Journée de la Chaire de Modélisation prospective
au service du développement durable,
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Carbon tax revenue recycling in South Africa with labour-saving technological change

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Chaire Modélisation prospective
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Why explore carbon taxation and employment in South Africa with a "hybrid" CGE?

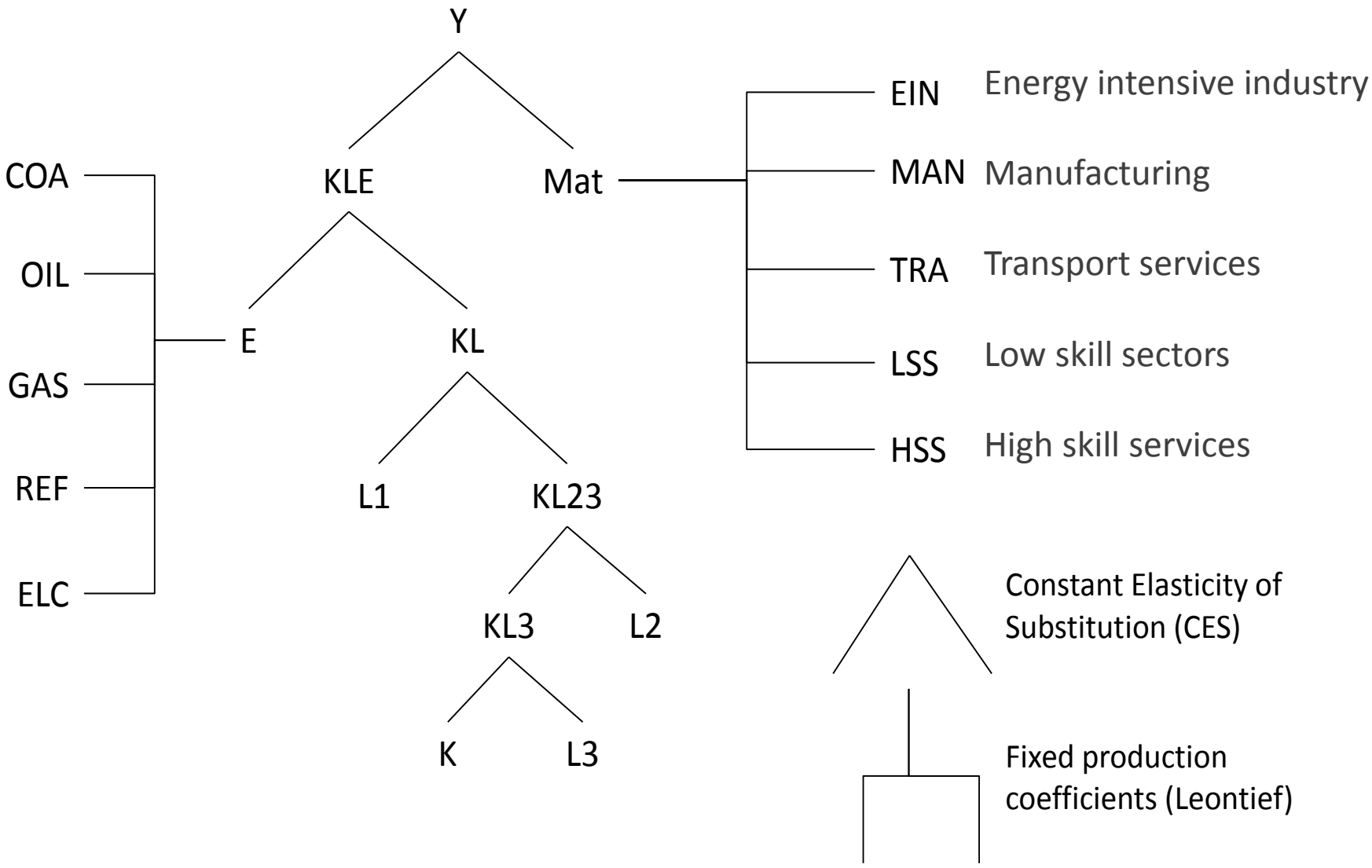
- Carbon tax planned (for 2018)
- Hopes: New economic activity
- Fears: Unemployment, 27% officially, 39% "broad"
- 99% of jobs in non-energy sectors: macro-economic feedbacks are important
- Problems with educational quality, a segmented labour market, and high skill labour shortage
- What are the impacts of Carbon tax revenue recycling if technological progress continues to be labour-saving?

Specific characteristics of IMACLIM-SA (1/2)

- Open economy, hybrid CGE, in a 1-step projection from 2005 to 2035
- 10 Sectors (5 in Energy). Criteria: Energy, Trade, Skills
- Factors: Capital + 3 Labour skill factors
- Hybridisation: Dual accounting of quantities and values of energy
- Electricity: technical coefficients based on South Africa TIMES model (SATIM) of Univ. of Cape Town*

* Thanks to support of the Energy Research Centre (ERC) of the University of Cape Town.

Nested CES KLEM production function



Physical volume based productivity gains

- Labour-saving & Capital augmenting technological change, with increasing input efficiency, for all scenarios :
  - Labour: +1.00% /year
  - Physical capital (K): +0.25% /year
  - Materials & Services: +0.25% /year
  - Auton. Energy Eff.: *none*, price-elasticity is sufficient
- L and K productivity high in manufacturing, low in services
- Trend in volume of exports/world trade: +2.00%/yr

Carbon tax revenue recycling scenarios

- CO_2 tax rates: 100 and 300 Rand$_{'05}$/tCO_2 (= 18 and 55 \$$_{'13}$/t$CO_2$)
- Revenue Recycling:
  1. Per capita Lump Sum for all households
  2. Reduction of profit taxes, with:
     - Unchanged profit mark-up rates
     - A reduction of profit mark rates
  3. Reduction of a Sales tax on final consumption
  4. Subsidies to labour

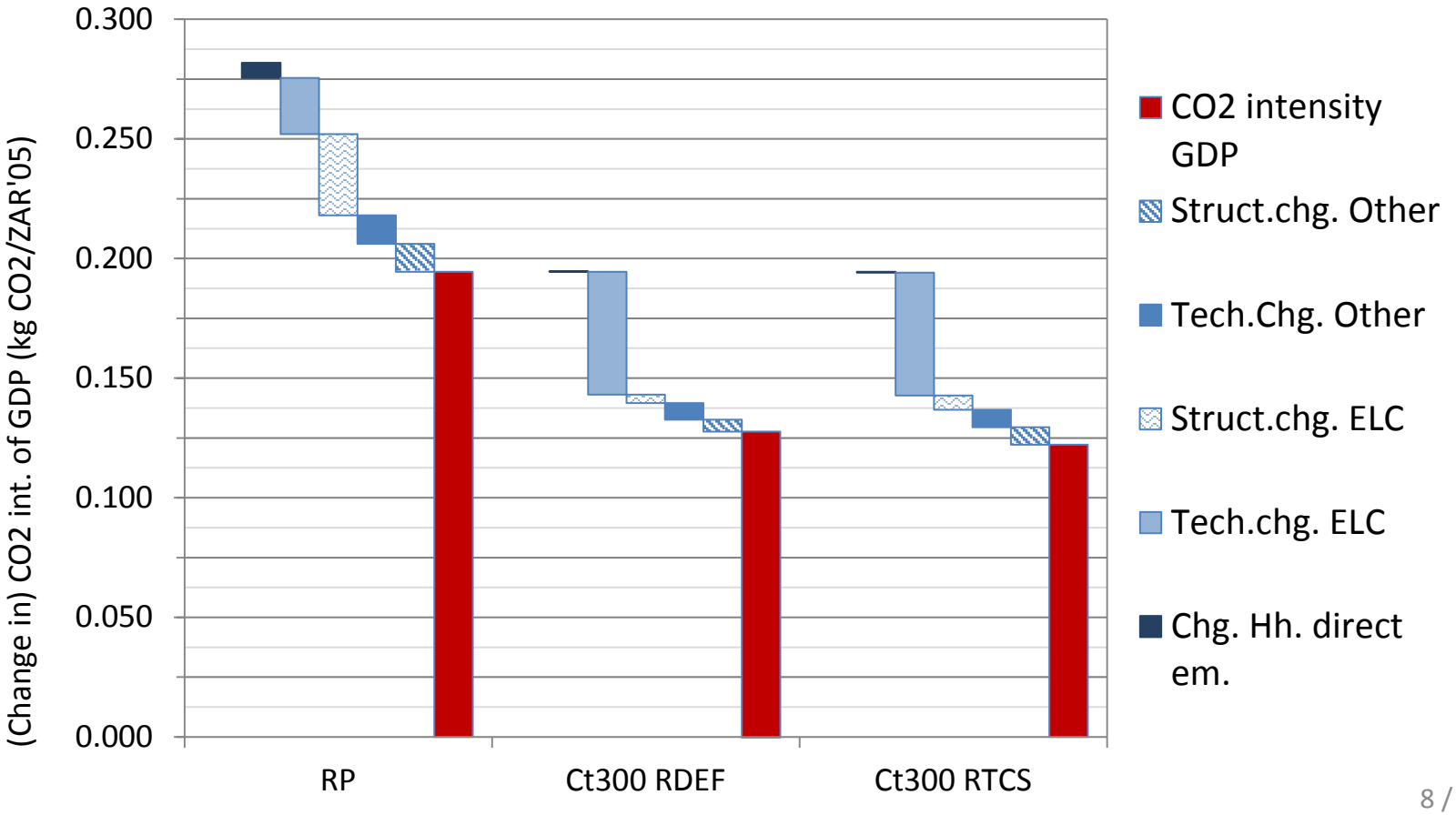
Results of scenarios with R300 Ctax

For a $18 Ctax little impact on GDP, but for a $55 Ctax choice of revenue recycling matters for impacts

Scenario	GDP growth 2005 to 2035	Broad unem-ployment	CO_2 emiss. (Mt)	GDP CO_2 intensity GDP (kg CO_2 /$\$_{'13}$ GDP)	Class 5 / Class 1 income ratio
Base Year (2005)	-	39%	443	1.54	42
Reference (2035)	**+125%**	**24%**	**687**	**1.06**	**45**
Lump-Sum	+63%	45%	323	0.69	**23**
Profit tax & Un-changed margins	+57%	47%	313	0.69	40.5
Profit tax & Lower margins	**+108%**	**29%**	**406**	**0.68**	**43**
Sales tax	+85%	37%	361	0.68	42
Labour subs.	**+96%**	**32%**	**377**	**0.67**	**42**

Limited decarbonisation beyond Reference

- Not much decarbonisation beyond Reference projection outside Electricity sector – Example of two R300 Ctax scenarios



Limited energy efficiency gains beyond Reference

- Price elasticity of energy use is low in energy-intensive sectors
- Energy efficiency outcomes are already high in Reference
  - E.g. Allwood et al (2011): energy efficiency potentials of steel, cement, plastics, aluminium, paper range between 23 to 40%

	COA	GAS	REF	EIN	MAN	LSS	HSS	TRA
Reference	-15.5%	-1%	-3%	-11%	-30%	-22%	-37%	-4%
R100 Ctax avg	-19%	-2%	-3%	-14.5%	-41%	-28%	-48.5%	-5%
R300 Ctax avg	-21%	-3%	-3.5%	-18%	-51.5%	-34%	-58%	-6.5%

Only a few scenarios promote Labour in production relative to Energy

- Scenarios **without** cost decreases (Lump sum, Profit taxes + fixed margins) have imports replacing domestic production strongly
- Also in these scenarios Labour output productivity remains high
- Sales tax reduction does not compensate for international trade, but is favourable to labour and labour-intensive sectors
- Economically successful scenarios (Labour subsidies and Profit tax reduction with margins reduction) recycle into a reduction of production costs for especially labour intensive, non-energy sectors

Limitations

- No border tax adjustment, no export rebates, no foreign Ctax
- No fixed CO_2 target
- Electricity scenario does not yet take into account recent higher cost estimates for nuclear energy, and recent lower costs for renewables
- Knowledge gap for exogenous productivity improvement:
  Future technology and costs of production by sector?
  (Physical) capital intensity, Labour intensity, Materials & Energy efficiency

Conclusion

- Rigidities limit the potential for decarbonisation: This means that relative to Reference the costs of production increase
- Real income, and total demand therefore decrease
- If technological change continues in the same way in the direction of labour-saving technology, this leads to higher unemployment
- Energy & Material efficiency are a very influential factor for low carbon growth and labour-friendly growth
- Remedy for the South African economy, investing in energy and material efficiency

Thank you for your attention

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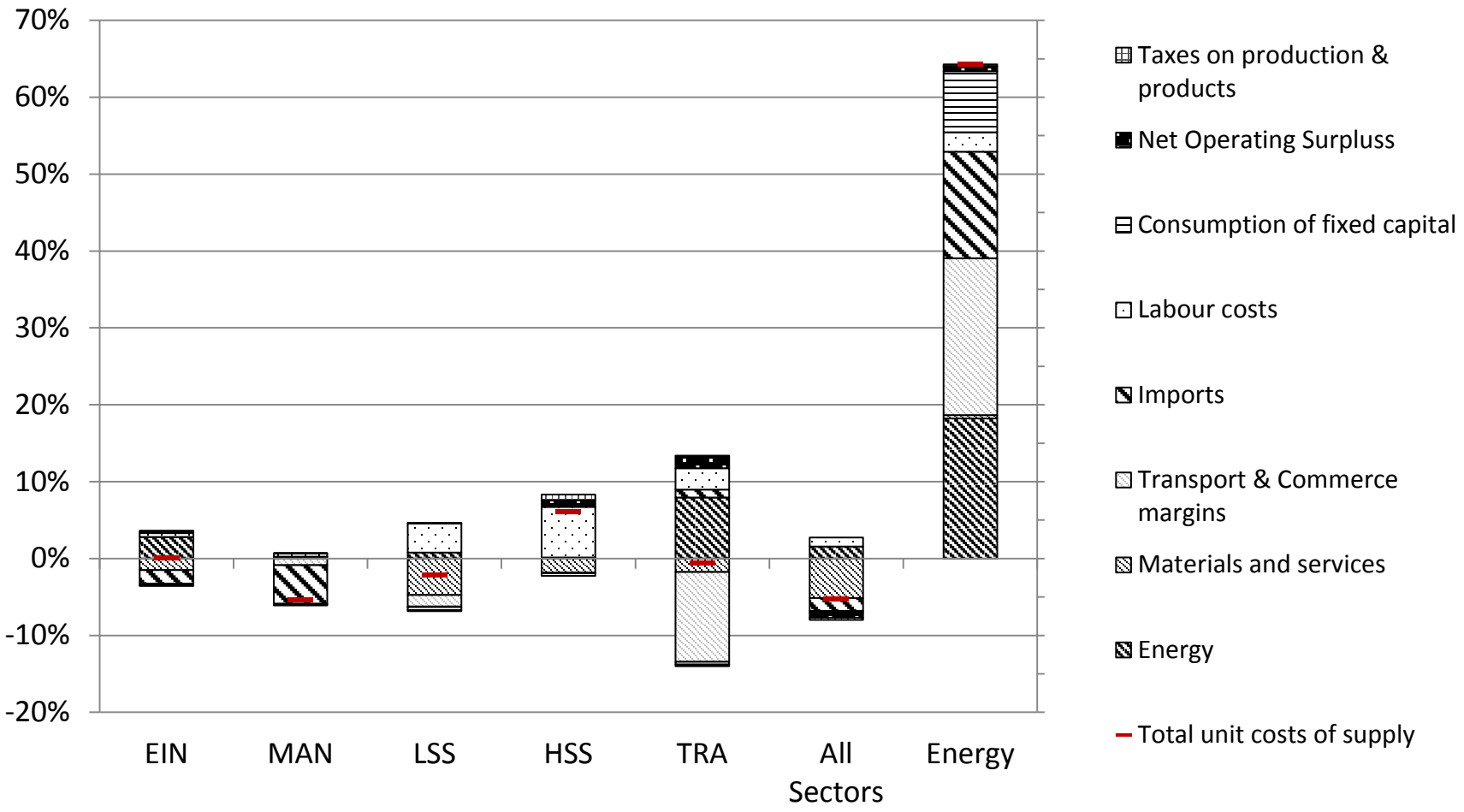
Electricity sector based on SA TIMES model

Model & Scenario / Base Year (BY) or 2035 with or w/o Ctax	*Unit*	SATIM with Updated IRP				IMACLIM-SA with *RVAT* scenario			
		BY 2006	No Ctax	R100 Ctax	R300 Ctax	BY 2005	No Ctax	R100 Ctax	R300 Ctax
Prices (in R05, & GDP PI deflated for IMACLIM)									
Avg coal price for Electricity	*mn R_{05}/PJ*	8.5	12.9	17.3	29.6	8.1	14.3	24.2	43.7
Index of real capital (unit) cost	*index*	100	100	100	100	100	95.4	94.5	92.7
Index of O&M (unit) costs	*index*	100	100	100	100				
Index of Materials & services (unit) cost	*index*					100	100.5	100.9	100.9
Index of Labour (unit) cost	*index*					100	148.4	145.3	141.3
Electricity production cost (*pY* excl τ_{NOS})									
Costs of ELC production (incl. Ctax paid)	*mn R05/PJ*	98	114	125	140	59	116	137	155
Volumes									
Electricity produced	*PJ*	904	1 791	1 731	1 690	844	1 401	1 229	1 017
Electricity imported	*PJ*	24	185	186	192	2.2	4.2	3.8	3.3
Coal consumed	*PJ*	2 663	4 392	3 285	1 916	2 541	3 569	2 419	1 199
CO_2 emitted by power generation	*Mt CO_2*	257	424	318	186	240	338	229	114
Physical intensities per PJ ELC									
CO_2	*Mt CO_2/PJ*	0.28	0.24	0.18	0.11	0.28	0.24	0.19	0.11
Coal	*PJ COA/PJ*	2.95	2.45	1.90	1.13	3.01	2.55	1.97	1.18
Capital (index)	*index*	1.00	1.16	1.34	1.67	1.00	3.47	4.02	5.02
Capital intensity vs Reference Projection			*1.00*	*1.16*	*1.45*		*1.00*	*1.16*	*1.45*
O&M (index)	*index*	1.00	1.07	1.12	1.11				
Materials & Services (assumed)	*index*					1.00	1.43	1.77	1.95
Labour (assumed, unweighted avg)	*index*					1.00	1.25	1.25	1.25

* Thanks to the support of the Energy Research Centre (ERC) of the University of Cape Town.

For more info on SATIM, see: ERC. 2013. Assumptions and Methodologies in the South African TIMES (SATIM) Energy Model. *Version 2.1, 2013/04/08*. Systems Analysis & Planning Group, Energy Research Centre, University of Cape Town, Cape Town

Real costs vs BY for RP



Real costs vs BY for R300 Labour subsidies scenario