Modeling Multi-Sectoral Land Use in Macro-Economic Model for EU-27

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Introduction

- NEMESIS: Dynamic of Sector Interdependencies at a Detailed Level (32 Production Sectors)
  - Goods and Services
  - Knowledge
- Extension of Interdependencies to Energy, Environment and Demography
- New Extensions to Land-Use in order to Achieve Economy-Physics Interdependencies
- And Make a New Evaluation Modeling for:
Plan

1. Overview of Integration

2. Land Claims and Land Price Equilibrium

3. Business as Usual Scenario and Policy Case
1. Overview of Integration

Multi-Sectoral Land-Use in a Macro-Economic model: NEMESIS

6 land-use sectors:
- Agriculture
- Forestry
- Urban
- Transport Infrastructures
- Nature Conservation
- (and Tourism)

9 land claims categories:
- For Agriculture: Grass land & Arable Land
- For Urban: Housing & Buildings
- For Transport: Rail & Road
1. Overview of Integration

- Endogenous determination of equilibrium land rental price at national level
  
  - **Land claims** for all sectors
  
  - A land supply function allow computation of land equilibrium price by country for Agriculture
  
  - Others Land-Use prices are related to Agriculture Land Price.
1. Overview of Integration

- **Land-Use**
  - Δ in Land-Use claims
  - Δ in land rental price

- **Feedbacks**
  - Δ construction & Investment price
  - Δ agriculture & food prices
  - Δ real wages & incomes
  - Δ competitiveness

- **Social**
  - Δ employment, housing & cost of living

- **Economy**
  - Δ consumption, investment & external trade

- **Environment**
  - Δ energy, consumption & GHG emissions (CO₂, N₂O, CH₄, SF₆, HFC, PFC)
2. Land Claims and Land Price Equilibrium: Agriculture Land-Use

Production decisions in agriculture

Maximisation of agriculture inter-temporal incomes per farms with exogenous number of farms

Inputs, outputs & land choices

Outputs
- Level of vegetal production
- Level of animal production

Inputs
- Use of labor, fertilizers, pesticides, energy, ...
- Use of capital & cheptel

Arable & Grass Land

Productivity

Inputs productivity

Yields per ha

Production prices

Determination of number of farms

Income relative difference in agriculture & others economic sectors

Number of Farms

- Land Price
- Urban Land-Use
- Price of Buildings
- New Buildings
- Investment in Dwellings and Investment in Industrial and Commercial Buildings
2. Land Claims and Land Price Equilibrium: Transport Infrastructures

- Land
- Price
- Land Used By Transport Infrastructures
- Extension of Transport Capacities: New Roads and New railways
- Transport Demand per Mode: Road, Rail and Sea&Air for Passagers and Fret
2. Land Claims and Land Price Equilibrium: Market equilibrium

Legend:
- $S$: Supply of land for agriculture
- $D$: Demand of land in agriculture
- $\lambda$: Agricultural land price
- $x$: Land used in agriculture
- $L$: Maximally available land for agriculture (asymptote)

Diagram showing the relationship between marginal land rent and total land area (fixed). The graph includes the supply ($S$) and demand ($D$) curves, with $\lambda$ representing the agricultural land price. The diagram also highlights transportation infrastructure, urban land use, nature protection (fixed), and unsuitable (fixed) land uses.
### Table 1: Land categories in 2000, as percentage of total territory, EU-27.

**Sustainability Impact Assessment of multifunctional land use**

<table>
<thead>
<tr>
<th>Country</th>
<th>Unsuitable</th>
<th>Nature</th>
<th>Urban</th>
<th>Transport</th>
<th>Agriculture</th>
<th>Forestry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>20.5%</td>
<td>10.8%</td>
<td>4.2%</td>
<td>2.2%</td>
<td>39.7%</td>
<td>22.6%</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.7%</td>
<td>7.0%</td>
<td>19.6%</td>
<td>5.9%</td>
<td>41.0%</td>
<td>25.7%</td>
</tr>
<tr>
<td>Czech Rep.</td>
<td>6.6%</td>
<td>8.6%</td>
<td>6.1%</td>
<td>0.9%</td>
<td>51.7%</td>
<td>26.0%</td>
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<tr>
<td>Denmark</td>
<td>4.9%</td>
<td>3.7%</td>
<td>7.5%</td>
<td>2.2%</td>
<td>62.6%</td>
<td>19.1%</td>
</tr>
<tr>
<td>Estonia</td>
<td>17.0%</td>
<td>3.8%</td>
<td>2.2%</td>
<td>1.4%</td>
<td>19.5%</td>
<td>56.1%</td>
</tr>
<tr>
<td>Finland</td>
<td>59.0%</td>
<td>11.4%</td>
<td>1.6%</td>
<td>0.3%</td>
<td>16.7%</td>
<td>10.9%</td>
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<tr>
<td>France</td>
<td>9.7%</td>
<td>4.9%</td>
<td>4.9%</td>
<td>2.1%</td>
<td>52.1%</td>
<td>26.3%</td>
</tr>
<tr>
<td>Germany</td>
<td>3.0%</td>
<td>6.0%</td>
<td>8.2%</td>
<td>4.9%</td>
<td>47.9%</td>
<td>30.0%</td>
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<tr>
<td>Greece</td>
<td>5.5%</td>
<td>15.3%</td>
<td>2.2%</td>
<td>2.4%</td>
<td>30.5%</td>
<td>44.1%</td>
</tr>
<tr>
<td>Hungary</td>
<td>7.5%</td>
<td>3.3%</td>
<td>5.9%</td>
<td>0.5%</td>
<td>61.6%</td>
<td>21.2%</td>
</tr>
<tr>
<td>Ireland</td>
<td>8.2%</td>
<td>2.8%</td>
<td>2.4%</td>
<td>1.9%</td>
<td>78.7%</td>
<td>5.9%</td>
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<tr>
<td>Italy</td>
<td>14.1%</td>
<td>12.1%</td>
<td>4.8%</td>
<td>0.7%</td>
<td>42.9%</td>
<td>25.3%</td>
</tr>
<tr>
<td>Latvia</td>
<td>7.0%</td>
<td>1.6%</td>
<td>1.4%</td>
<td>1.3%</td>
<td>39.5%</td>
<td>49.3%</td>
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<tr>
<td>Lithuania</td>
<td>7.0%</td>
<td>1.2%</td>
<td>3.4%</td>
<td>1.4%</td>
<td>41.3%</td>
<td>45.7%</td>
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<tr>
<td>Luxemburg</td>
<td>9.3%</td>
<td>10.0%</td>
<td>4.1%</td>
<td>2.3%</td>
<td>61.0%</td>
<td>13.3%</td>
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<tr>
<td>Malta</td>
<td>0.2%</td>
<td>0.0%</td>
<td>19.8%</td>
<td>36.2%</td>
<td>43.8%</td>
<td>0.0%</td>
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<td>Netherlands</td>
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<td>5.8%</td>
<td>13.5%</td>
<td>4.0%</td>
<td>56.5%</td>
<td>14.7%</td>
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<tr>
<td>Poland</td>
<td>6.0%</td>
<td>0.8%</td>
<td>3.4%</td>
<td>3.1%</td>
<td>59.0%</td>
<td>27.8%</td>
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<tr>
<td>Portugal</td>
<td>26.4%</td>
<td>12.3%</td>
<td>2.7%</td>
<td>1.2%</td>
<td>33.7%</td>
<td>23.7%</td>
</tr>
<tr>
<td>Romania</td>
<td>17.7%</td>
<td>0.4%</td>
<td>6.5%</td>
<td>0.4%</td>
<td>62.0%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Slovakia</td>
<td>15.4%</td>
<td>0.0%</td>
<td>6.0%</td>
<td>1.1%</td>
<td>49.3%</td>
<td>28.0%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>49.4%</td>
<td>14.4%</td>
<td>1.1%</td>
<td>0.5%</td>
<td>9.9%</td>
<td>24.8%</td>
</tr>
<tr>
<td>Spain</td>
<td>13.8%</td>
<td>19.1%</td>
<td>1.7%</td>
<td>0.4%</td>
<td>39.9%</td>
<td>25.1%</td>
</tr>
<tr>
<td>Sweden</td>
<td>64.7%</td>
<td>10.1%</td>
<td>1.6%</td>
<td>0.3%</td>
<td>13.2%</td>
<td>10.2%</td>
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<tr>
<td>United King.</td>
<td>19.3%</td>
<td>4.3%</td>
<td>7.7%</td>
<td>2.1%</td>
<td>58.0%</td>
<td>8.6%</td>
</tr>
<tr>
<td>Europe</td>
<td>20.1%</td>
<td>8.3%</td>
<td>4.3%</td>
<td>1.6%</td>
<td>42.8%</td>
<td>22.9%</td>
</tr>
</tbody>
</table>
2. Land Claims and Land Price Equilibrium: Land Supply Elasticity

<table>
<thead>
<tr>
<th>Country</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITED KINGDOM</td>
<td>0.001%</td>
</tr>
<tr>
<td>IRELAND</td>
<td>0.001%</td>
</tr>
<tr>
<td>DENMARK</td>
<td>0.006%</td>
</tr>
<tr>
<td>HUNGARY</td>
<td>0.013%</td>
</tr>
<tr>
<td>MALTA</td>
<td>0.013%</td>
</tr>
<tr>
<td>ITALY</td>
<td>0.024%</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>0.024%</td>
</tr>
<tr>
<td>NETHERLANDS</td>
<td>0.027%</td>
</tr>
<tr>
<td>SPAIN</td>
<td>0.027%</td>
</tr>
<tr>
<td>CZECH REPUBLIC</td>
<td>0.031%</td>
</tr>
<tr>
<td>SLOVAKIA</td>
<td>0.043%</td>
</tr>
<tr>
<td>FRANCE</td>
<td>0.052%</td>
</tr>
<tr>
<td>AUSTRIA</td>
<td>0.056%</td>
</tr>
<tr>
<td>GERMANY</td>
<td>0.058%</td>
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<tr>
<td>POLAND</td>
<td>0.063%</td>
</tr>
<tr>
<td>BELGIUM</td>
<td>0.080%</td>
</tr>
<tr>
<td>LITHUANIA</td>
<td>0.084%</td>
</tr>
<tr>
<td>ROMANIA</td>
<td>0.089%</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>0.120%</td>
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<tr>
<td>SLOVENIA</td>
<td>0.150%</td>
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<tr>
<td>FINLAND</td>
<td>0.160%</td>
</tr>
<tr>
<td>ESTONIA</td>
<td>0.180%</td>
</tr>
<tr>
<td>GREECE</td>
<td>0.180%</td>
</tr>
<tr>
<td>LATVIA</td>
<td>0.210%</td>
</tr>
</tbody>
</table>

Table 2: Elasticity of Land Supply for EU-27 Countries
3. Business As Usual Scenario and Policy Case

BAU scenario

% Change between 2005 and 2025

Grass Land | Arable Land | Housing | Buildings | Transport Infrastructure | Land Price | GDP

-10 0 10 20 30 40 50 60 70
3. Business As Usual Scenario and Policy Case

BAU scenario

GDP Average Annual Growth Rate (2005-2025)
3. Business As Usual Scenario and Policy Case

BAU Scenario

Change in Real Land Price between 2005 and 2025

AT BE CZ DE DK EE ES EU FI FR GR HU IE IT LT LU LV MT NL NO PL PT RO SE SI SK UK
3. Business As Usual Scenario and Policy Case

Change in Arable Land between 2005 and 2025

- Change in Arable Land between 2005 and 2025

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Sustainability Impact Assessment of multifunctional land use
3. Business As Usual Scenario and Policy Case

BAU scenario

Change in Grass Land between 2005 and 2025

-12.00% -10.00% -8.00% -6.00% -4.00% -2.00% 0.00% 2.00% 4.00%

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Sustainability Impact Assessment of multifunctional land use
3. Business As Usual Scenario and Policy Case

BAU scenario

Change in Urban Area between 2005 and 2025

[Bar chart showing the percentage change in urban area for different countries between 2005 and 2025.]
3. Business As Usual Scenario and Policy Case

BAU scenario

Change in Land Used by Transport Infrastructures (2025/2005)

-5.00% 0.00% 5.00% 10.00% 15.00% 20.00% 25.00% 30.00%

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3. Business As Usual Scenario and Policy Case

Policy Case: Increase in Nature Conservation

Results for EU-27 (% Change from Baseline)

- Land Price: 7.00%
- Agricultural Land: -1.00%
- Construction Price: -0.00%
- GDP: 1.00%
- Built Areas: 0.00%
3. Business As Usual Scenario and Policy Case
Policy Case: Increase in Nature Conservation

% Change in Real Land Price

-5.00%  0.00%  5.00%  10.00%  15.00%  20.00%  25.00%

AT  BE  CZ  DE  DK  EE  ES  FI  FR  GR  HU  IE  IT  LT  LU  LV  MT  NL  NO  PL  PT  RO  SE  SI  SK  UK
3. Business As Usual Scenario and Policy Case

Policy Case: Increase in Nature Conservation

% Change in Total Agricultural Land

-3.00% -2.50% -2.00% -1.50% -1.00% -0.50% 0.00% 0.50%

AT BE CZ DE DK EE ES EU FI FR GR HU IE IT LT LU LV MT NL NO PL PT RO SE SI SK UK
3. Business As Usual Scenario and Policy Case

Policy Case: Increase in Nature Conservation

% Change in Construction Price

-1.00% 0.00% 1.00% 2.00% 3.00% 4.00% 5.00% 6.00%
AT BE CZ DE DK EE ES EU FI FR GR HU IE IT LT LU LV MT NL NO PL PT RO SE SI SK UK
3. Business As Usual Scenario and Policy Case

Policy Case: Increase in Nature Conservation

% Change in GDP

-7.00%
-6.00%
-5.00%
-4.00%
-3.00%
-2.00%
-1.00%
0.00%
1.00%

AT BE CZ DE DK EE ES EU FI FR GR HU IE IT LT LU LV MT NL NO PL PT RO SE SI SK UK
3. Business As Usual Scenario and Policy Case
Policy Case: Increase in Nature Conservation

% Change in Built Areas

-1.60%  -1.40%  -1.20%  -1.00%  -0.80%  -0.60%  -0.40%  -0.20%  0.00%  0.20%

AT  BE  CZ  DE  DK  EE  ES  EU  FI  FR  GR  HU  IE  IT  LT  LU  LV  MT  NL  NO  PL  PT  RO  SE  SI  SK  UK
Concluding Remarks

- Important feedbacks of land-use onto macro-economy, and conversely
- Inclusion of Tourism
- Extension of the framework to NUTS-2 regions (PLUREL)
- Linkage with detailed sectoral models (SENSOR): EFISCEN (Forestry), CAPRI (Agriculture) and CLUE-S (Regional Land-Use) (See Tuesday 9:00 audimax)