General Equilibrium Analysis & Cost-Benefit Analysis – Application to Roads of National Significance

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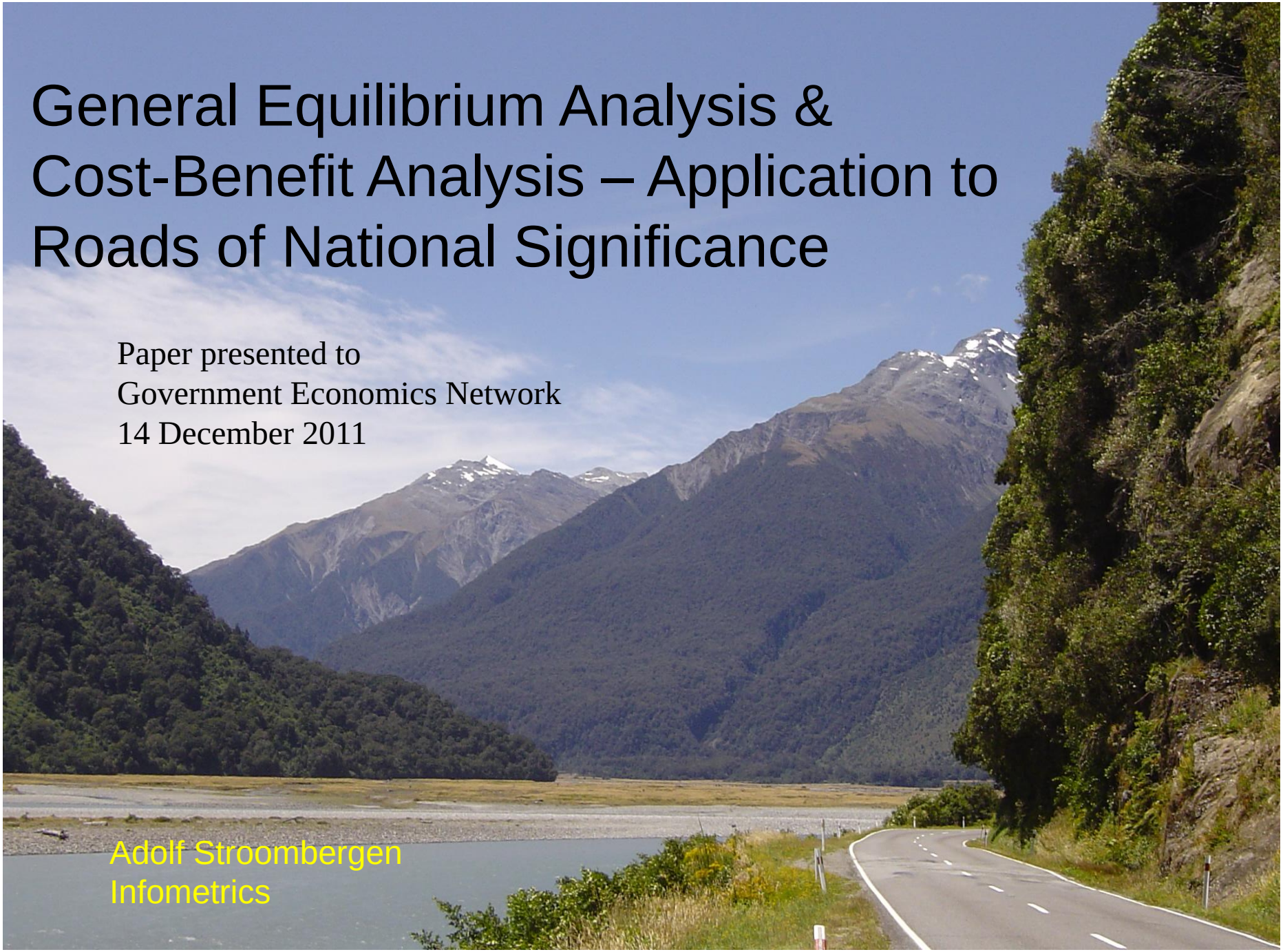

What is a General Equilibrium Model?

- Economic behaviour described by mathematical equations
  - household spending decisions
  - world demand for NZ exports
  - choice of fuels and factor inputs by industry
- Wider ambit than traditional cost-benefit analysis
- Economy divided into numerous industries (53)
- Track flow-on effects from one industry to another; eg
  - energy prices -> industry costs -> competitiveness -> exports-> labour demand -> household spending -> other industries
- Designed for “what if”? scenarios, not forecasting
- Able to accommodate government policies
  - (tax, welfare, spending on infrastructure, user pays, subsidies)

...and external shocks (oil price rises, protectionism, some aspects of global warming)

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GE Modelling: Caveats

- Time not explicit.
- Largely Neo-Classical world.
- Model not suited to estimating transition paths.
- Aggregation bias (53 industries).
- No lumpiness in production.
- No endogenous technological change.

<u>Roading:</u>

- No spatial disaggregation.
- Road supply and use is not an industry in the national accounts: use proxies.

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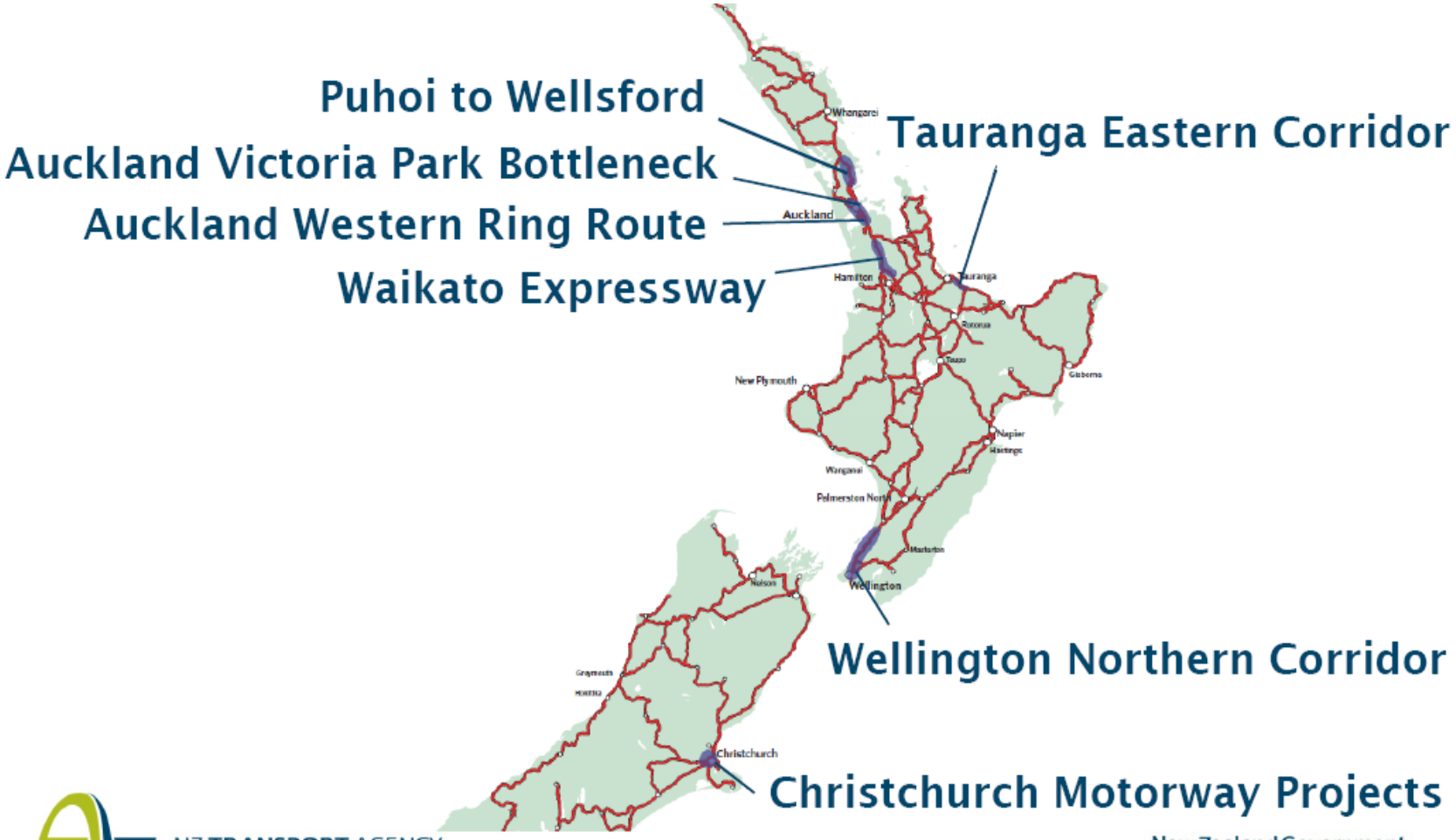
Roads of National Significance



NZ TRANSPORT AGENCY
WAKA KOTAHI

New Zealand Government

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Direct Benefits and Costs

Four main direct impacts:

1. Accident cost savings — reduction in loss of life and permanent disability, reduction in health care costs, reduction in vehicle repair costs.

2. Travel time savings — savings in travel time (both economic and non-economic in nature).

3. Vehicle operating costs — lower fuel usage and vehicle repair costs

4. Project capital costs and financing impacts.

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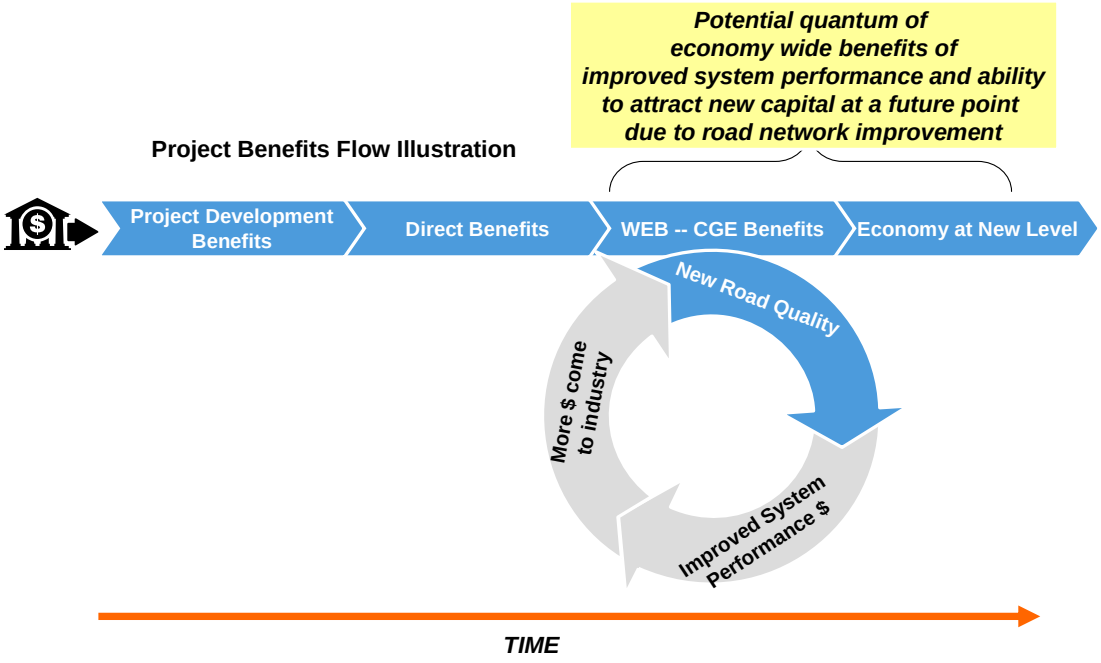
GE Analysis of RONS



- Enhanced resource productivity of transport-dependent commercial and industrial activities.
- Less time and money is spent transporting goods between suppliers and consumers, between cities, and between ports and factories.
- So more investment can be directed into other areas such as telecommunications and energy infrastructure, dairy processing, etc.

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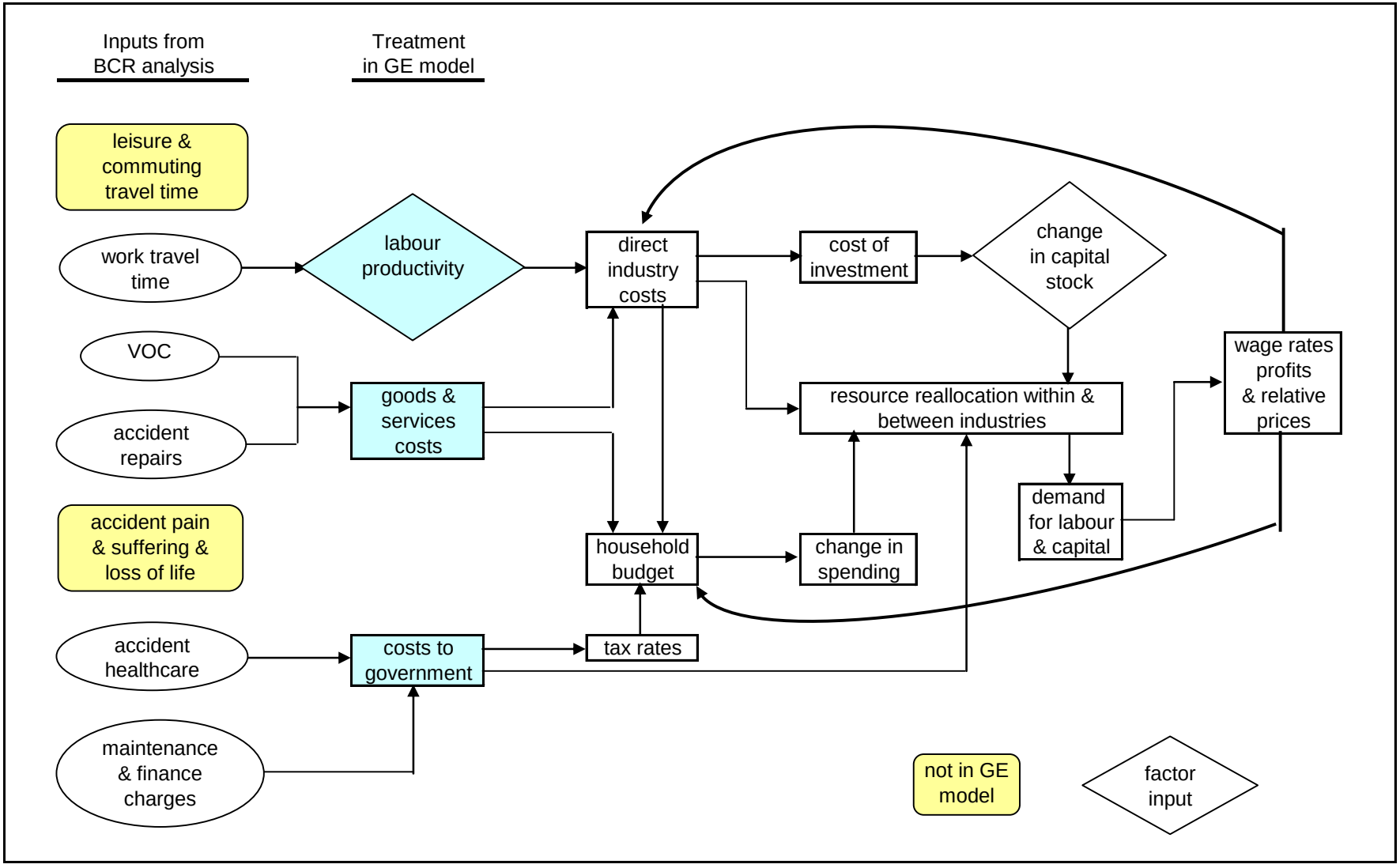
From CBA to GE

Benefits (CBA)	GE Representation
Travel Time	
Lower travel time – work related	Increase in labour productivity
Lower travel time – leisure	Non-market =>Not in GE model
Lower travel time – commuting	50-50 split between market & non-market
Accidents	
Accident cost savings - reduction in health care costs	Lower government consumption (spending on health services), so lower taxation
Accident cost savings - reduction in loss of life and permanent disability	Non-market =>Not in GE model
Accident cost savings and lower vehicle operating costs - reduction in vehicle repair costs.	Lower expenditure on vehicle repair by industries and households
VOC	
Lower vehicle operating costs - fuel use	Increase in end use efficiency for petrol & diesel
Lower vehicle operating costs - depreciation	Lower user cost of capital

Note benefits could be negative

RONS in GE Model



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GE Analysis of RONS

- Petrol and diesel consumption is used to allocate productivity effects by industry, as CBA has no information on this.
- Similarly for changes in vehicle operating costs.
- Firms that do not operate their own vehicle fleet obtain their benefit indirectly through the effects on the road passenger and road freight industries.

- Could be a poor proxy for the allocation of benefits if RONS users are not representative of all road users.
- Eg. Wellington to Levin RONS is unlikely to carry the national share of forestry traffic, so benefit to forestry from Wellington-Levin RONS will be over-stated.
- GE benefits still contain whatever error margins exist in standard CBA.
- Agglomeration benefits are another form of *Wider Economic Benefit* - probably some overlap with GE benefits.

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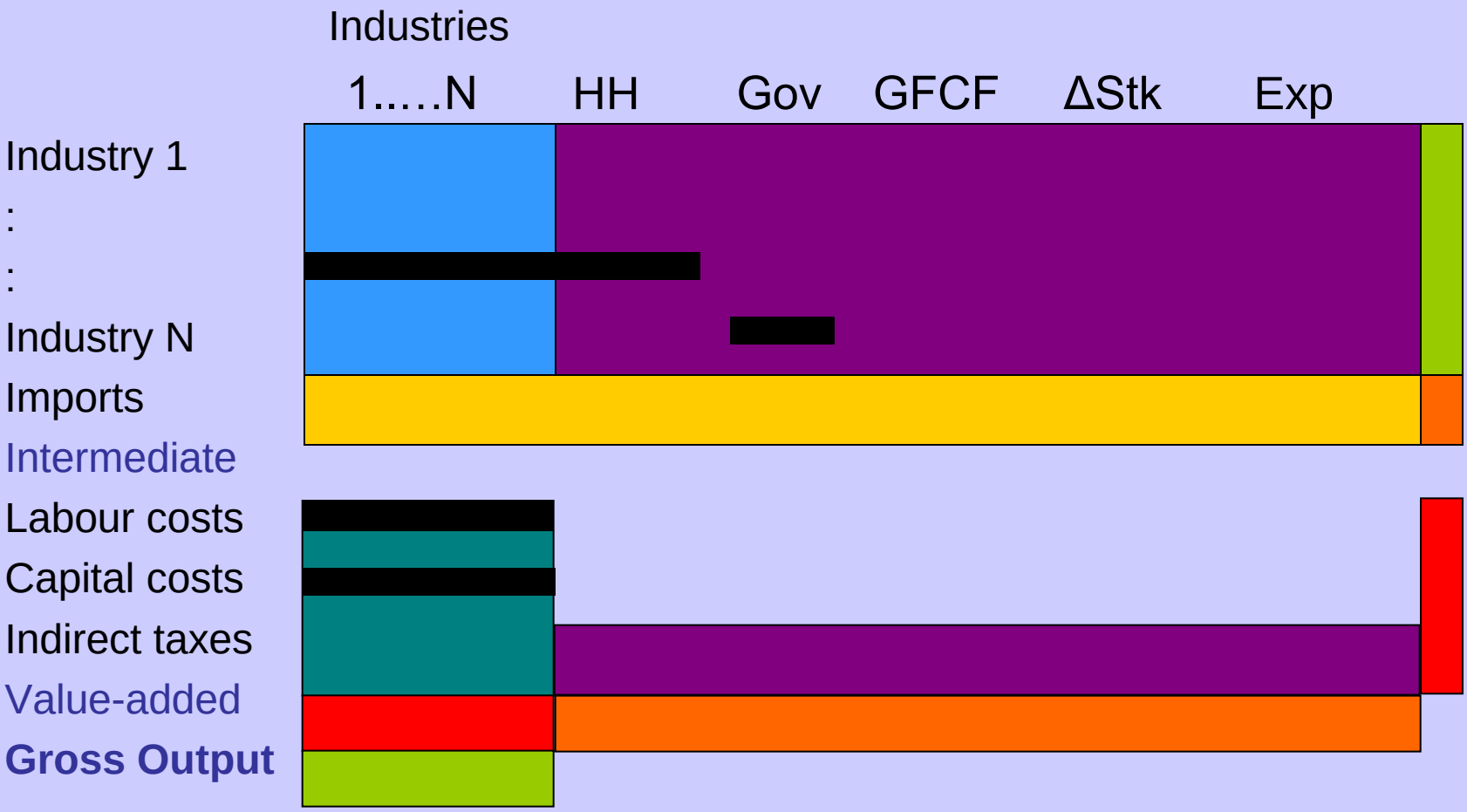
Production Account in ESSAM Model



Results (operational phase)

			BAU	Fixed RoR All RONS			Fixed K All RONS	
			$m(05/06)	Δ %	Δ $m		Δ %	Δ $m
	Consumption (private +govt)		180086	0.47%	852		0.14%	259
	Exports		71630	0.64%	461		0.29%	205
	Imports		78169	0.31%	245		0.14%	111
	GDP		232576	0.58%	1350		0.19%	443
	RGNDI		231284	0.48%	1116		0.15%	344
	Population ('000)		4734	0.00%	0		0.00%	0
	RGNDI/capita ($)		48856	0.48%	236		0.15%	73
	Real wage rate (index)		1.3882	0.24%			-0.22%	
	Household effective income tax rate (%)		15.83	0.57%			0.82%	
	CO_2 emissions (kt) [$100/t]		74761	0.55%	412		0.27%	202
		Source						
A	Capital cost undiscounted	NZTA	$m		9105.8			9105.8
B	Typical yearly maintenance & operation	NZTA			15.7			15.7
C	Tolls	NZTA			6.0			6.0
D=0.06A-B	Financing charge at 6% (less tolls)				540.3			540.3
E=F+G+H	Total gross benefit in 2020		$m		1040.4			1040.4
F	Safety	NZTA	$m		77.1			77.1
F1	Loss of life & permanent disability				64.5			64.5
F2	Lost output				2.5			2.5
F3	Health care				1.9			1.9
F4	Vehicle repair				7.3			7.3
F5	Legal				1.0			1.0
G	Vehicle operating costs	NZTA			35.5			35.5
H	Travel and congestion time	NZTA	$m		927.7			927.7
I	Travel and congestion time	NZTA	m hrs		44.2			44.2
I1	Work				13.9			13.9
I2	Commuting				5.8			5.8
I3	Other				24.6			24.6
J=F3+F4+F5+G+(H/I)*I1	Economic savings input to model*		$m		337.4			337.4
K1	Change in RGNDI from model	model			1116.2			343.6
K2	- inflated to 2008 prices	1.072			1196.5			368.4
L=K2/J	Ratio GE benefits to market benefits				3.55			1.09
M=(K2+E-J)/E	Overall increase in total benefits				1.83			1.03

Notes: *Pro rata on travel time except for VPT

Under fixed RoR:
- total benefits +83% over CBA.
- market benefits +255% over CBA.

Under fixed K:
- total benefits +3% over CBA.
- market benefits +9% over CBA.

- but different benefit measures would give different results.

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Future Improvements?

- More detail on traffic mix needed, especially for region specific roading projects.
- At least identify heavy vehicles and industry.
- Define demand for vehicles, fuel, maintenance, etc, as demand for a service: model changes in VOC as changes in productivity.
- Explore different financing mechanisms – RUC, excise duty, road tolls.

- Interface between GE benefits and agglomeration benefits.