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## Main Project: Linking natural capital and ecosystem services with macroeconomic models

### Issue

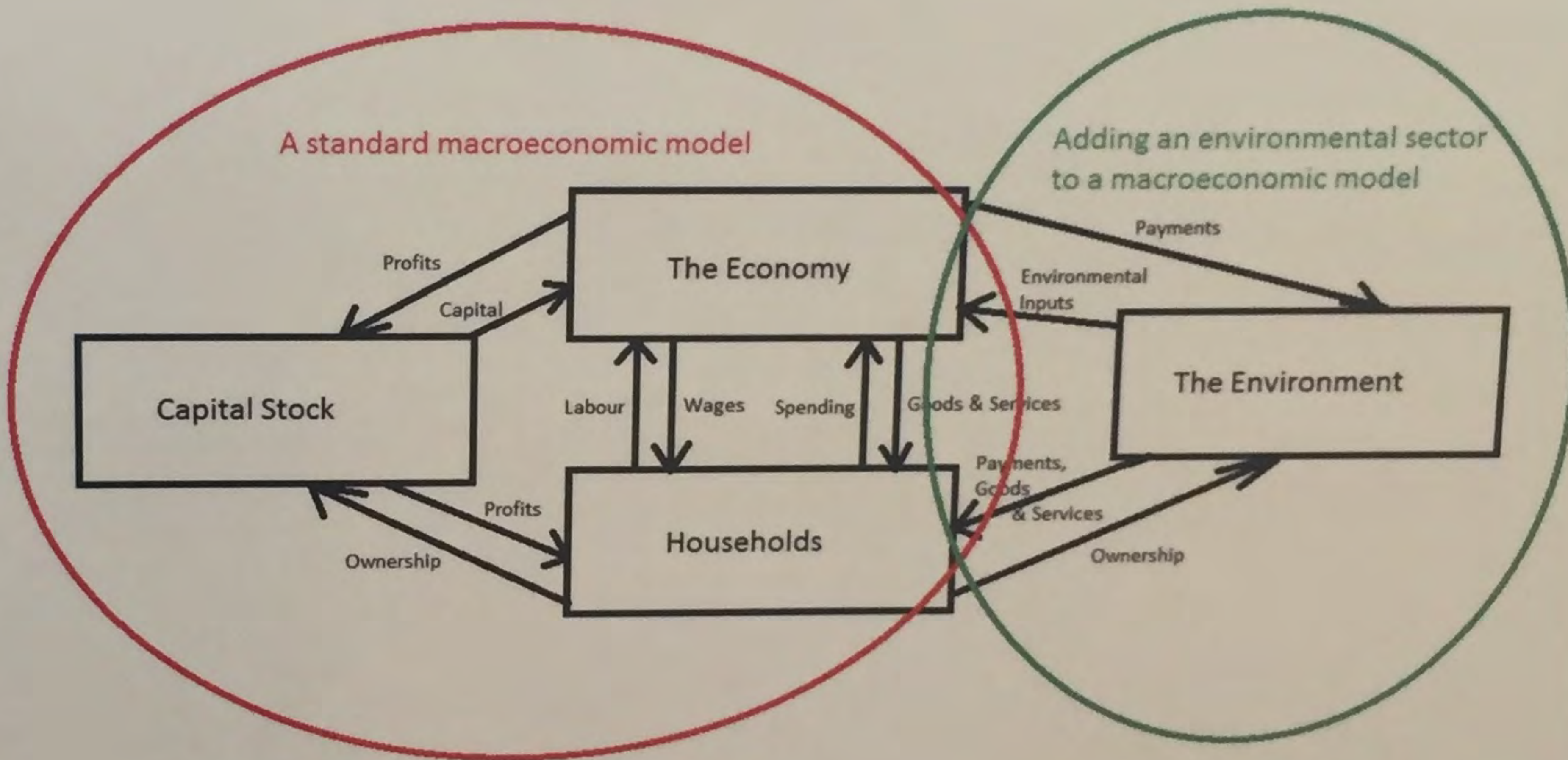
- At the Fraser of Allander Institute, we use large-scale "Computable General Equilibrium" (CGE) Models to model economic scenarios
- Previous environmental and energy applications, e.g. Impact of offshore wind, impact of energy efficiency, etc
- Emissions key to our earlier contributions e.g. have analysed the likely impact of a Scottish-specific carbon tax
- However, no other aspects of environment incorporated. Notably no environmental assets included in the models.
- Under Theme 1 of the Scottish Government's Rural and Environment Science and Analytical Services Division, Strategic Research Programme, we have been tasked with linking environmental assets with our macroeconomic models

### Outputs

- With an environmentally augmented CGE model, we will be able to run scenarios that show the value of linking the environment and the economy with a single framework
- For example:
  - how do demand and supply shocks affect the values of natural capital?
  - how do natural capital shocks (e.g. climate change related) affect the economy (GDP and employment)?
  - how do the links between the environment and the economy affect the first order impacts of an analysis e.g. a natural capital shock may have a clear economic impact, but this economic impact may have a further impact upon natural capital, which has second round effects on the economy, and so on.

### What are Natural Capital & Ecosystem Services?

- Environmental assets, or "natural capital", provide flows of benefits to producers and consumers which we label as "ecosystem services"
- An example of an ecosystem service flow that benefits producers: the ONS estimate that the value of agricultural biomass provided by the environment, which supports agricultural industry production, was equivalent to 16% of agricultural sector profits in 2014.
- An example of an ecosystem service flow that benefits consumers: the ONS estimate that the value of recreational services provided by nature was £6.5bn in 2014.
- Ecosystem Services can be categorised as:
  - "Provisioning Services", based on market value of the output produced with these inputs e.g. agricultural biomass
  - "Regulating Services", based on the extra costs that would be incurred if this service was not provided by nature e.g. air pollution removal provided by trees
  - "Cultural Services", based on non-market valuation techniques for these goods e.g. recreational services provided by nature
- Depending on definition, the value of the services produced by natural capital may or may not be included in current estimates of economic output, Gross Domestic Product (GDP)
- In principle, natural capital can be added to our macroeconomic models entirely analogously to how physical capital is presently included.



## First Case Study: The economic & environmental impact of healthy eating in Scotland

### Research Question

- Red meat → carbon emissions
- Red meat → poor health outcomes
- Possibility of win-win if reduce red meat consumption?
- Springmann et al (2016) "adhering to health guidelines on meat consumption could cut global food-related emissions by nearly a third by 2050"
- But what are the economic consequences of this?
- Is there a possibility for a "triple win"?

### Method

- Disaggregate the Scottish Agriculture sector (in Scottish Government data) into Red Meat and Other Agriculture
- Associate carbon emissions with each industrial sector in whole economy
- Interpret healthy eating guidelines as
  - a reduction in household expenditure on Red Meat and Meat Processing of 39%
  - a reduction in expenditure on other food and drink sectors of 3%
  - Overall household expenditure is unchanged – requires an increase in expenditure on other sectors of 0.5%

### Results

- Scottish GDP rises by £5m (0.0%)
- Scottish Employment falls by 916 employees (-0.0%)
- Scottish "Territorial" carbon emissions fall by 0.5MtCO<sub>2</sub>e (-0.9%)
- Scotland's "Carbon Footprint" (emissions produced in Scotland and abroad that are associated with goods consumed by Scottish residents) falls by 0.7MtCO<sub>2</sub>e (-0.7%)
- See very small economic impacts, with positive carbon impacts (i.e. reduction in emissions). This is achieved by reductions in economic activity in high emissions sectors like Red Meat production, combined with increases in economic activity in low emissions sectors like Retail – see chart (NB GDP effect is the sum of the impacts on Gross Value Added (GVA) across all sectors).
- This analysis ignores health impacts but these will be positive (reduced healthcare costs and improved workforce productivity)
- Potentially "triple win"? - makes policy to achieve this outcome attractive

