Raising agricultural productivity and land values through greenhouse gas policy: lessons for Colombia from New Zealand

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CEDE Seminar

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Motivation

1. Rural poverty and low agricultural productivity
   - some driven by under-investment as a result of conflict – e.g. Arias, Ibanez and Zambrano (2014)
   - Much related to poor education and land tenure
2. High livestock emissions contributing to climate change
3. Growing international concerns about 'land grabbing'
   - Domestic and international

Key questions

Can we use funding motivated by climate change to address rural poverty?

Are there risks of perverse effects on equity?

Outline

Greenhouse gas emissions and mitigation in agriculture

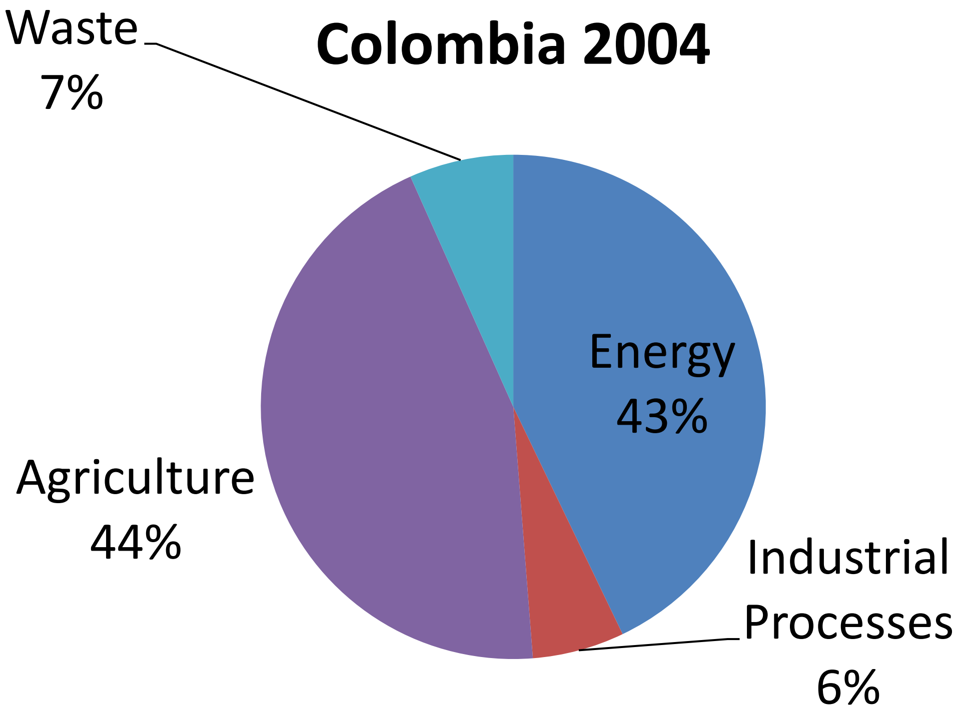
International – domestic contract / policy

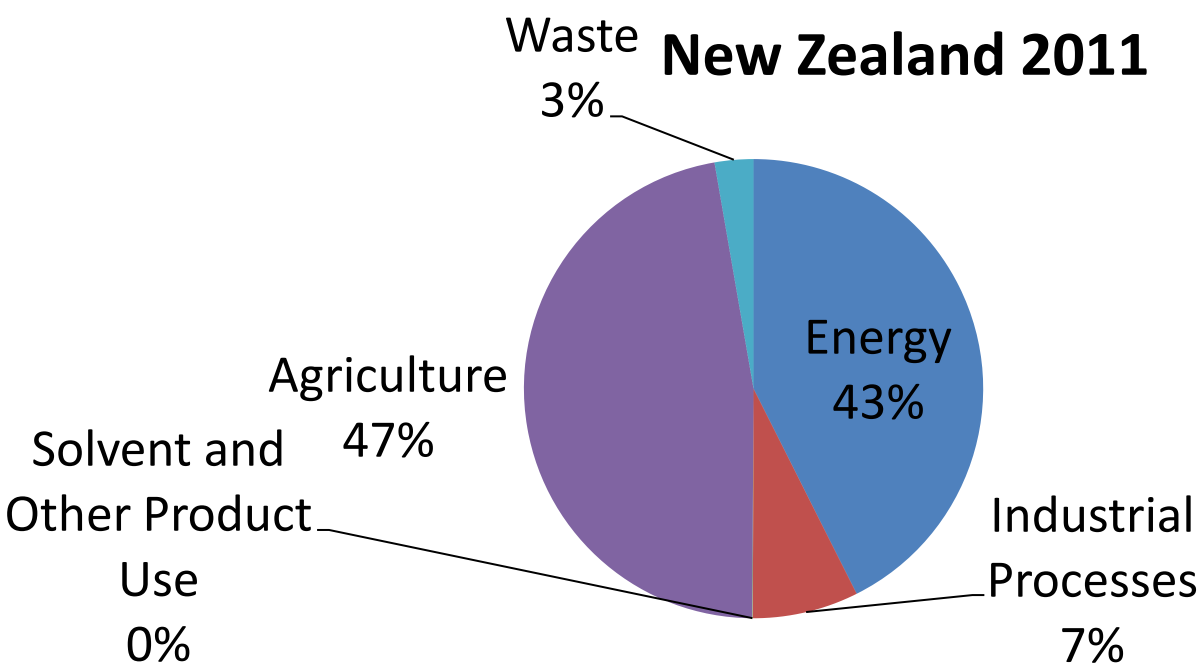
Who will benefit from higher productivity?

Analysis of drivers of rural land values

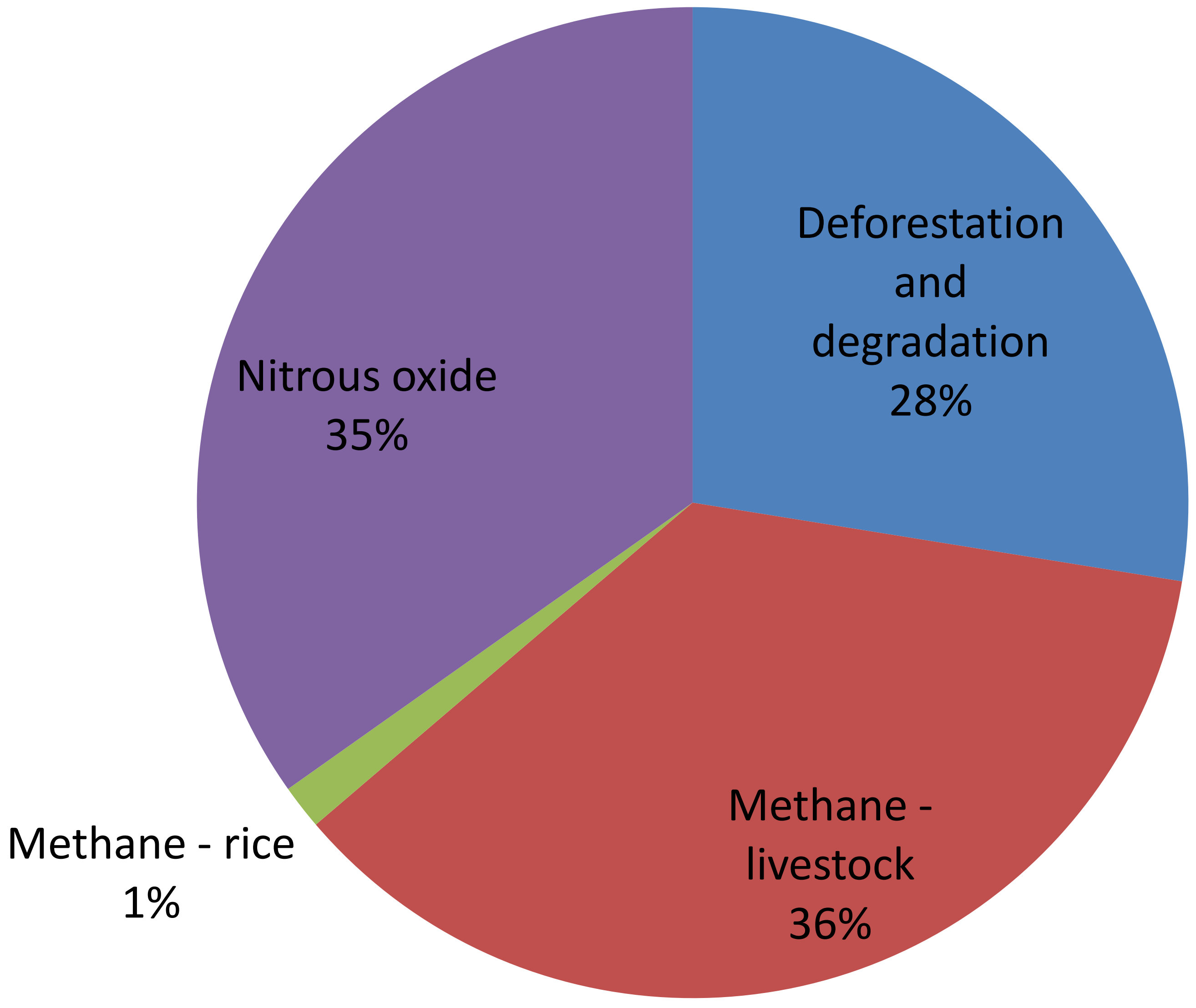
Implications for Colombia?

Why look at NZ?





Land-use emissions Colombia 2004



GHG emissions and mitigation in livestock agriculture

Methane (burping) and nitrous oxide (urine and fertiliser)

Main mitigation actions are:

- Land use change – producing different food
  - reducing (ruminant) meat consumption
- Reducing emissions per unit of meat / milk – by raising productivity

Option 1: Land use change

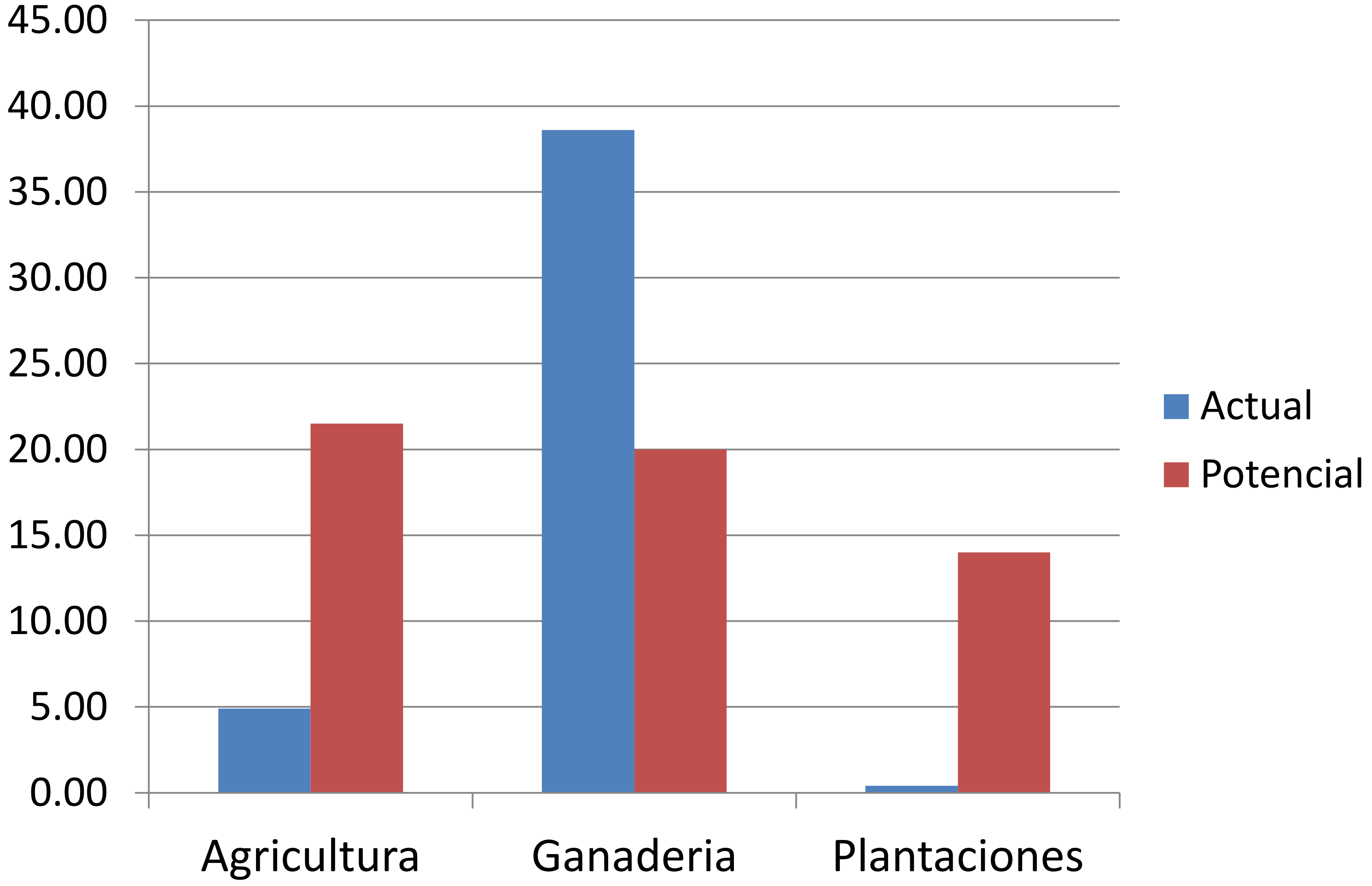
Experience with biofuels has taught us that leakage in land-based sectors can be serious.

Food production is a concern.

Therefore don’t focus solely on reducing production.

But could motivate shift in production from livestock to crops

Potential for land-use change in Colombia (million ha)



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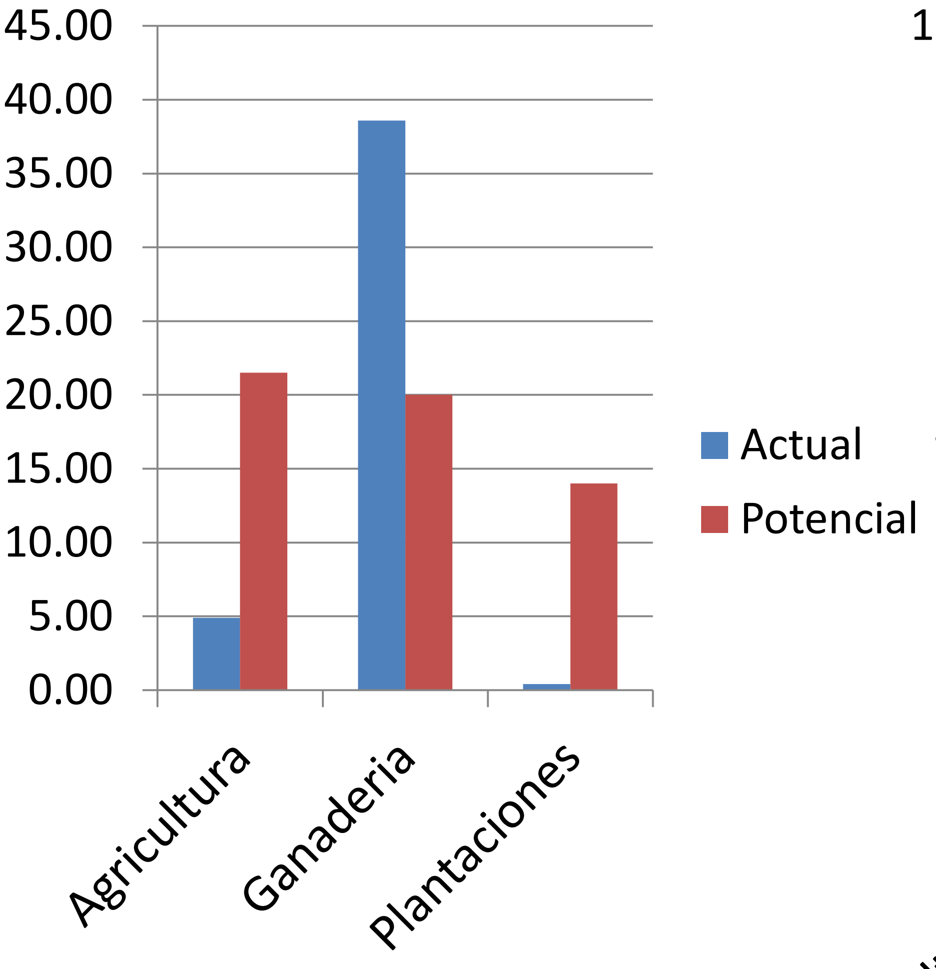
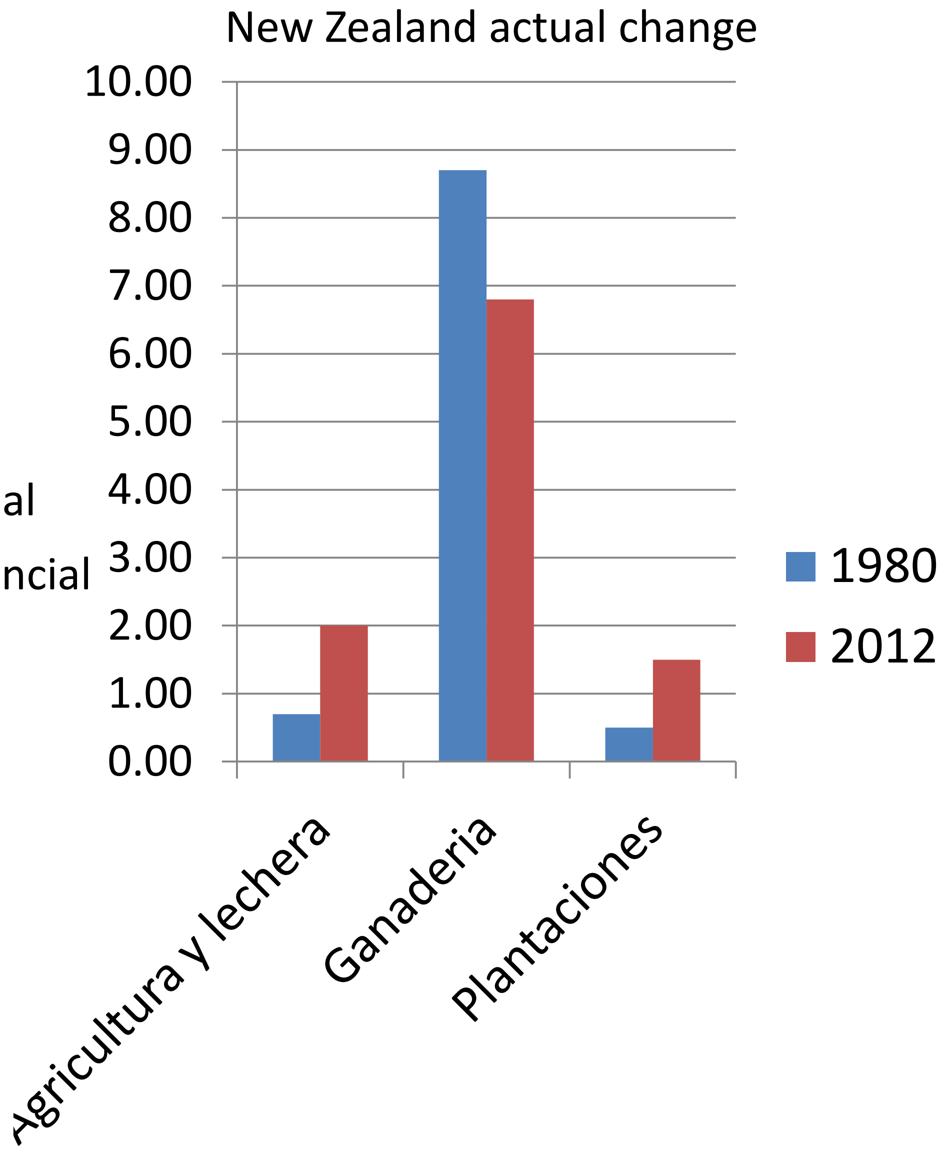
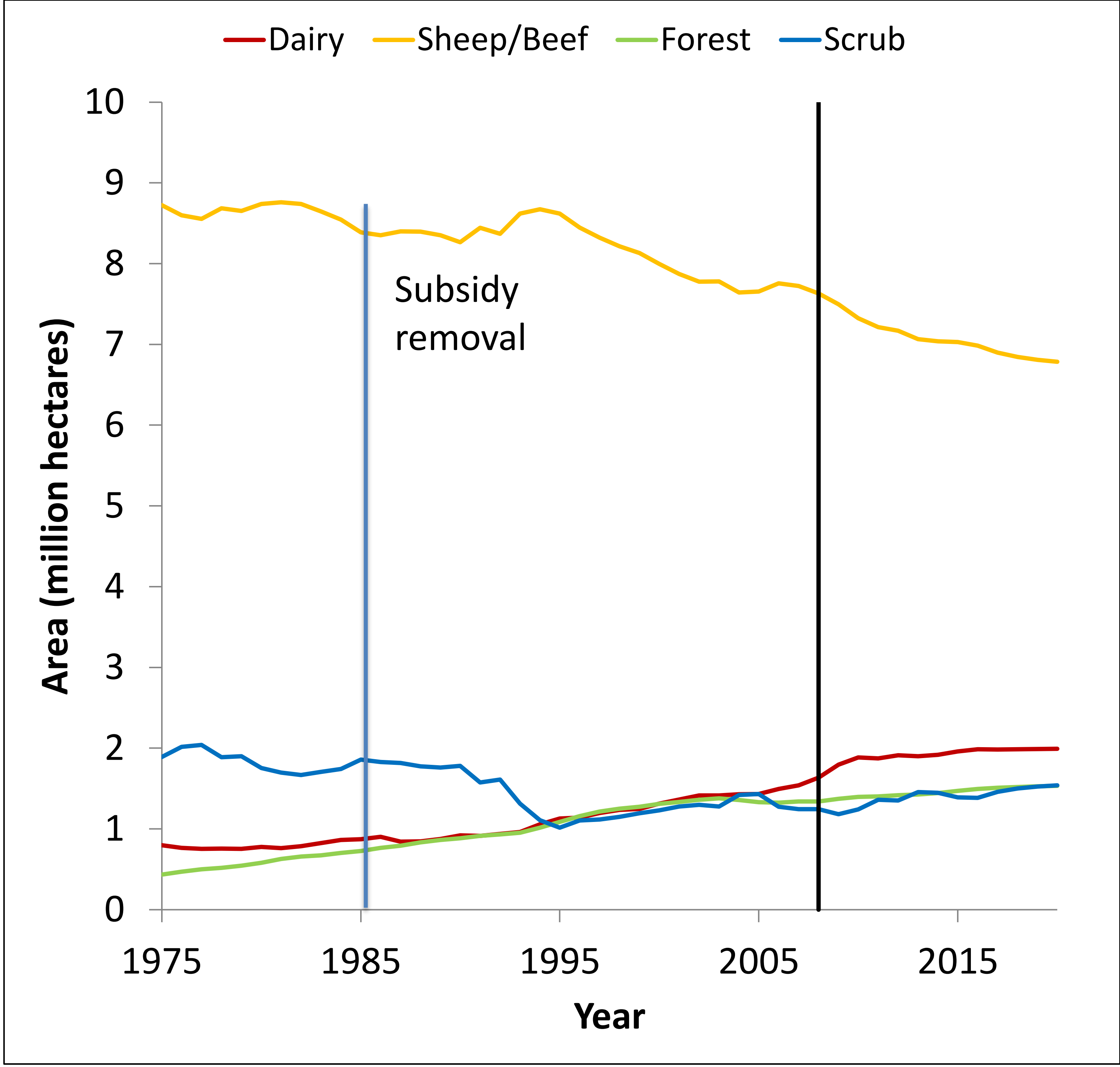




Land-use change – NZ over time

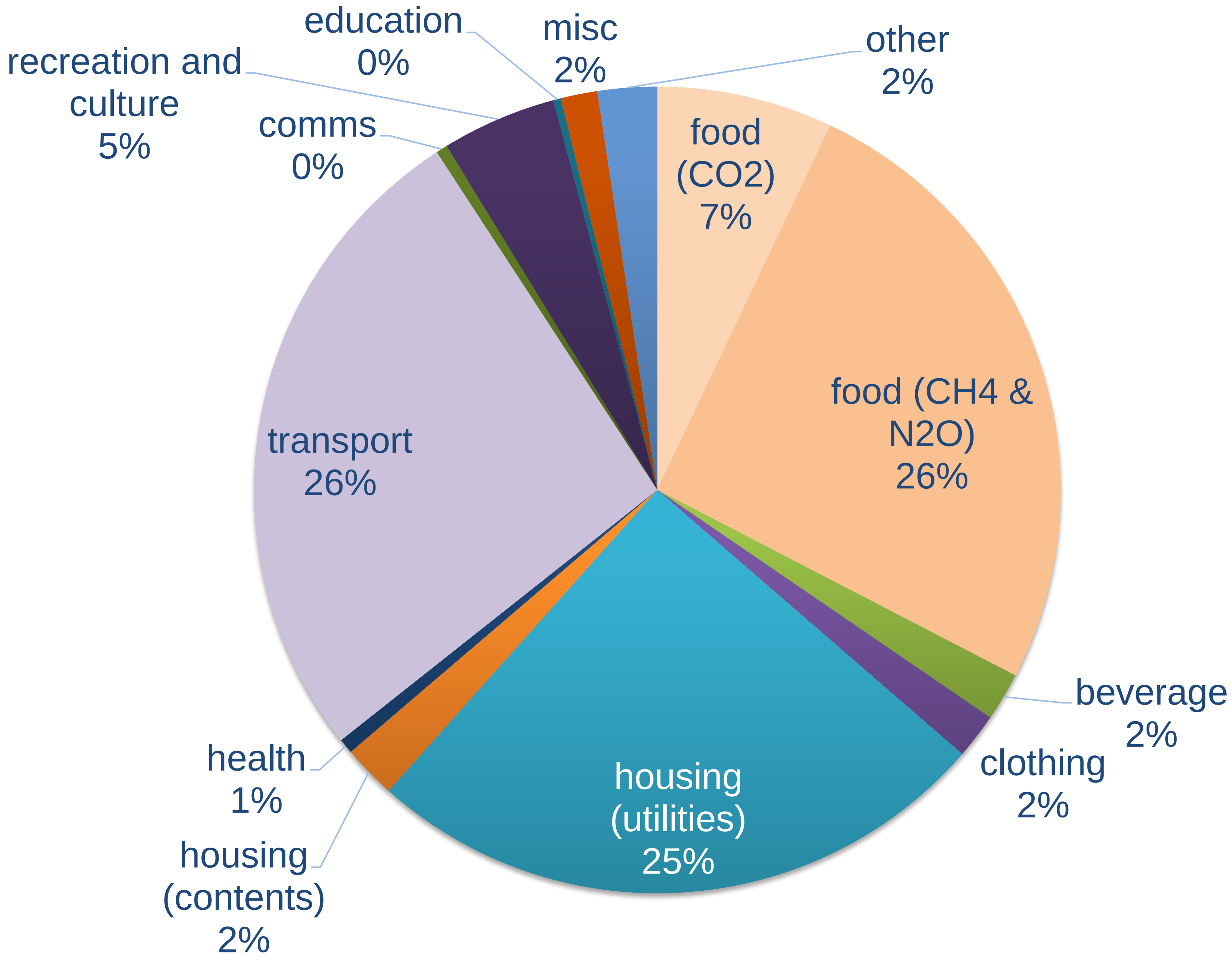


Reducing red meat and milk consumption

In NZ this can involve absolute reductions per person.

In Colombia it may involve absolute increases but reductions relative to business as usual – move toward chicken and pork and other protein sources.

Composition of NZ per capita consumption emissions 2012



Option 2: Raise productivity: emissions per unit milk

NZ ~ 0.8

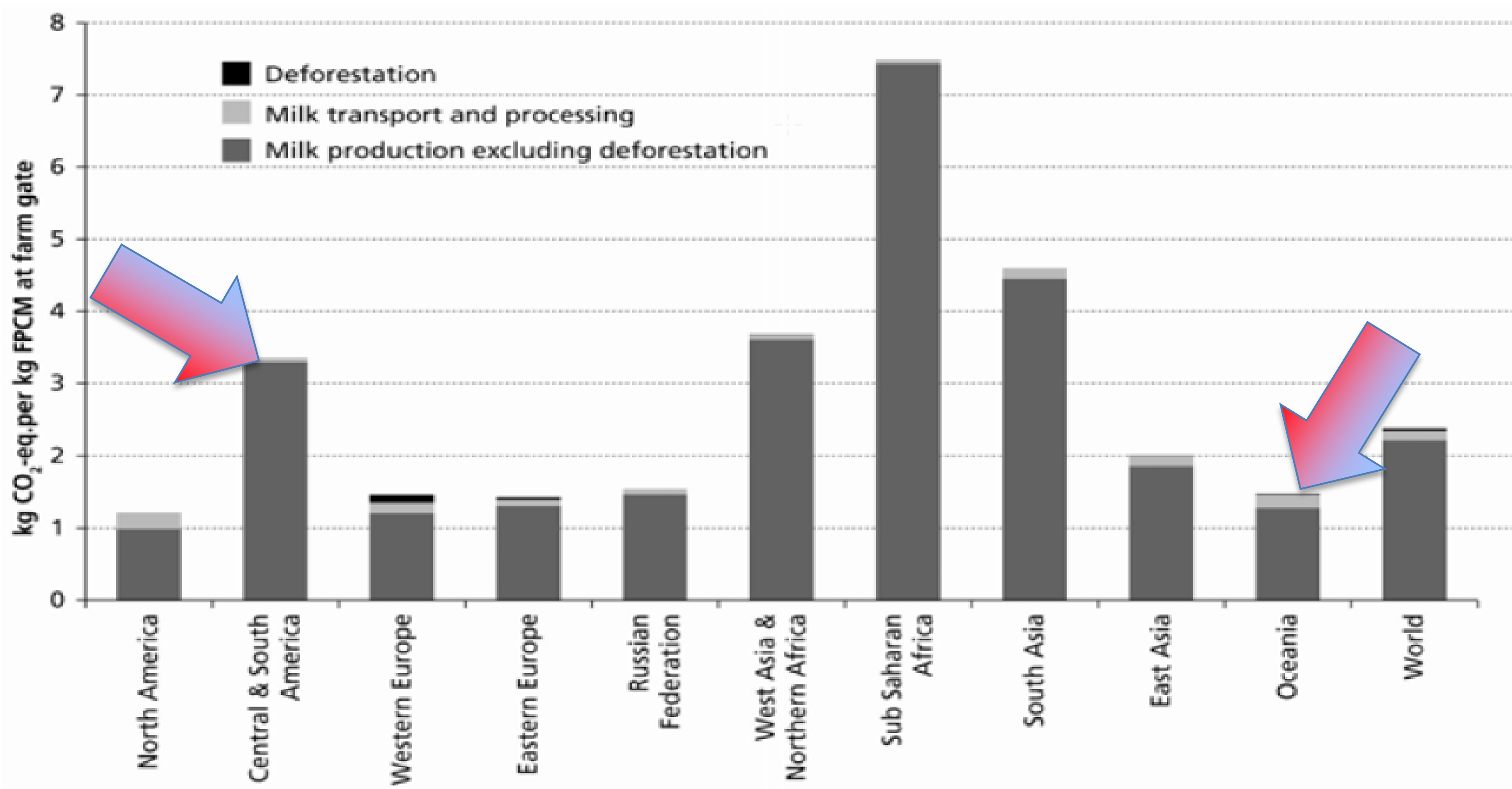
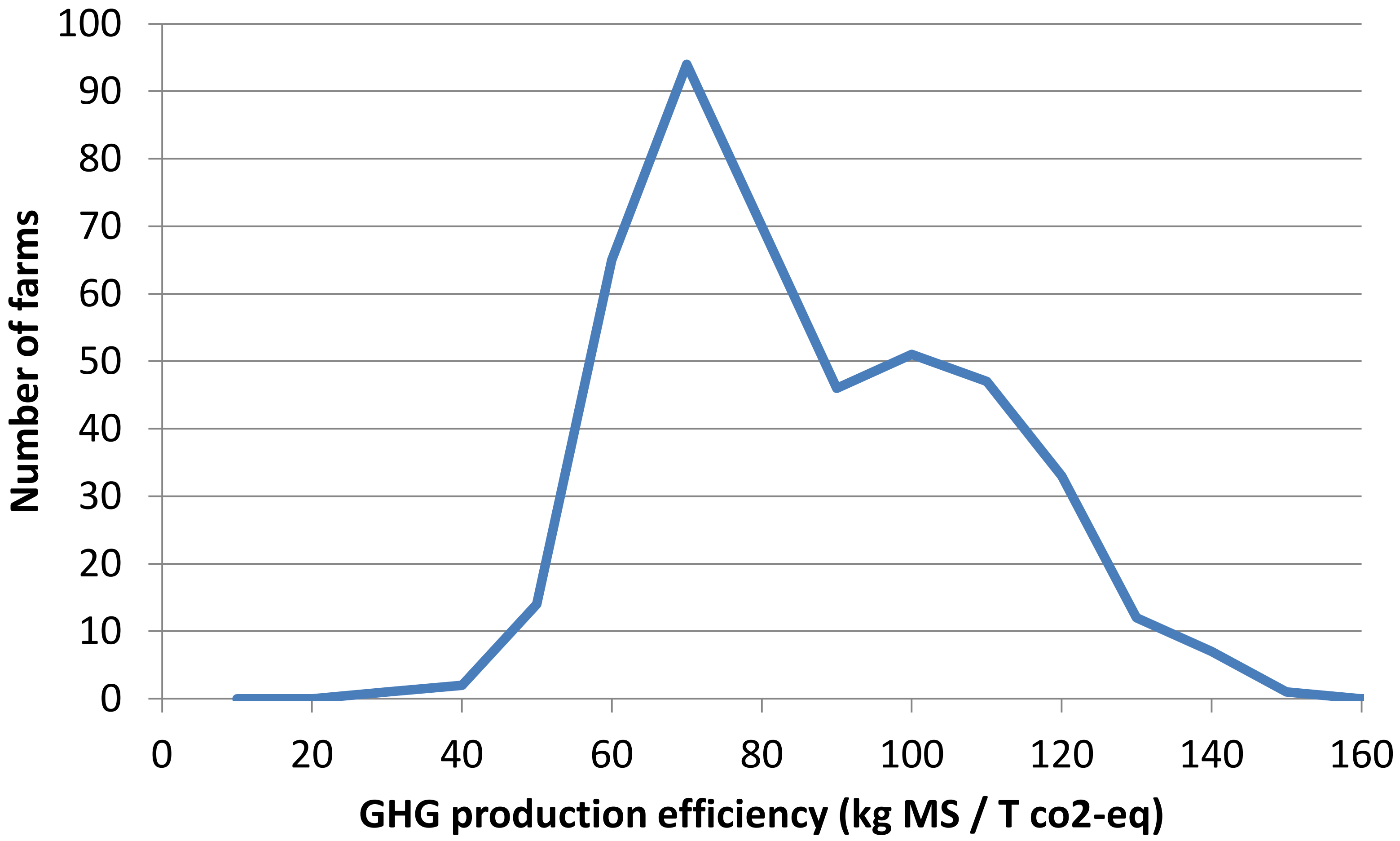


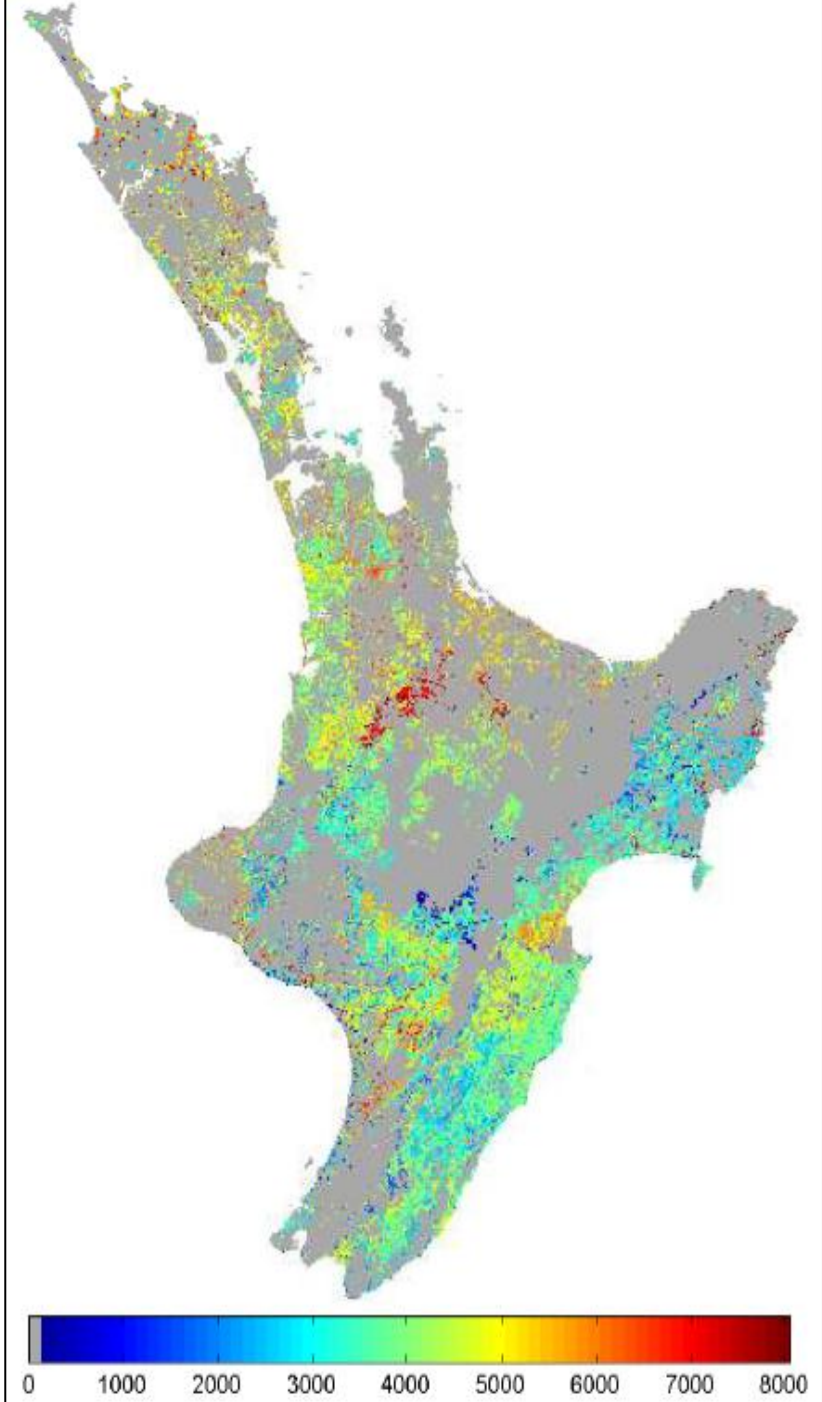
Figure 4.1. Estimated GHG emissions per kg of FPCM at farm gate, averaged by main regions and the world

Considerable variation in production per unit of emissions
Dairy:– location and management

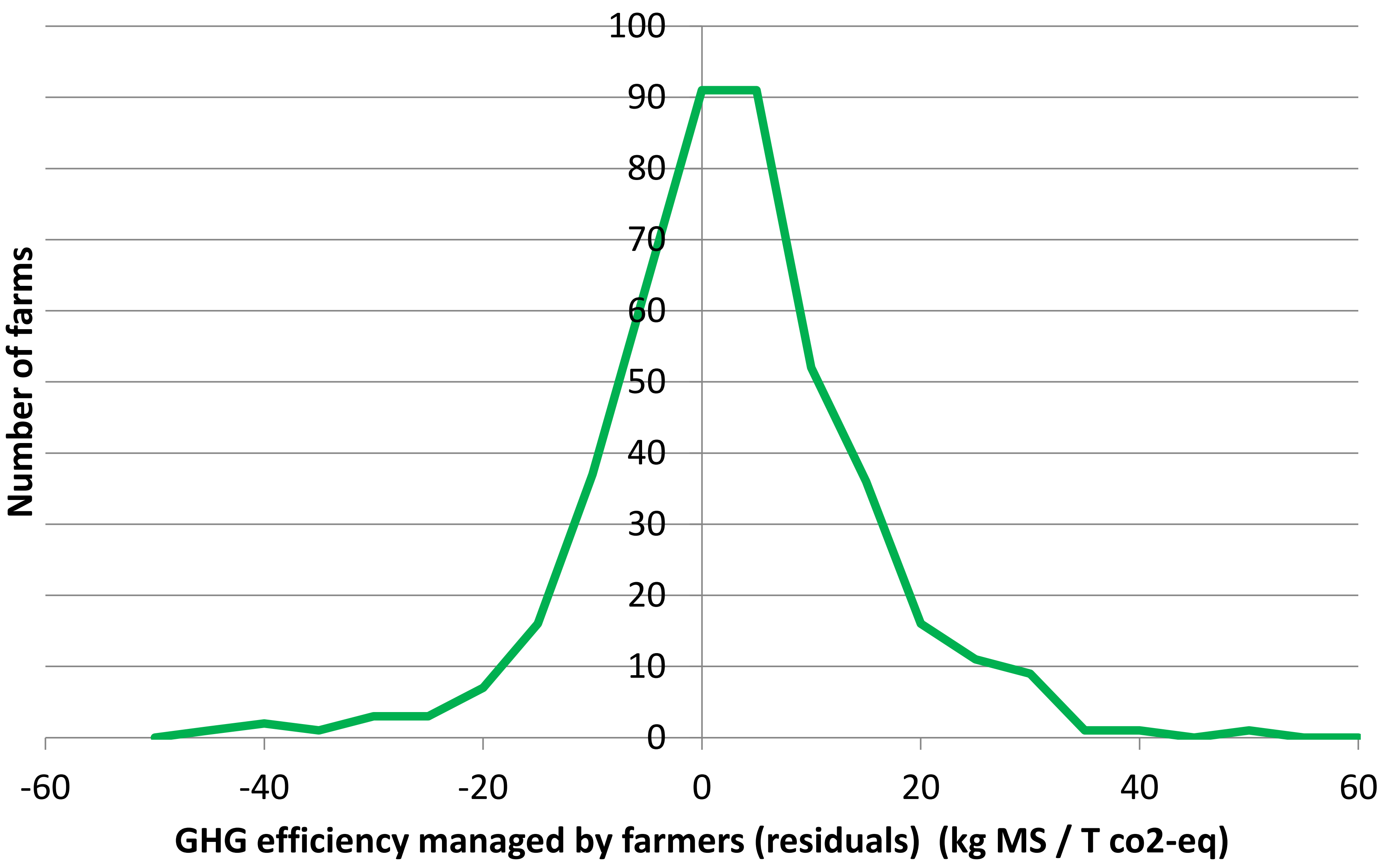


Grow food in the right places

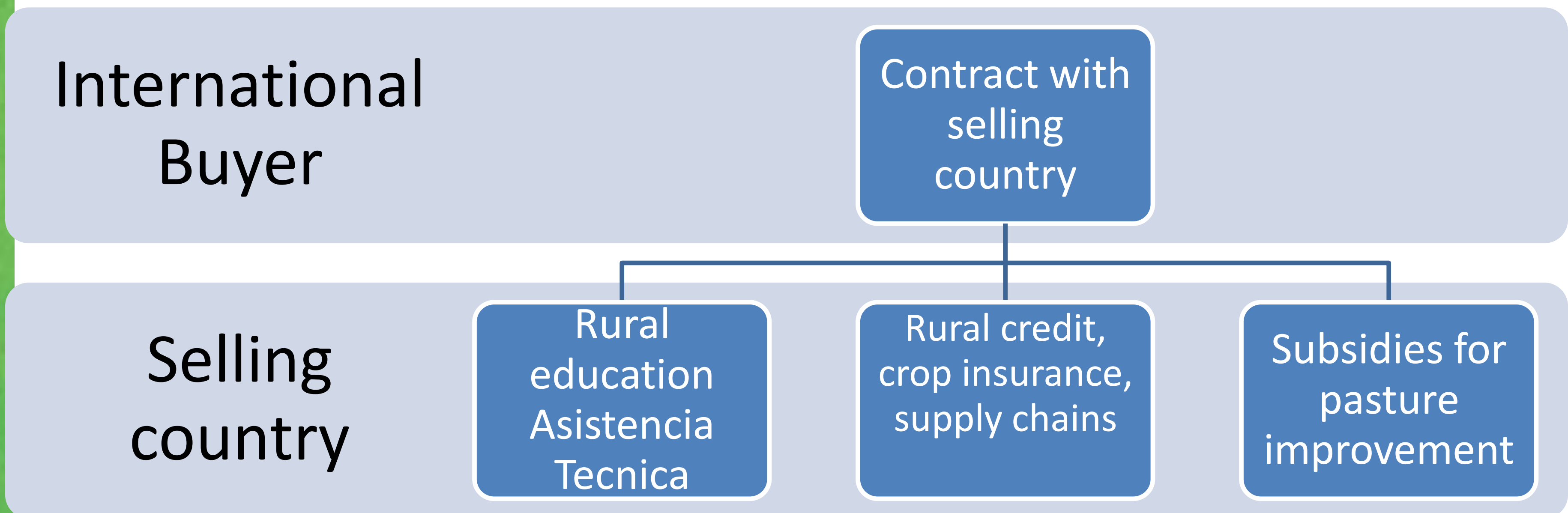
Productivity and emissions intensity vary enormously over space



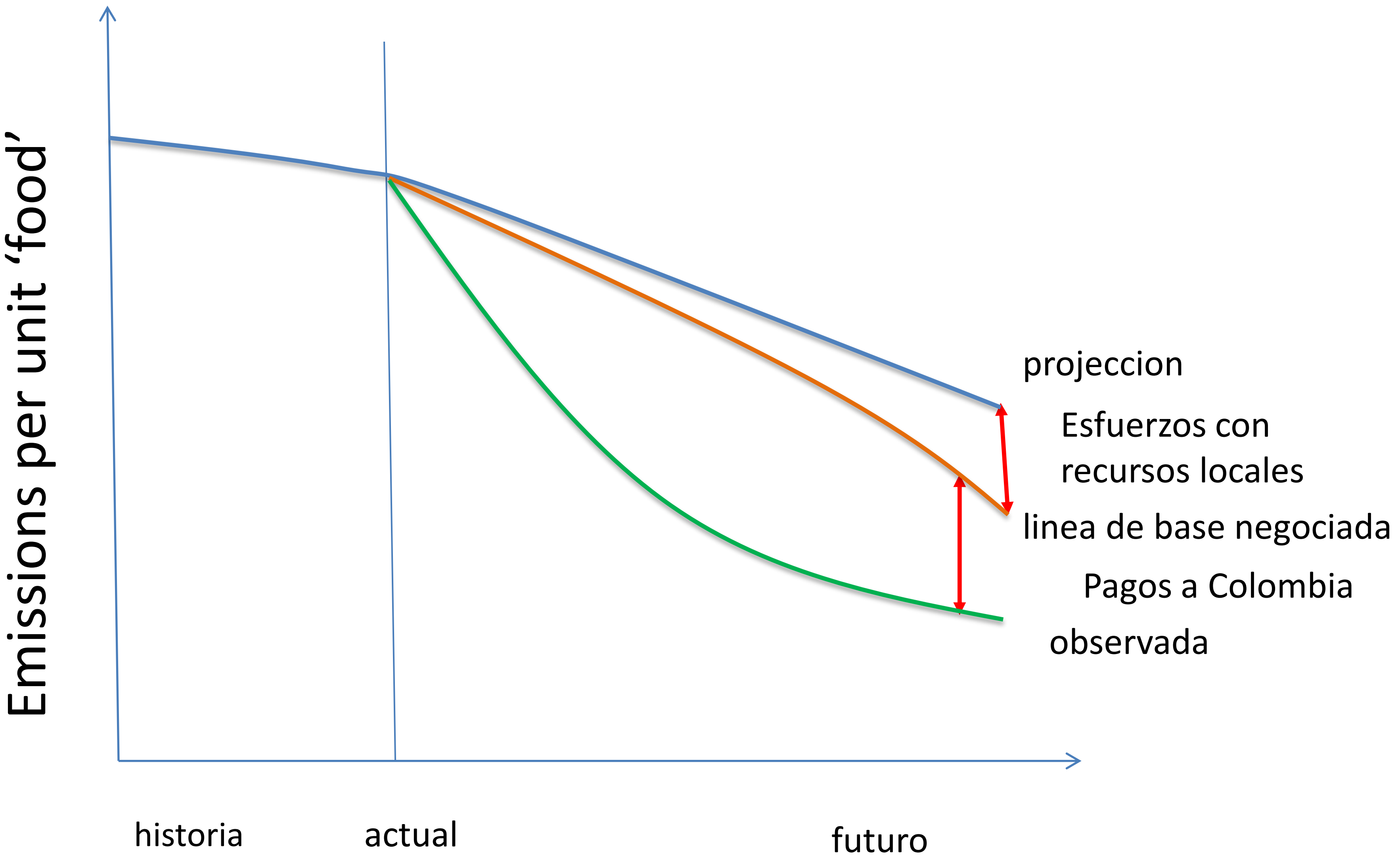
Dairy: Variation in management only (mean 70)



How to design international – domestic contract / policy



Contract for mitigation on a large scale (Jurisdictional)



What can we observe internationally?

Ideal: food production and emissions

How can we observe production?

1. Surveys? Exports?
2. Observe pasture, forests, fruit trees and agriculture by satellite

How can we observe emissions?

1. Survey on production systems?
   Age at slaughter, calving rate, milking rate
2. Nitrogen fertiliser use

Proxies for emissions efficiency

1. Observe the location of pasture
2. Observe ‘Mejoramiento de pastos’ and silvo-pastoral systems by satellite

Who is international contract with? Who can control emissions efficiency?

- National government?
  - Corporaciónes Regionales?
    - Fedegan?

- Each step you move down you lose some policy levers but may increase strength of incentives and stability of interest in rural productivity?

Who will really benefit from improved livestock productivity?

Consumers? – not with free trade

Rural workers? – only if their productivity rises or they are scarce and demand rises

Landowners?

Analysis of drivers of rural land values

Theory

Data

Methodology

- time series
- cross section

Results

Conceptual Framework

$$\boldsymbol{LV_{ijt}} = \sum_{\boldsymbol{s=0}}^{\infty} \frac{\mathrm{E}\pi_{\mathrm{ij^*,t+s}}}{(\boldsymbol{1}+\boldsymbol{r})^{\boldsymbol{s}}}$$

where

$$\boldsymbol{\pi_{ijt} = \ p_{jt} Q_{ijt} - \ c_{ijt}(Q_{ijt})}$$

and

$$j_t^* = \mathrm{argmax_j} \left\{ \sum_{s=0}^{\infty} \frac{E\pi_{ij^*,t+s}}{(1+r)^s} : j \ \in \{\{\, D, SB, F, C, H\} |\ E_t(\boldsymbol{P}, \boldsymbol{A})\} \right\}, \forall \ \mathrm{t}$$

Motu

Conceptual Framework

Farmland is more than an input to agricultural production – also a home site

Amenity value of farmland

$$LV_{ijt} = \sum_{s=0}^{\infty} \frac{E\pi_{ij^*,t+s} + V\left(M_{ij^*,t+s}\right)}{(1+r)^s}$$

Conceptual Framework

Farmland also has an option value – the option to convert to a non-agricultural land use in the future

$$\boldsymbol{LV_{ijt}} = \sum_{s=0}^{\boldsymbol{c}} \frac{E\pi_{ij^*,t+s} + V\left(M_{ij^*,t+s}\right)}{(1+r)^s} + \sum_{\boldsymbol{s=c}}^{\infty} \frac{\boldsymbol{R_{iU,t+s}}}{(\boldsymbol{1}+\boldsymbol{r})^{\boldsymbol{s}}}$$

Empirical Strategy

Estimate long-run equilibrium relationship between present value of expected profits and land values

$$\log Value\backslash ha_t = \beta_0 + \beta_1 \log PV\ EProfit_t + \beta_2 Trend + \epsilon_t$$

We observe current profits – conceptual framework emphasises long-run expected profitability

Control for changes in amenity values and urban option values driven by macro changes

QVNZ Data

Sales

- 1980-2012
- Total sale price, land area sold, number of sales by MB/year/QV use category

- Variable of interest – average sale price per hectare weighted by use using land area in each use assessed for valuation

Valuations

- 1989-2012
- Total capital value, land area assessed, number of assessments by MB/year/QV use category

- For time series used to check representativeness of sales data

Data

Profit data – Beef and Lamb NZ and MPI Monitor Farm Reports

- Dairy and sheep/beef economic farm surplus

Commodity prices

- Unit export prices for dairy, meat/wool and forestry
- Adjusted for removal of agricultural subsidies
- Create a trade-weighted agricultural commodity price index

Empirical Strategy

$$PV\ EProfits_t = PV\ \widehat{Profits}_t + \eta_t$$

Problem: even assuming prices follow a random walk, our measure of expected profits contains measurement error because of, for example, droughts

Solution: IV estimation strategy, using global agricultural commodity prices as an instrument for profits.

Results: Land values

	OLS	IV	IV
log $PV\ PROFITS_{\mathrm{t}}$	0.222	1.156**	
	(0.207)	(0.515)	
log $PV\ PROFITS_{\mathrm{t,1982}}$			1.059***
			(0.400)
$Trend$	0.037***	0.025**	0.037***
	(0.0086)	(0.011)	(0.007)
$Constant$	-51.33***	-52.206***	-74.562***
	(16.9)	(20.1)	(13.7)
T	31	31	31
R^2	0.583	-	-
$EG\ \tau$-stat	-3.584^{+}	-3.661^{+}	-4.212**

Results: macro drivers

	GDP	Aus House Prices	GDP Growth
log $PV\ PROFITS_t$	1.225**	1.171***	0.946**
	(0.560)	(0.453)	(0.433)
log $PV\ PROFITS_{t,1982}$			
log GDP_t	1.046**		
	(0.449)		
log $Aus\ HPI_t$		0.346**	
		(0.158)	
$Year$			0.028***
			(0.011)
$GDP\ Growth_t$			0.060**
			(0.024)
$Constant$	-28.429***	-3.18	-56.130***
	(8.445)	(3.451)	(18.644)
T	31	31	31

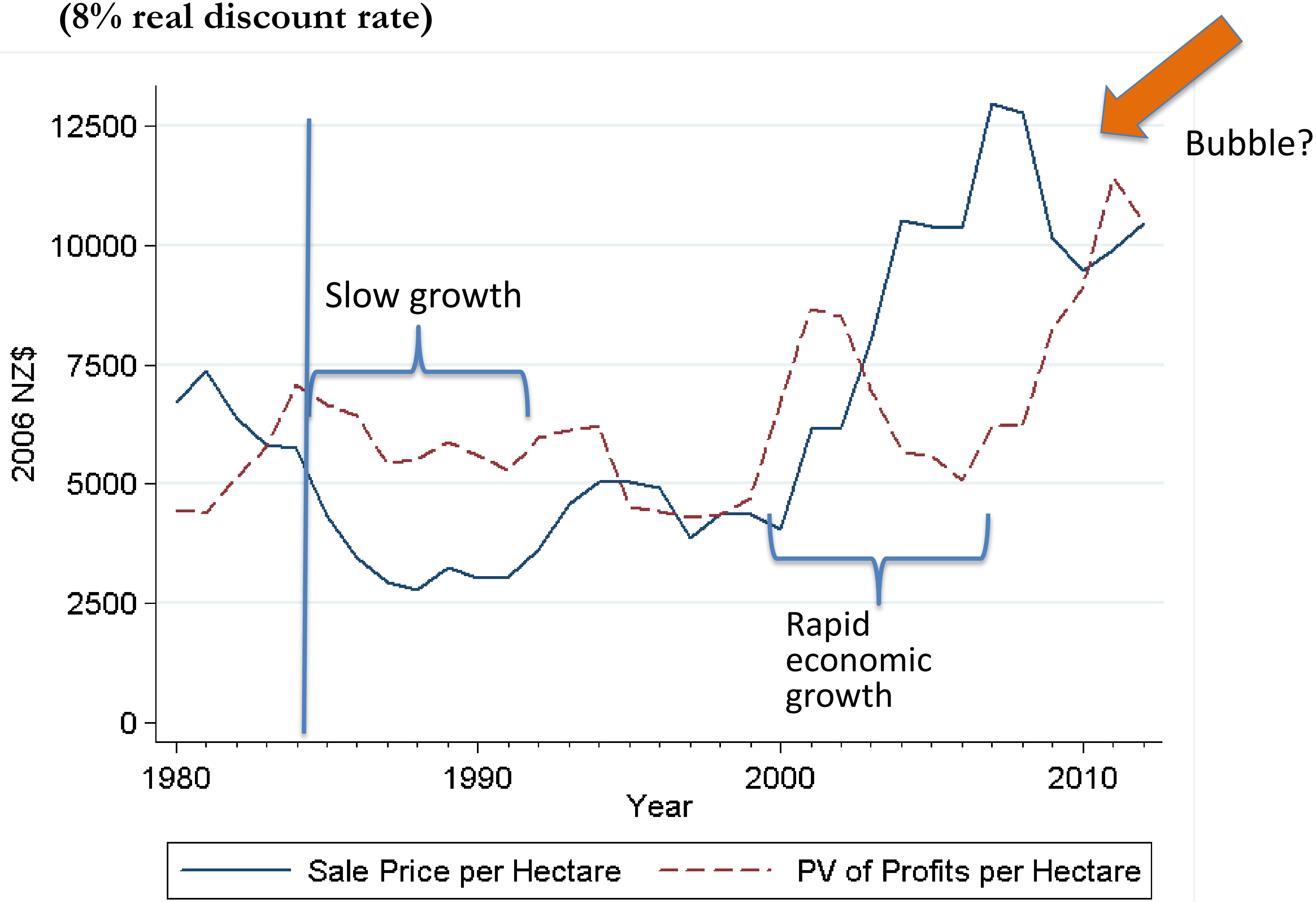
Macro-economic effects on land values (regression on residuals because of low T)

$\left(\dfrac{impaired\ assets}{gross\ lending}\right)_{t-1}$	-0.076***
	(0.02)
$Constant$	0.154
	(0.116)
T	22
R^2	0.183

Low levels of credit availability reduce option values – and may affect current profitability by delaying land-use change.

Macro-economic effects?

Rural sale price per hectare and present value of profits per hectare (8% real discount rate)



Time series conclusions

Strong long-run relationship between profits and land values – close to 1.

There are periods when the value of rural land is higher than implied by profitability:

- when credit is easily available so land use change is more rapid, and
- the economy is doing well in general so may reflect higher amenity and option values

Cross sectional land values

Same land value data – at level of 'meshblock' (around 50 people)

Additional data on:

1. climate: productive
   - focus on growing season (growing degree days
   - water availability
   - amenities
   - all year
   - nice days – warm, dry, no wind, sunny
2. soils and slope
3. distances to
   - markets (airport, port, town) and
   - amenities (beach, ski field, school)

Conceptual Framework

LV = PV E [Profits in current land use

+ rural option value

+ amenities

+ urban option value]

Focusing on productive value of climate (to explore climate vulnerability)

Cross section results

	I
GDDs (00s)	0.612***
GDD^2 (00s)	-0.013***
Raindays	0.011***
Solar Radiation	-3.693***
% irrigated	0.262***
Wind Speed	
Rainfall (00s mm)	
Sun hours	
Avg summer temp	
Average winter temp	
ln (Distances)	
Soils	
Slope	
N	5567
R-squared	17

New Zealand conclusions

Agriculture land markets respond to:

- productivity
- Profitability (almost one to one)
- options for future land use; and
- amenity values

Implications

- Regulation that affects profitability will be mostly capitalised in land values.

- Land values will be most heavily affected by changes in profitability where option and amenity values are low.

Implications for Colombia?

Strong complementarity between agricultural productivity improvements and climate change policy in the agriculture sector

Benefits are likely to go mostly to those who own the land

Huge option values likely because of mis-use of land and low investment during the conflict period.

- Land may be valued well above present value of current returns – risk of small farmers being excluded?

Design GHG policy to avoid exacerbating inequality

- Yet another reason for prioritising clarity and equity in land-ownership

Motu

www.motu.org.nz