productivity in the retail and wholesale industries is the decrease of employment, in industries with some level of GS1 penetration. Labour savings in those industries leads to jobs being reallocated toward industries with higher real wages or those that are more labour intensive.[3]

- **A demand-side effect:** Following the higher labour productivity in retail and wholesale industries from using GS1 technologies, the marginal value of labour rises which leads to an increase of real wages. Real household consumption increases, which drives the growth in industry outputs. Consequently, labour demand increases in these industries. For example, the positive effect on household spending increases output in the supermarket and grocery industry by $344 million.

3.1.   New Zealand's real GDP increases by $417 million

Figure 2 overleaf shows the macroeconomic impacts of a 5% labour productivity increase in retail and wholesale industries that use GS1 standards, under the central scenario.

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[3]   Employment is considered fixed at the national level, but labour is perfectly mobile between industries and moves based on real wage differences across sectors.

Figure 2 National economic impacts following a labour productivity increase

Change in output from baseline (2018) in $ million (in real terms), central scenario
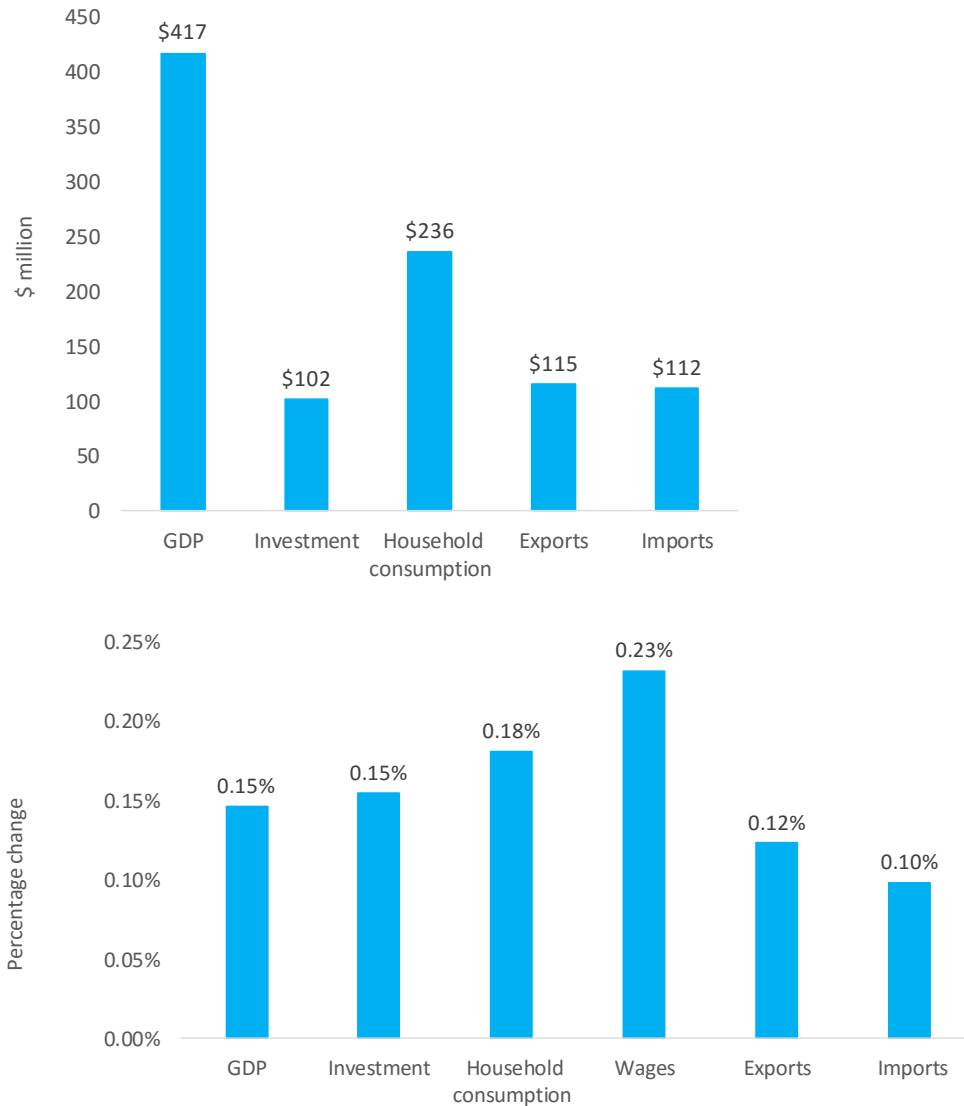
Higher labour productivity in retail and wholesale industries, causes New Zealand's output to increase and domestic prices to drop in all sectors, reflecting more efficiency and lower costs per unit of output. The flow-on effects to the New Zealand economy are:

- New Zealand's real GDP rises by $417 million (0.15%)
- household consumption increases by $236 million (0.18%)
- exports increase by $115 million (0.12%)
- imports increase by $112 million (0.10%)
- capital investment increases by $102 million (0.15%)
- wages increase by 0.23%.

3.2. Labour is reallocated across industries

The increase in labour productivity in industries using GS1 standards cause labour to relocate away from retail and wholesale industries, into other industries which are labour intensive and offer higher wages, such as t service industries. Table 1 shows the reallocation of labour across retail and wholesale industries following a 5% increase in labour productivity for industries using GS1.

Table 1 Employment cost impacts on industries using GS1 standards

Change from baseline (2018) in $ million and in percent, in real terms

Industries using GS1 standards	5% labour productivity increase impacts					
	Lower bound		Central		Upper bound	
	$ million	%	$ million	%	$ million	%
Supermarket & grocery stores	$70	4.1%	$77	4.5%	$85	4.9%
Motor vehicle parts wholesaling	$65	14.3%	$68	15.0%	$71	15.6%
Warehousing & storage services	$3	1.0%	$3	1.0%	$3	1.1%
Machinery & equipment wholesaling	$3	0.1%	$2	0.1%	$0	0.0%
Postal & courier services	-$3	-0.4%	-$4	-0.5%	-$5	-0.7%
Food & beverage services	-$6	-0.2%	-$5	-0.2%	-$5	-0.2%
Specialised food retailing	-$11	-3.7%	-$12	-4.2%	-$13	-4.6%
Department stores	-$19	-2.6%	-$21	-2.8%	-$22	-3.1%
Basic material wholesaling	-$19	-1.7%	-$20	-1.7%	-$22	-2.0%
Other goods wholesaling	-$20	-1.3%	-$23	-1.5%	-$28	-1.8%
Other store-based retailing	-$23	-2.3%	-$26	-2.6%	-$29	-2.9%
Motor vehicle parts retailing	-$26	-3.0%	-$29	-3.3%	-$32	-3.7%
Grocery & liquor product wholesaling	-$29	0.0%	-$28	0.0%	-$24	0.0%
Recreational & clothing retailing	-$38	-3.9%	-$43	-4.4%	-$48	-4.9%
Furniture & hardware retailing	-$51	-3.6%	-$57	-4.0%	-$63	-4.4%
Total	**-$103**	**-0.2%**	**-$117**	**-0.3%**	**-$133**	**-0.4%**

Source: NZIER

This is an example of how labour productivity improvements can increase consumer spending, expand industries and create demand for more labour.

Productivity improvement leads to labour savings. The direct effect of an increase in labour productivity in the retail and wholesale industries is the decrease of employment, or labour saving of $117 million (-0.3%) in industries with some level of GS1 penetration.

Figure 3 shows how employment is reallocated across a selection of industries within the national economy. Employment decreases in industries where labour has become more efficient and in their supporting industries, such as furniture and hardware retailing (-57 million), recreational and clothing retailing (-$43 million) and personal services (-$39 million), and reallocates toward higher-paying wage industries and more labour intensive industries, such as supermarket and grocery stores ($77 million), professional industry associations ($72 million), motor vehicle parts wholesaling ($68 million) or government services ($18 million).

Figure 3 Employment effects on selected industries

Change in output from baseline (2018) in $ million (in real terms), central scenario

Employment change (in $ million)
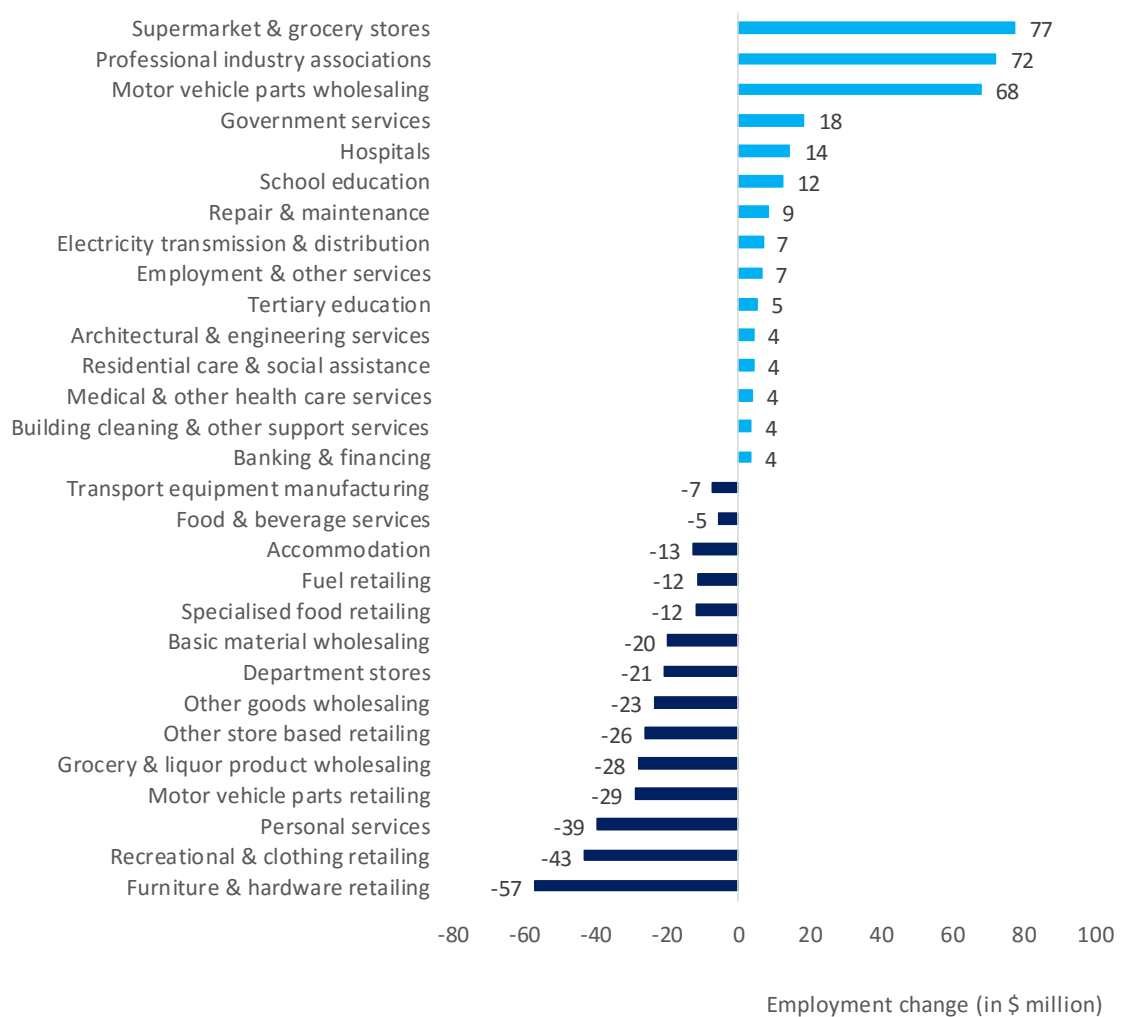
Source: NZIER

3.3. Direct impacts on retail and wholesale industries

Table 2 presents the direct impact on output from a 5% increase in labour productivity in the retail and wholesale industries using GS1 standards. The labour productivity improvement has a positive effect on GS1 industries with an additional $105 million worth of outputs on average under the central scenario. The additional outputs are particularly significant for supermarket and grocery stores ($344 million), and for motor vehicle parts wholesaling ($247 million). These industries are characterised by a relatively higher intensity in capital and a higher growth in capital, following labour productivity improvements.

Higher labour productivity causes outputs to decrease in industries that were relatively more intensive in labour and/or with a lower market penetration of GS1 standards. This is the case for grocery and liquor product wholesaling (-$106 million) and basic material wholesaling (-$80 million), for example.

Table 2 Impacts on industry outputs for retail and wholesale industries using GS1 standards

Change from baseline (2018) in $ million, in real terms

Industries using GS1 technologies	5% labour productivity increase impacts		
	Lower bound	**Central**	**Upper bound**
Supermarket & grocery stores	$308	$344	$379
Motor vehicle parts wholesaling	$235	$247	$258
Machinery & equipment wholesaling	$21	$23	$18
Warehousing & storage services	$14	$17	$19
Postal & courier services	$7	$8	$11
Department stores	$5	$8	$11
Specialised food retailing	-$15	-$17	-$19
Food & beverage services	-$11	-$4	$2
Motor vehicle parts retailing	-$37	-$42	-$46
Other store-based retailing	-$38	-$43	-$47
Recreational & clothing retailing	-$61	-$69	-$76
Other goods wholesaling	-$66	-$78	-$92
Furniture & hardware retailing	-$75	-$84	-$93
Basic material wholesaling	-$79	-$80	-$89
Grocery & liquor product wholesaling	-$112	-$106	-$83
Total GS1 industries	**$95**	**$124**	**$152**

Source: NZIER

3.4. National industry outputs expand

Figure 4 presents the flow-on effects on selected top industries that benefit the most from a labour productivity increase in retail and wholesale industries using GS1 standards. The overall effect is that economic output increases by $592 million in 2018.

Increased labour productivity enables profit-maximising producers to expand by employing resources more efficiently, particularly labour, due to the rise in marginal productivity. As a consequence, industries with relatively higher degree of penetration of GS1 standards are expanding their outputs while releasing some labour to other industries, which also expand, albeit less productively.

Figure 4 Flow-on effects on selected top industries

Change in output from baseline (2018) in $ million (in real terms), central scenario

Industry output change (in $million)
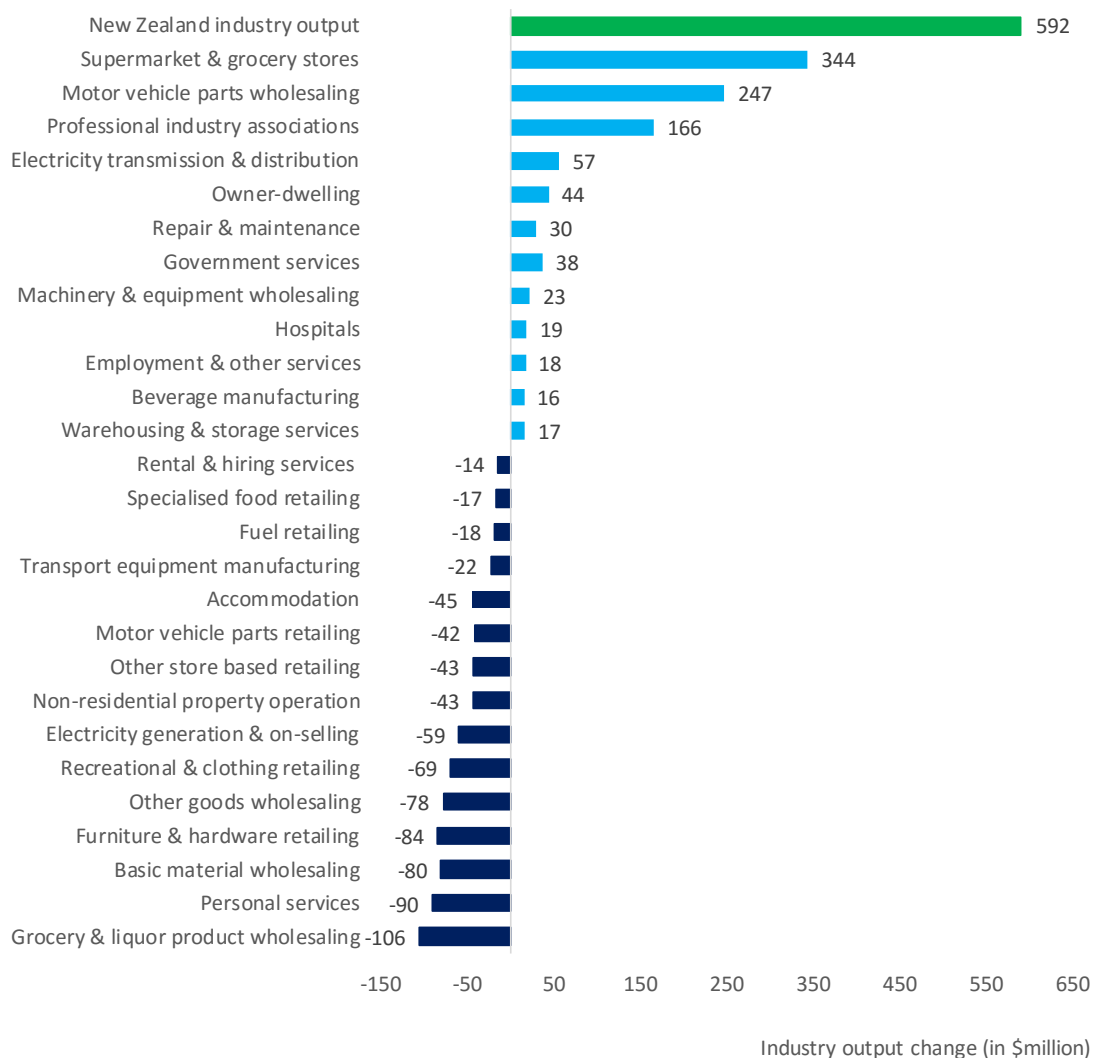
Source: NZIER

3.5.　Real exports increase marginally

Figure 5 shows the impact of a 5% labour productivity increase (mid bound) on real exports. New Zealand exports increase marginally by 0.1% ($97 million). Industries that have linkages with the retail and wholesale industries experience a decrease in their commodity exports, along with their outputs.

Figure 5 Impacts of a 5% labour productivity increase on exports

Change in output from baseline (2018) in $ million (in real terms), central scenario

Category	Value
Total NZ exports	97
Meat & offal	14.0
Prepared fish	7.9
Motor vehicles, trailers, & semi-trailers	8.0
Milk & cream	7.1
Air passenger transport	7.2
Other dairy products	4.8
Wines	4.7
Kiwifruit	3.5
Wood	3.4
Basic chemicals & other paper products	3.4
Vegetables	-1.5
Spirits & tobacco products	-2.0
Intellectual property licensing services	-2.4
Ships, pleasure, & sporting boats	-3.2
Wholesale trade	-3.3
Beverage services	-2.7
Wastes & scraps	-4.3
Takeaways	-3.5
Meal services	-3.4
Accommodation	-20.9

$ million

Source: NZIER

3.6.   Household consumption and wages

Table 3 overleaf presents the impacts of a 5% labour productivity increase on household spending and wages.

As a result of higher labour productivity in the retail and wholesale industries using GS1 standards, the marginal value of labour rises which leads to an increase of real wages. Real household consumption increases, which drives the growth in industry outputs.

Table 3 Impacts on household consumption and wages

Change in output from baseline (2018) in $ million and in percent, in real terms

| Indicator | 5% labour productivity increase impacts | | | | | |
| | Lower bound | | Central | | Upper bound | |
	$ million	%	$ million	%	$ million	%
Household consumption	$202	0.15%	$236	0.18%	$270	0.21%
Wages	NA	0.20%	NA	0.23%	NA	0.26%

Source: NZIER

4. Economic impact of a labour cost increase scenario

For the labour cost shock, we modelled a scenario where the labour cost saving from the adoption of GS1 standards did not occur. The results from Easton (2009) suggest that the cost could increase by 5% without GS1 standards.

With a labour cost increase in GS1 industries, we observe two effects:

- **a supply-side effect:** The direct effect of an increase in labour cost in the retail and wholesale industries is an increase in employment, in industries with some level of GS1 penetration. With a rise in employment,[4] wages decrease, and labour relocates to sectors offering a relatively higher real wage and/or with lower GS1 market penetration.

- **a demand-side effect:** Following the rise in labour cost in the retail and wholesale industries using GS1 technologies, the marginal value of labour decreases which leads to a decrease in real wages. Real household consumption decreases, which drives the fall in industry outputs. Consequently, labour demand decreases in these industries.

4.1. GDP decreases by $1.3 billion

Table 4 presents the macroeconomic impacts of a 5% labour cost increase in retail and wholesale industries that use GS1 standards.

With higher labour costs in retail and wholesale industries, New Zealand's GDP decreases, and domestic prices raise in these sectors along with their supplying and downstream industries, reflecting a higher costs per unit of output. In the central scenario, the flow-on effects to the New Zealand economy are:

- New Zealand's real GDP decreases by $1.34 billion (-0.47%)
- household consumption drops by $759 million (-0.59%)
- exports fall by $371 million (-0.41%)
- imports decrease by $359 million (-0.33%)
- capital investment decreases by $328 million (0.50%)
- wages decrease by 0.40%.

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[4] In our CGE model, employment is considered fixed at the national level, but labour is perfectly mobile between industries and moves based on real wage differences across sectors.

Table 4 National economic impacts following a labour cost increase

Changes from baseline (2018), in $ million and in percent

Scenarios		GDP	Household consumption	Wages	Exports	Imports	Capital
Lower bound	% change	-0.42%	-0.52%	-0.31%	-0.36%	-0.29%	-0.44%
	Level ($m)	-$1,184	-$670	NA	-$327	$317	-$289
Central	% change	-0.47%	-0.59%	-0.35%	-0.41%	-0.33%	-0.50%
	Level ($m)	-$1,341	-$759	NA	-$371	$359	-$328
Upper bound	% change	-0.53%	-0.65%	-0.40%	-0.46%	-0.37%	-0.56%
	Level ($m)	-$1,498	-$848	NA	-$414	$400	-$366

Source: NZIER

4.2. Labour cost increases

Figure 6 shows the labour cost increase in retail and wholesale industries that use GS1 standards, as well as in their supporting industries (downstream and supplying). Labour cost increases the most (in $ million) in industries relatively more labour-intensive and/or with higher degree of penetration of GS1 standards.

Figure 6 Employment costs increase for affected industries following a labour cost increase in GS1 industries

Change from baseline (2018) in $ million and percent
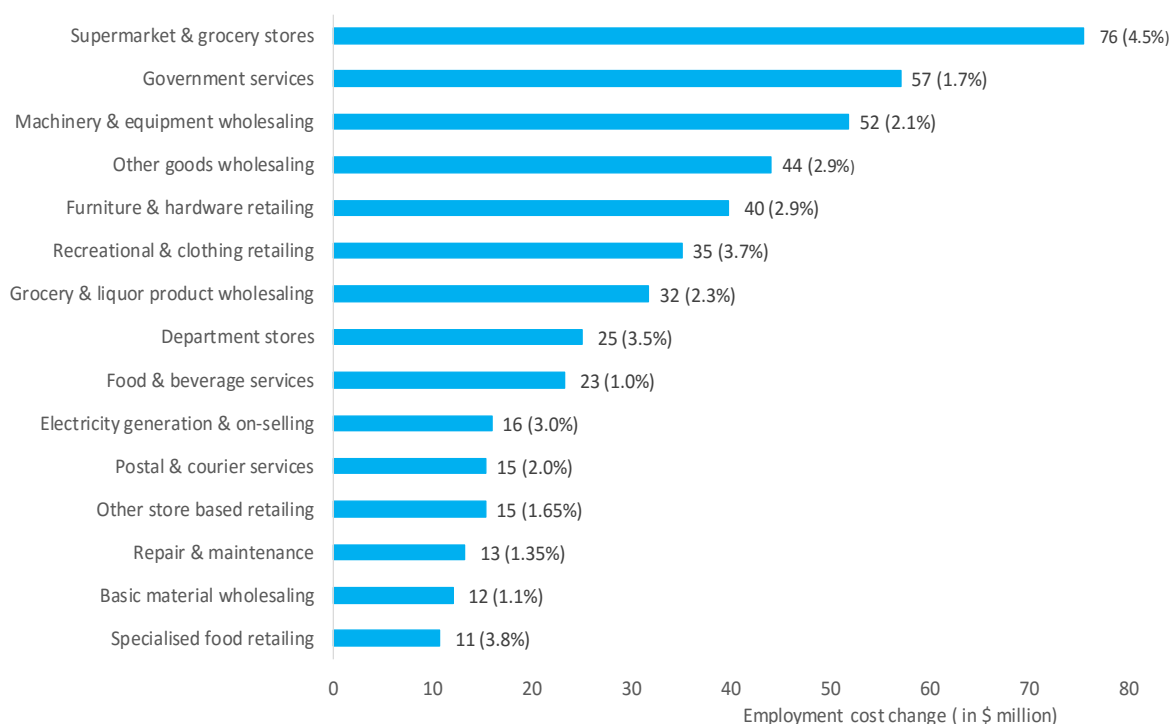
Source: NZIER

4.3.   National output drops by $1.9 billion

Table 5 presents the direct and flow-on effects of a labour cost increase in the retail and wholesale industries with GS1 standards. National output decreases by $1.9 billion under the central scenario. Most retail and wholesale industries are negatively affected as they are directly affected by the increase in labour costs and are usually more labour intensive.

Higher labour costs lead to a decrease in outputs in retail and wholesale industries that use GS1 standards and/or that are relatively more intensive in labour. Industries (supplying and downstream) that support the retail and wholesale industries are also negatively affected. Outputs increase for competing industries.

Output in supermarket and grocery stores increases ($54 million in the central scenario) because most of the products from the industry are necessity goods, which have a lower elasticity of demand – households will have little choice but to continue buying them in similar quantities, but at a higher price.

Table 5 Impacts on industry output following a labour cost increase in GS1 industries – selected industries

Change from baseline (2018) in $ million, in real terms

Industry	5% labour cost increase		
	Lower bound	Central	Upper bound
Other store-based retailing	-$328	-$366	-$403
Electricity transmission & distribution	-$238	-$284	-$330
Owner-dwelling	-$158	-$182	-$205
Accommodation	-$69	-$126	-$184
Basic material wholesaling	-$108	-$119	-$130
Grocery & liquor product wholesaling	-$76	-$78	-$81
Labour unions & other interest groups	-$4	-$74	-$144
Hospitals	-$57	-$65	-$72
Transport equipment manufacturing	-$52	-$62	-$71
Motor vehicle parts retailing	-$43	-$52	-$61
Other goods wholesaling	-$39	-$51	-$63
Employment & other services	-$41	-$51	-$60
School education	-$41	-$47	-$54
Architectural & engineering services	-$33	-$41	-$49
Non-residential property operation	-$52	-$38	-$25
Dairy product manufacturing	-$29	-$32	-$36
Motor vehicle parts wholesaling	-$17	-$22	-$28
Machinery & equipment wholesaling	$4	-$6	-$16
Furniture & hardware retailing	$9	$12	$16
Fertiliser & pesticide manufacturing	$11	$13	$14
Fuel retailing	$13	$15	$18

Industry	5% labour cost increase		
	Lower bound	Central	Upper bound
Specialised food retailing	$17	$21	$25
Personal services	$13	$23	$59
Recreational & clothing retailing	$40	$38	$36
Warehousing & storage services	$27	$43	$59
Repair & maintenance	$38	$47	$56
Supermarket & grocery stores	$56	$54	$51
Government services	$110	$125	$139
Food & beverage services	$118	$224	$332
Electricity generation & on-selling	$295	$357	$420
Total	**-$1,775**	**-$1,998**	**-$2,221**

4.4.   Total exports decrease by $371 million

Table 6 presents the export effects of a labour cost increase in the retail and wholesale industries with GS1 standards. Industries that have linkages with the retail and wholesale industries experience a decrease in their commodity exports, along with their outputs.

Table 6 Impacts on exports following a labour cost increase in GS1 industries – selected industries

Change from baseline (2018) in $ million, in real terms

Industry	5% labour cost increase		
	Lower bound	Central	Upper bound
Accommodation	-$27	-$49	-$71
Meat & offal	-$21	-$26	-$31
Pharmaceutical products	-$16	-$18	-$20
Milk & cream	-$15	-$18	-$21
Air passenger transport	-$14	-$17	-$20
Prepared fish	-$14	-$16	-$19
Other chemical products & man-made fibres	-$12	-$14	-$16
Basic iron, steel, & other metals	-$11	-$13	-$15
Steel products, semi-finished metal products	-$10	-$12	-$13
Wastes & scraps	-$10	-$11	-$13
Basic chemicals & other paper products	-$9	-$11	-$13
Other dairy products	-$9	-$11	-$12
Postal & courier services	-$7	-$10	-$12
Motor vehicles, trailers, & semi-trailers	-$7	-$9	-$10

Industry	5% labour cost increase		
	Lower bound	Central	Upper bound
Television, cameras, & other electronic goods	-$6	-$7	-$7
Maintenance of transport machinery & equipment	$1	$2	$2
Computer software & services	$2	$3	$3
Other business services	$3	$3	$4
Storage & warehousing services	$2	$4	$6
Motion picture, radio, TV services	$5	$6	$7
Soap & perfumes	$5	$6	$6
Higher education	$6	$8	$10
Beverage services	$11	$20	$30
Takeaways	$14	$25	$37
Meal services	$29	$50	$71
Total New Zealand exports	**-$327**	**-$371**	**-$414**

4.5. Household consumption decreases by $759 million

Table 7 presents the impacts of a labour cost increase on household spending and wages.

Because of higher labour costs in the retail and wholesale industries using GS1 standards, the marginal value of labour decreases which leads to a drop in real wages. Real household consumption drops, which drives the fall in industry outputs.

Table 7 Impacts on household consumption and wages
Change in output from baseline (2018) in $ million and in percent, in real terms

Indicator	5% labour cost increase impacts					
	Lower bound		Central		Upper bound	
	$ million	%	$ million	%	$ million	%
Household consumption	-$670	-0.52%	-$759	-0.59%	-$848	-0.65%
Wage	NA	-0.31%	NA	-0.35%	NA	-0.40%

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Appendix A CGE modelling

A.1   CGE modelling captures the full impact of GS1 standards in the retail and wholesale industries

To capture the full impact of an increase in labour productivity resulting from the adoption of GS1 standards in the retail and wholesale industries, we use one of our suite of CGE models.

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.

A.2   Why do we prefer CGE over multipliers?

Multiplier studies[5] are popular for economic impact analysis as they are relatively cheap and produce appealing big figures. However, they are based on several assumptions which requires them to be interpreted and considered with considerably care.

Key caveats include that multiplier studies:

- Do not consider any adjustment path between the status quo and the future state of the economy
- Do not consider the impacts of policy changes on the price of goods, services, intermediate inputs, labour (wages) and capital
- Assume that land, labour and capital are available in unlimited quantities, and at no additional cost to firms
- Cannot consider the opportunity cost of using additional resources in one industry on the rest of the economy – there are almost never any losers (i.e. contracting industries) in multiplier studies.

Because of these assumptions, multipliers overestimate the impacts of a change in a particular industry on the rest of the economy. Both the Ministry of Business, Innovation and Employment (MBIE) and Treasury have highlighted the inherent flaws in using

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[5]   Also known as 'input-output studies'

multiplier studies for serious economic analysis.[6] NZIER no longer offers multiplier-based analysis to our clients as they no longer align with our independence and reputation for delivering high quality, data-driven analysis.

For all these reasons, we prefer to use CGE models.

A CGE model provides an estimation of opportunity costs (between action and inaction), winners and losers. Resources are limited. It also considers price impacts of shocks and can capture linkages between industries as well as spill-over effects.

NZIER's CGE models are highly regarded amongst government agencies with whom we have worked to conduct policy analysis or sectoral impact studies. This includes MBIE, Treasury, the Ministry of Foreign Affairs and Trade, the Ministry for Primary Industries and the Ministry for the Environment.

A.3   How do CGE models 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.

Most CGE models are written and solved in a specific software system, usually GAMS[7] or GEMPACK.[8]

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 have to remain fixed, depends on a number of factors, including the purpose for which the model simulations are to be used. The choice that we make is called the model closure.

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.

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[6]   For an overview of these weaknesses, see the New Zealand Treasury and MBIE. Both documents, and Gretton (2013), clearly state that multipliers over-state economic impacts and thus lack credibility for economic analysis. Or in Treasury's words: "Unless there is significant unemployment of people with the requisite skills, **it is therefore likely that multiplier effects do not exist**".

[7]   General Algebraic Modelling System: https://www.gams.com/

[8]   General Equilibrium Modelling Package: https://www.copsmodels.com/gempack.htm

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.

A.4   Our CGE model ORANI-NZ

NZIER's ORANI-NZ[9] model is the only top-down CGE model of the New Zealand economy.

ORANI-NZ is based on a Statistics New Zealand's Input-Output table that identifies the structure of the industries involved. It contains information on 106 industries, 201 commodities and fifteen regions. It therefore offers a unique capability to highlight the role of the GS1 standards in retailing and wholesaling in the New Zealand economy.

Figure 7 shows how the model captures the complex and multidirectional flows between the various actors of the national economy and how they interact with the rest of the world. More technical details on the model are available upon request.

Figure 7 Our CGE model represents the circular flows between all the agents and activities in the economy
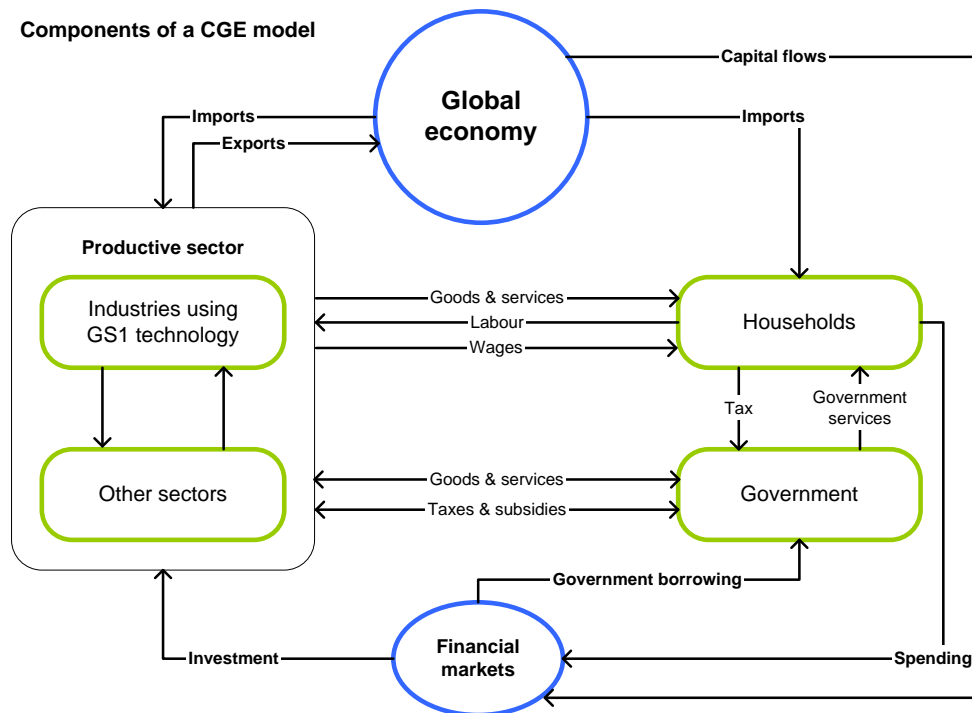
Source: NZIER

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[9]   ORANI-NZ was developed at NZIER based on the original Australian ORANI model created by Professor Mark Horridge of the Centre of Policy Studies, Victoria University-Melbourne, Australia. http://www.copsmodels.com/term.htm. NZIER maintains close connections with the Centre, ensuring that our modelling techniques reflect international best-practice.

A.5   Our modelling approach

A.5.1   BAU 2018

We wanted to assess the economic impacts of an increase in labour productivity in the retail and wholesale industries that use GS1 standards.

Our first step was to develop a baseline or BAU picture of the economy. To do so, we calibrate our model of the national economy to the latest available data from Stats NZ. This allows us to ensure we correctly benchmark the size of the various industries and gives us a BAU snapshot of the national economy.

A.5.2   Scenario design

As stated previously, we are interested in estimating the economic contribution of GS1 standards in use in the retail and wholesale industries.

We do not explicitly model the *timing* of the implementation of GS1 in the different industries but instead, analyse a static, long-term scenario that estimates the overall contribution of the adoption of GS1 standards to the New Zealand economy.

We first simulate an increase the labour productivity in the retail and wholesale industries that use GS1 standards. In effect, we are asking the model to determine how the national economy will adjust to an increase in labour productivity in retail and wholesale industries using GS1, in a way that uses the national economy 'resources most efficiently to return all markets to equilibrium.

In a second set of simulations, built on Easton's (2009) methodology, we tested the effect of a 5% increase in labour costs in the retail and wholesale industries that use GS1 standards. In doing so, we are exploring what would the national economy look like if GS1 standards were *not* used in selected industries, compared to the 2018 baseline.

Our CGE model assumes no relocation costs. In reality, relocation will be required to find alternative employment, increasing the time required and other costs to find new work.

A.6   Closure

As noted previously, in any CGE model, it is important to understand which factors have been allowed to vary and which remain fixed by assumption (also known as exogenous variables). The particular combination of fixed factors is known as the closure.

Table 8 lists the main variables included in the modelling underlying this report.

- National employment is fixed but labour is completely mobile between industries and regions, and real wages adjust to labour market changes. This is consistent with the idea that both the labour force and the rate of employment are, in the long run, determined by mechanisms outside the model.
- Household and government expenditures move together to accommodate a fixed balance of trade as a share of GDP.
- Rates of return are exogenous, and capital is mobile between industries and regions. This mobility can occur either in the form of machinery etc. being physically moved, or capital in one industry/region being allowed to depreciate without replacement while investment builds up the stock of another industry/region.

- Foreign currency prices of imports are naturally exogenous.
- Real government consumption is also exogenous.
- Other exogenous variables include rates of production tax, technological coefficients, national population, and national labour supply.

Table 8 Fixed elements of the CGE model

Variables
Taxes on production
Technological change
Government demand
Gross growth rate of capital
Gross rate of return on capital
Number of households
National population
National labour supply
Import prices, foreign currency
Foreign demand for New Zealand exports
Land use

Source: NZIER

Appendix B Additional results from the CGE modelling

Table 9 Summary of national economic impacts

Change from baseline (2018)

Indicator			GDP	Investment	Household consumption	Wages	Exports	Imports
2.5% labour productivity increase	Lower bound	% change	0.06%	0.07%	0.08%	0.10%	0.05%	0.04%
		Level ($m)	$176	$43	$123	NA	$41	$33
	Mid bound	% change	0.07%	0.08%	0.09%	0.12%	0.06%	0.05%
		Level ($m)	$205	$50	$144	NA	$48	$38
	Upper bound	% change	0.08%	0.09%	0.10%	0.13%	0.07%	0.06%
		Level ($m)	$235	$57	$165	NA	$54	$43
5% labour productivity increase	Lower bound	% change	0.13%	0.13%	0.15%	0.20%	0.11%	0.09%
		Level ($m)	$357	$87	$250	NA	$84	$67
	Mid bound	% change	0.15%	0.15%	0.18%	0.23%	0.12%	0.10%
		Level ($m)	$417	$102	$292	NA	$97	$77
	Upper bound	% change	0.17%	0.18%	0.21%	0.26%	0.14%	0.11%
		Level ($m)	$477	$116	$335	NA	$109	$87
7.5% labour productivity increase	Lower bound	% change	0.19%	0.20%	0.24%	0.30%	0.16%	0.13%
		Level ($m)	$543	$132	$379	NA	$128	$102
	Mid bound	% change	0.22%	0.24%	0.28%	0.35%	0.19%	0.15%
		Level ($m)	$633	$154	$444	NA	$147	$117
	Upper bound	% change	0.26%	0.27%	0.32%	0.39%	0.21%	0.17%
		Level ($m)	$726	$177	$510	NA	$166	$131

Source: NZIER

Table 10 Additional flow-on effects on selected industries

Changes in industry output from baseline (2018), in $ million

Industry	2.5% labour productivity increase			5% labour productivity increase			7.5% labour productivity increase		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
Supermarket & grocery stores	$153	$171	$188	$308	$344	$379	$466	$519	$574
Motor vehicle parts wholesaling	$118	$127	$131	$235	$247	$258	$350	$375	$400
Labour unions & other interest groups	$77	$83	$89	$153	$166	$177	$230	$247	$265
Electricity transmission & distribution	$24	$27	$30	$50	$57	$61	$77	$86	$93
Government services	$12	$20	$33	$26	$38	$61	$32	$60	$98
Owner-dwelling	$19	$22	$25	$38	$44	$51	$57	$68	$78
Repair & maintenance	$13	$16	$19	$27	$30	$37	$38	$47	$58
Machinery & equipment wholesaling	$10	$10	$8	$21	$23	$18	$36	$33	$25
Hospitals	$8	$9	$11	$16	$19	$22	$25	$29	$34
Employment & other services	$8	$9	$10	$16	$18	$19	$24	$26	$29
Warehousing & storage services	$7	$8	$10	$14	$17	$19	$21	$25	$30
School education	$7	$8	$9	$13	$15	$17	$20	$23	$27
Dairy product manufacturing	$7	$8	$8	$13	$15	$17	$20	$23	$26
Fertiliser & pesticide manufacturing	$7	$8	$8	$14	$15	$16	$21	$23	$25
Architectural & engineering services	$6	$7	$8	$12	$14	$16	$19	$21	$24
Specialised food retailing	-$7	-$8	-$9	-$15	-$17	-$19	-$22	-$25	-$28

Industry	2.5% labour productivity increase			5% labour productivity increase			7.5% labour productivity increase		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
Fuel retailing	-$8	-$9	-$10	-$16	-$18	-$20	-$24	-$27	-$30
Transport equipment manufacturing	-$10	-$12	-$15	-$21	-$22	-$27	-$28	-$35	-$43
Food & beverage services	-$6	-$2	$1	-$11	-$4	$2	-$16	-$6	$4
Accommodation	-$18	-$22	-$27	-$36	-$45	-$54	-$53	-$67	-$81
Motor vehicle parts retailing	-$19	-$21	-$23	-$37	-$42	-$46	-$56	-$63	-$70
Other store based retailing	-$19	-$21	-$24	-$38	-$43	-$47	-$58	-$65	-$72
Non-residential property operation	-$21	-$21	-$21	-$42	-$43	-$43	-$63	-$64	-$63
Electricity generation & on-selling	-$25	-$28	-$29	-$53	-$59	-$61	-$81	-$89	-$92
Recreational & clothing retailing	-$30	-$34	-$38	-$61	-$69	-$76	-$93	-$104	-$116
Other goods wholesaling	-$32	-$43	-$44	-$66	-$78	-$92	-$89	-$121	-$140
Basic material wholesaling	-$42	-$45	-$44	-$79	-$80	-$89	-$122	-$125	-$135
Furniture & hardware retailing	-$37	-$42	-$46	-$75	-$84	-$93	-$114	-$127	-$141
Personal services	-$42	-$45	-$49	-$84	-$90	-$96	-$125	-$134	-$144
Grocery & liquor product wholesaling	-$55	-$47	-$46	-$112	-$106	-$83	-$175	-$155	-$135
New Zealand industry output	**$245**	**$293**	**$343**	**$497**	**$592**	**$694**	**$751**	**$901**	**$1,056**

Table 11 Additional employment effects

Changes from baseline (2018), in millions

Industry	2.5% labour productivity increase			5% labour productivity increase			7.5% labour productivity increase		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
Supermarket & grocery stores	$35.5	$39.2	$42.8	$70.4	$77.5	$84.7	$104.5	$114.9	$114.9	$125.4
Labour unions & other interest groups	$33.7	$36.3	$39.1	$66.8	$72.3	$77.4	$100.2	$107.8	$107.8	$115.8
Motor vehicle parts wholesaling	$32.6	$34.9	$36.0	$64.9	$68.0	$70.8	$96.3	$103.2	$103.2	$109.8
Government services	$6.1	$9.6	$16.0	$12.7	$18.5	$29.5	$15.7	$29.1	$29.1	$47.5
Hospitals	$6.1	$7.1	$8.2	$12.3	$14.5	$16.7	$18.7	$21.9	$21.9	$25.3
School education	$5.2	$6.1	$6.9	$10.6	$12.3	$14.0	$16.1	$18.6	$18.6	$21.2
Repair & maintenance	$3.7	$4.4	$5.4	$7.5	$8.5	$10.4	$10.7	$13.1	$13.1	$16.4
Electricity transmission & distribution	$2.9	$3.3	$3.6	$6.0	$6.9	$7.4	$9.3	$10.4	$10.4	$11.2
Employment & other services	$3.0	$3.3	$3.6	$6.0	$6.6	$7.1	$9.0	$9.9	$9.9	$10.9
Tertiary education	$2.3	$2.7	$3.1	$4.6	$5.4	$6.2	$7.0	$8.2	$8.2	$9.4
Residential care & social assistance	$1.8	$2.2	$2.6	$3.6	$4.4	$5.3	$5.5	$6.8	$6.8	$8.1
Architectural & engineering services	$1.9	$2.2	$2.5	$3.8	$4.4	$5.0	$5.7	$6.6	$6.6	$7.7
Medical & other health care services	$1.7	$2.0	$2.4	$3.5	$4.2	$4.9	$5.3	$6.3	$6.3	$7.4
Building cleaning & other support services	$1.6	$1.9	$2.2	$3.3	$3.7	$4.3	$4.9	$5.7	$5.7	$6.6

Industry	2.5% labour productivity increase			5% labour productivity increase			7.5% labour productivity increase		
	Lower	Central	Upper	Lower	Central	Upper	Lower	Central	Upper
Banking & financing	$1.4	$1.9	$2.4	$2.8	$3.7	$4.9	$4.0	$5.7	$5.7	$7.5
Food & beverage services	-$3.0	-$2.9	-$2.7	-$5.8	-$5.5	-$5.3	-$8.6	-$8.2	-$8.2	-$7.8
Adult, community, & other education	-$2.8	-$3.0	-$3.0	-$5.6	-$5.9	-$6.0	-$8.4	-$8.7	-$8.7	-$8.9
Transport equipment manufacturing	-$3.3	-$3.9	-$4.7	-$6.6	-$7.3	-$8.7	-$9.2	-$11.2	-$11.2	-$14.0
Fuel retailing	-$5.1	-$5.7	-$6.4	-$10.2	-$11.5	-$12.8	-$15.4	-$17.4	-$17.4	-$19.4
Specialised food retailing	-$5.3	-$5.9	-$6.6	-$10.5	-$12.0	-$13.3	-$15.9	-$18.0	-$18.0	-$20.1
Accommodation	-$5.0	-$6.3	-$7.6	-$10.0	-$12.6	-$15.2	-$15.0	-$18.8	-$18.8	-$22.7
Basic material wholesaling	-$10.2	-$10.9	-$10.9	-$19.1	-$19.7	-$22.1	-$29.4	-$30.5	-$30.5	-$33.4
Department stores	-$9.3	-$10.2	-$11.2	-$18.7	-$20.6	-$22.5	-$28.1	-$31.0	-$31.0	-$33.8
Other goods wholesaling	-$9.8	-$12.7	-$13.2	-$19.9	-$23.4	-$27.5	-$27.3	-$36.0	-$36.0	-$41.8
Other store based retailing	-$11.6	-$13.0	-$14.4	-$23.2	-$26.1	-$29.0	-$35.0	-$39.4	-$39.4	-$43.8
Grocery & liquor product wholesaling	-$14.0	-$12.7	-$12.8	-$28.7	-$28.1	-$23.5	-$44.6	-$41.1	-$41.1	-$37.8
Motor vehicle parts retailing	-$12.8	-$14.4	-$16.0	-$25.8	-$28.9	-$32.1	-$38.8	-$43.6	-$43.6	-$48.4
Personal services	-$18.5	-$19.8	-$21.3	-$36.7	-$39.5	-$42.1	-$54.9	-$58.9	-$58.9	-$62.9
Recreational & clothing retailing	-$19.0	-$21.4	-$23.8	-$38.3	-$43.0	-$47.8	-$57.7	-$65.0	-$65.0	-$72.2

Source: NZIER