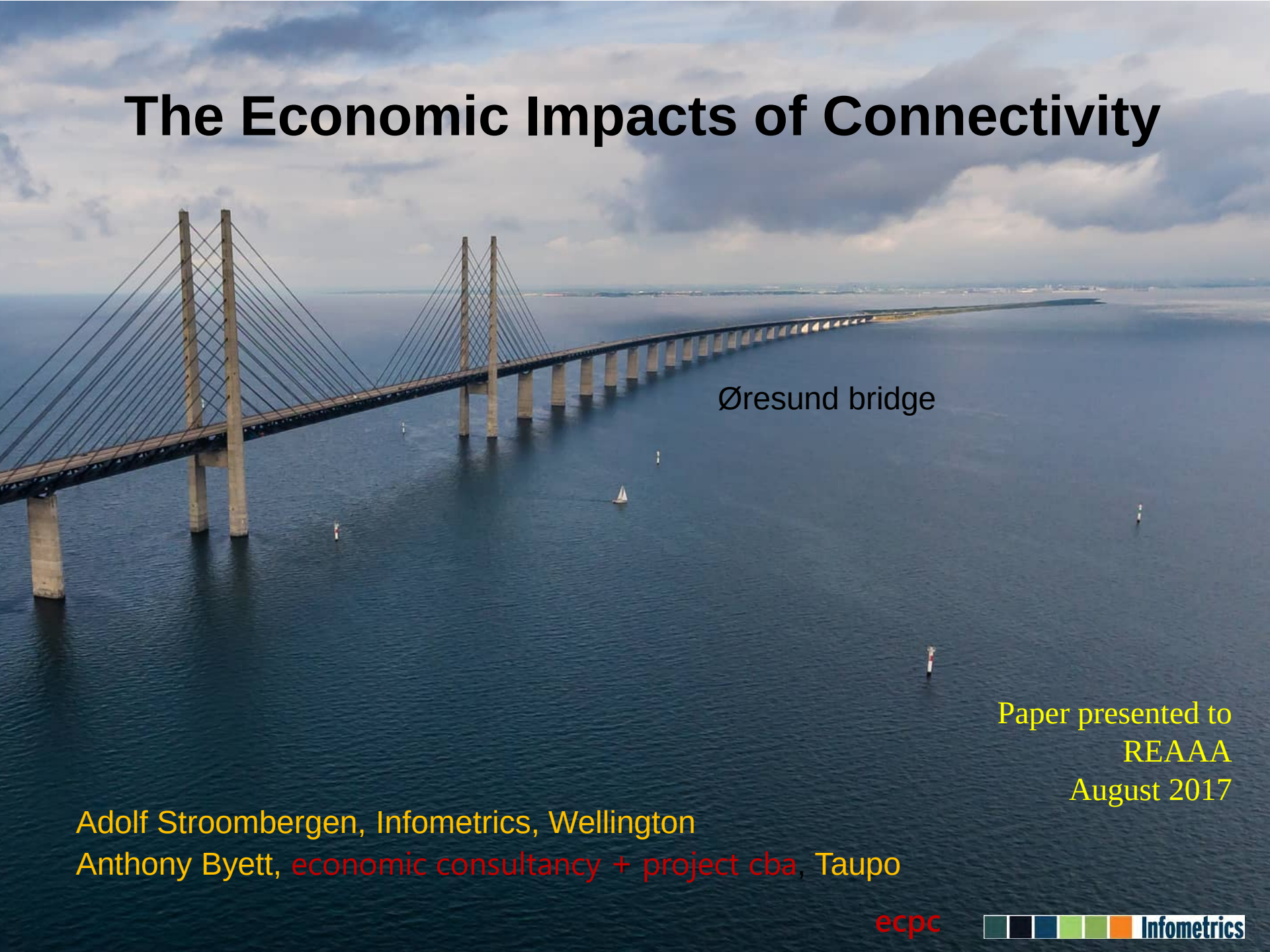
The Economic Impacts of Connectivity



Øresund bridge

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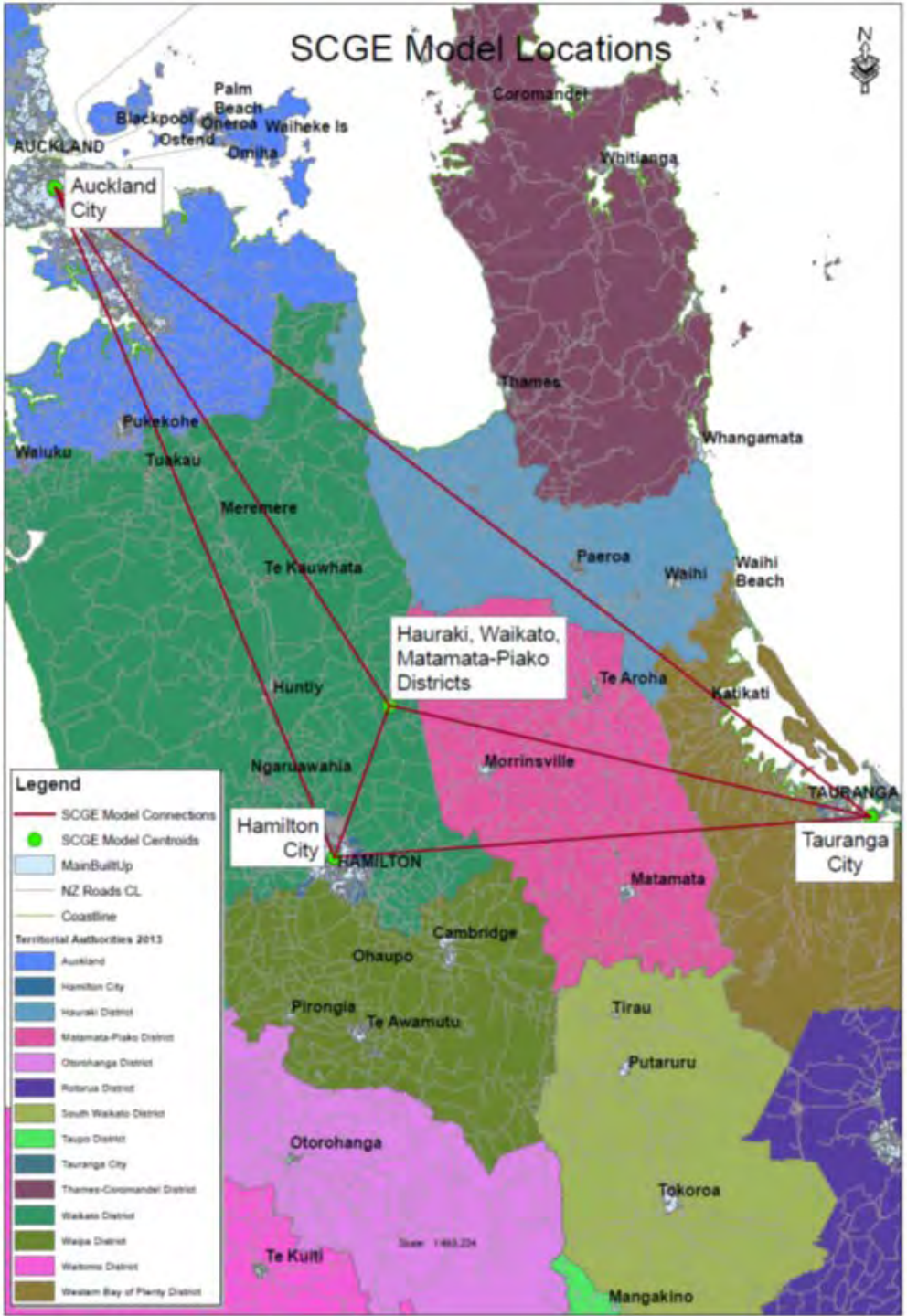

Context:

What if a significant road transport improvement occurred between Auckland, Hamilton and Tauranga?

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The typical appraisal

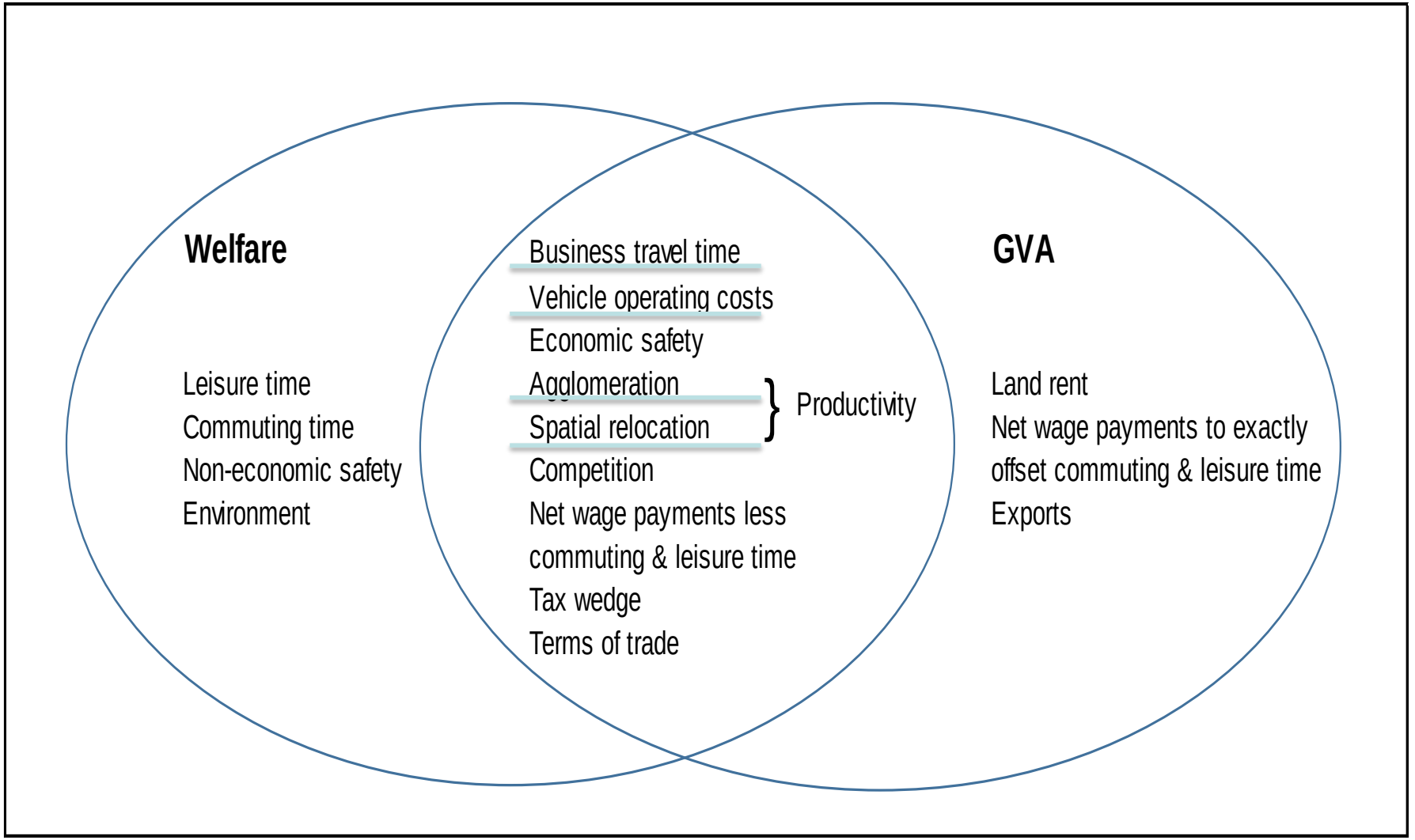
NZTA EEM

- Measure travel saving
  - Travel time + vehicle operating costs
- Add on agglomeration benefits

Issues:

1. Can be costly to model traffic flows
2. How to validate traffic model?
3. Traffic model assumes ‘fixed land use’
4. Travel cost savings do not show where benefit will eventuate
   - Auckland or Hamilton?
5. Nor how
   - more jobs or leisure?

Potential transport effects



Measuring transport effects

Welfare benefit	Modelling welfare benefits		Modelling GDP effects		Modelling spatial effects	Plausible reasons for effects to exist
Transport user benefits	NZTA EEM		*			Reduced travel costs.
Agglomeration externalities due to intra-urban urbanisation and localisation			GVA MODEL			Increased competition. Improved coordination. New firm nursery. Better job matching. Increased skill specialisation. More knowledge exchange.
Agglomeration externalities due to inter-urban localisation						Specialisation around existing industry. Increased innovation derived from higher international trade and investment.
Spatial changes in land use		SCGE MODEL		SCGE MODEL	SCGE MODEL	Better able to match work-residence locations with preferences, leading to changes in locations of firms and households.

** GVA model may be picking up some productivity effects related directly to reductions in travel time*

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Case Study Improvement
Waikato Expressway & Kaimai Ranges

	Time saving	Distance saving
Pokeno to Horotiu	-14min	-3.0km
Horotiu to Hamilton & Cambridge South	-10min	-2.5km
SH24/SH29 intersection and bottom of old Kaimai road	-7min	-2.5km

Effective population densities re-estimated on the basis of changes in time and distance between mesh blocks. E.g.

- Effective population density accessible to the Waikato District increase by 27.5.
- Weighted time to Auckland Airport decreases by 4.7%.

First phase results
Waikato Expressway & Kaimai Ranges

- Reduction in travel costs expected = 0.22% of regional annual travel costs, according to SCGE model
- Expect similar to be measured by traffic model and EEM
- Note: travel costs less than implied by time & distance reductions on previous slide as these routes are not necessarily the fastest between Auckland and Tauranga.

	Reduced travel costs
Auckland	0.24%
Waikato	0.17%
Hamilton	0.12%
Tauranga	0.18%
Mean	0.22%

Will these savings lead to more jobs for Auckland, Hamilton or Tauranga?

First and second phase results
Waikato Expressway & Kaimai Ranges

Also get a further 0.12% improved output productivity due to (a) being closer to each other and (b) increased specialisation, according to GVA model

- Probably slightly more than EEM measure

	Reduced travel costs	Agglomeration effect (from GVA)
Auckland	**0.24%**	**0.01%**
Waikato	**0.17%**	**0.31%**
Hamilton	**0.12%**	**0.54%**
Tauranga	**0.18%**	**0.44%**
Mean	**0.22%**	**0.12%**

Mostly in

- Consumer services
- Community services
- Business services
- Manufacturing

Implicit in the productivity gains from agglomeration is an implied reduced need for employment; -4,500 people or 0.21% fewer.

Where do they go?

Third phase results
Waikato Expressway & Kaimai Ranges

Scenario 1*: Changes in employment by residence and work zone ('000)

** Assume no overall growth in regional workforce*

		Work zone				
		Auckland	Waikato	Hamilton	Tauranga	Total
Residential zone	Auckland	0.6	0.1	0.1	0.1	0.9
	Waikato	0.2	-0.4	0.1	0.0	-0.1
	Hamilton	0.1	0.0	-0.6	0.0	-0.5
	Tauranga	0.1	0.0	0.0	-0.5	-0.3
	Total	1.0	-0.3	-0.4	-0.3	0.0

1

Macroeconomic results (percentage changes)

	Scenario 1 *No more jobs*	Scenario 2 *1% more pop.*	Scenario 3 *Plus agglom.*
Private consumption	-0.1	1.7	1.7
Exports	5.4	-0.8	-0.3
Imports	4.6	3.4	3.4
GDP	0.2	0.9	1.0
Utility	0.2	2.0	2.0

2

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More third phase results
Waikato Expressway & Kaimai Ranges

Changes in employment by residence and work zone ('000)
Scenario 3 less Scenario 2

Residential zone	Work zone: Auckland	Waikato	Hamilton	Tauranga	Total
Auckland	-0.2	0	0	0	-0.2
Waikato	0	0.1	0	0	0
Hamilton	0	0	0.1	0	0.1
Tauranga	0	0	0	0	0.1
Total	-0.2	0	0.1	0	0

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The 3 major effects

1. More work and living towards the centre – better matching of people's work-life preferences
2. Greater welfare gain – even better matching at the margin during growth
3. Further re-location (this time away from the centre)

Summary

THE PROJECT

- 0.4% GDP improvement
- $380 million ($2010) p.a.
- $5.2 billion in present value over 30 years at a real 6% pa discount rate.

Gains largest in Auckland

Spatial relocation allows
large welfare gains

First order effects
largest

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Summary

Bill Phillips, MONIAC

THE PROJECT

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First order effects largest

THE MODELS

Showed insights not otherwise available

- Jobs
- Sectors
- Locations
- Growth dynamics

Relatively easy to test scenarios

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Extra slides if required

Øresund bridge, Drogden tunnel

- Malmö (Sweden by bridge) to Copenhagen (Denmark by tunnel)
- 8km bridge + 4km tunnel
- Road and rail
- Cost approx €4 billion
- Funded over 30yrs by tolls
- Except land connections (public $)
- Toll €56 1-way (or €22 commuter)
- By train 35min
- Bi-national region of 3.7m people
- More commuting from Sweden to Denmark

Example of GVA MODEL

Only 2 of 55 sectors

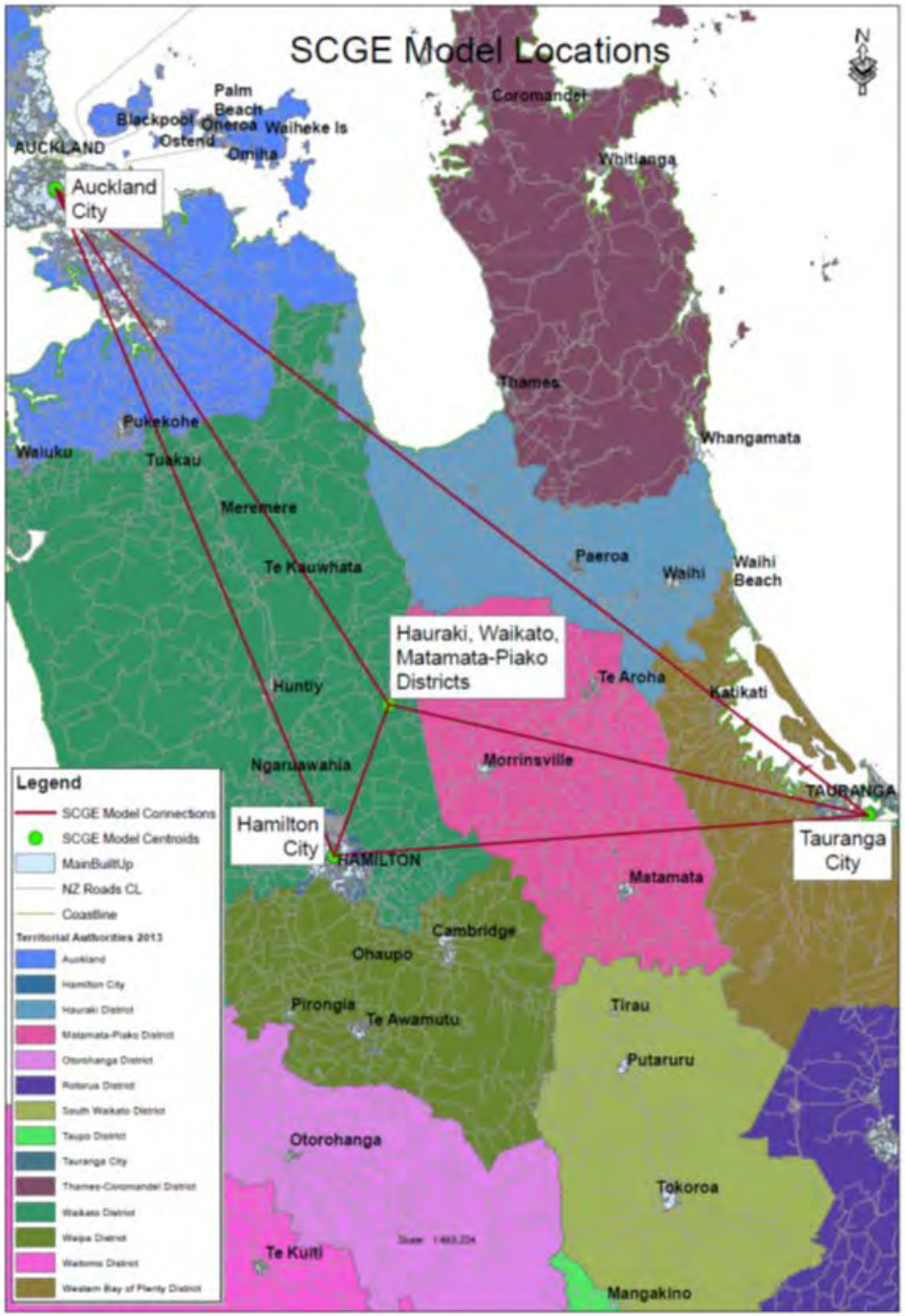
Vectors of LTA (86) data for industry i at time t

$Employ_{it} = f(Pop_t\ XVAR_t\ AGTC_t,\ AAir_t)$

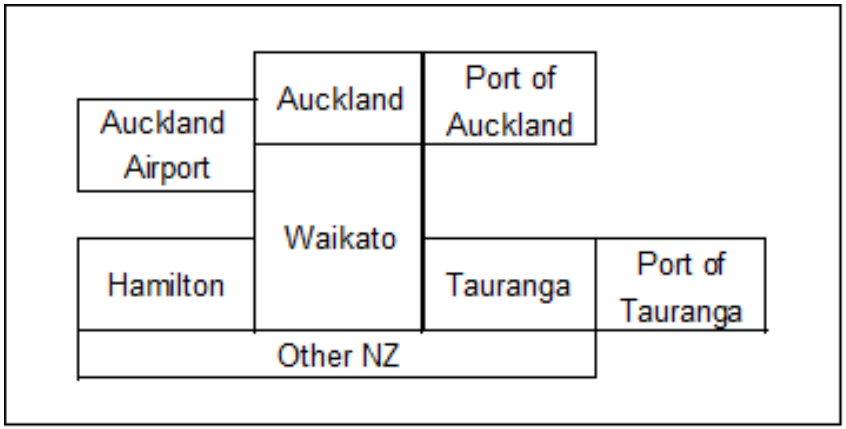
$GDP_{it} = g(Employ_{it}\ XVAR_t\ AGTC_t,\ AAir_t)$

Parameter estimates (red>95%, grey>90%)

		Professional, Scientific and Technical Services		Manufacturing	
	Variable	**Employ**	**GDP**	**Employ**	**GDP**
	C	**-5.549**	**-2.791**	-2.255	-1.242
	ln(EMPL)		**0.955**		**0.996**
	ln(WKPOP)	**1.305**		**0.977**	
XVAR	**ZTARA**		**0.185**		
XVAR	**Z2013**		**-0.463**		0.094
XVAR	**QDEG**	**3.243**	**0.765**		
XVAR	**OCCUP**			**-3.969**	
XVAR	**AGE**	**-3.779**			**-2.027**
XVAR	**EMP2POP**	**1.554**		**0.811**	
XVAR	**MAXNZSEC**				**2.102**
	ln(AGTC)		**0.041**	**0.214**	
	ln(AAIR)		**-0.013**	**0.103**	**-0.058**
	N	168	168	168	168
	R2	0.935	0.997	0.825	0.961



SCGE Model Zonal Maps



- Auckland, Hamilton, Tauranga and (rest of) Waikato are residential and work zones.
- Ports are only for exports and imports by air or sea.
- Other NZ is a ‘land port’.

SCGE Outline (1)

Households

Utility (U) of household j which selects option k (where to live and where to work) is given by:

$$U_{kj} = V_k + \varepsilon_{kj}$$

Here V_k is the general utility attached to live/work option k and ε_{kj} is an idiosyncratic element of utility. Utility is gained from consumption of goods and land (location), not from transport.

From the standard multinomial logit model the proportion of households (L) who select option k is given by:

$$\frac{L_k}{\sum_k L_k} = \frac{e^{V_k}}{\sum_k e^{V_k}}$$

In other words the ratio of the utility of option k to total utility is the equal to the proportion of households who choose that option. So the number of households choosing any given live/work option k is:

$$Ln(L_k) = c + \sigma \mathrm{Ln}(U_k)$$

SCGE Outline (2)

Production and Trade

$$X_w = \lambda_w L_w^{\beta} N_w^{(1-\beta)}$$

Agglomeration effects enter via λ. Output is a composite of transport and other goods:

$$X_w = \theta G_w + T_w$$

Exports outside the region from work zone w via port zone p:

$$E_{wp} = \varphi_{wp}(P_T D_{wp})^{\eta}$$

Goods demand by home zone is converted into demand by work zone or port zone (for imports from outside region) by a gravity model:

$$G_{uv} = g_u \frac{L_u L_v}{(D_{uv})^{\delta}}$$

SCGE Outline (3)

Transport

Transport services consumed in each region are equal to the sum of commuting and freight margins (all to households).

$$T_r = \sum_w (L_{wr} D_{wr} + F_{(w+p)r})$$

Assorted other equations and identities:

- Supply-demand balance
- Household income and expenditure
- Industry costs and revenue
- Regional balance of payments and GDP

Model expressed in logarithmic form and solved by matrix inversion (≈ 220x220) using GAUSS.

First and second phase results
Waikato Expressway & Kaimai Ranges

	Reduced travel costs	Agglomeration effect (from GVA)
Auckland	0.24%	0.01%
Waikato	0.17%	0.31%
Hamilton	0.12%	0.54%
Tauranga	0.18%	0.44%
Mean	0.22%	0.12%

Implicit in the productivity gains is an implied reduced need for employment; -4,500 people or 0.21% fewer.

Where do they go?

Scenario 1: Supply of industrial land is fixed in each zone and the total regional supply of labour is fixed. No agglomeration benefits.

Scenario 2: As in Scenario 1 plus 1% (induced?) extra labour and residential land.

Scenario 3: As in Scenario 2 plus agglomeration benefits.

Case Study
Waikato Expressway & Kaimai Ranges (3)

Scenario 1: Changes in utility excluding commuting and migration by residence and work zone

Residential zone	Work zone: Auckland	Waikato	Hamilton	Tauranga	Total
Auckland	0.1%	4.4%	9.7%	17.0%	0.2%
Waikato	3.1%	-0.8%	0.3%	7.9%	0.0%
Hamilton	5.2%	-0.5%	-0.8%	7.3%	-0.5%
Tauranga	14.2%	6.5%	10.3%	-0.7%	-0.2%
Total	0.2%	-0.3%	-0.2%	-0.3%	0.1%

Scenario 1: Changes in utility including commuting and migration by residence and work zone

Residential zone	Work zone: Auckland	Waikato	Hamilton	Tauranga	Total
Auckland	0.2%	9.8%	21.3%	37.4%	0.5%
Waikato	6.9%	-1.8%	0.8%	17.4%	0.1%
Hamilton	11.3%	-1.1%	-1.7%	16.0%	-1.0%
Tauranga	31.1%	14.2%	22.6%	-1.5%	-0.4%
Total	0.5%	-0.7%	-0.5%	-0.6%	0.2%

SCGE Model Caveats

- Still a pilot model.
- Time not explicit.
- Largely Neo-Classical world.
- Aggregation bias (2 industries).
- No lumpiness in production.

Future Improvements?

1. Cobb-Douglas production and consumer utility functions are limiting.
2. Other (non-transport) goods may be too broad. Could miss benefits of reallocated expenditure.
3. Splitting other goods would also present an opportunity to distinguish between goods of different transport intensity and allow better links to agglomeration benefits.
4. Elasticity values such as σ in need more research.
5. Business time savings are not directly captured in the model – simulated as productivity improvements, but only in relation to transporting freight.

Conclusion

- The gains from a spatial reallocation of economic activity outweigh those from greater population density – at least for this particular case study. (Hensher et al, 2012, found a similar relative mix of effects for a proposed rail link in Australia).
  - Suggests may get
- Under a scenario of growing labour force over the combined regions, the road improvements are likely to lead to relatively higher population and workforce growth rates in Auckland and relatively lower growth in the other zones.
- In all cases the improvement in household utility is at least as much as the improvement in GDP, the result of people being able to better match their residential location, work location and consumption to their preferences.
- These are gains from greater allocative efficiency; gains that occur even when there is no change in the total level of resources (land and labour) available to the economy.