DISTRIBUTION OF BEEF CATTLE IN SCOTLAND: HOW IMPORTANT IS AGRICULTURAL POLICY?

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Presentation to
Outline

• Motivation
• Background
• Methods
• Results
• Further Developments
Motivation

• Interest in sustainability of farming systems in Scotland but also their resilience – particular interest in food security debate

• Extensive discussion about impact of 2005 reforms on Scottish agriculture but also looking ahead to further reforms post 2013

• Interesting exercise to look back over time and examine impact of policy changes as may give us some indication of future impacts
Proportion of units with cattle, June 2007

Legend:
- 0% - 6%
- 6% - 16%
- 16% - 17%
- 17% - 24%
- 25% - 31%
- 32% - 39%
- 39% - 45%
- 46% - 54%
- 55% - 67%
- 68% - 69%

Only parishes with 5 or more holdings with cattle have been included to meet disclosure requirements. Source: Scottish Government RROS, 2000

Pie chart showing:
- Total Finished Livestock 32%
- Total Livestock Products 14%
- Total Store livestock 3%
- Total Capital Formation 3%
- Total Other Agricultural Activities 4%
- Total Non-Agricultural Activities 7%
- Total Horticulture 9%
- Total other crops 12%
- Total cereals 16%
• Considerable discussion in Scotland about need to maintain capacity
  – Raises a number of questions but if livestock disappear will the capacity disappear too?
    • Loss of stock
    • Loss of skills
    • etc
• Therefore interest in the resilience of the Scottish livestock sector
  – Various definitions of resilience
• Also interest particularly since decoupling on impact on environment and possible land abandonment
  – Greater interest in spatial impacts of policy in Scotland
Cattle numbers 1866-2007

Thousand heads


1866-1921
1940-1973
1974-2007
Variations in Time and Space

Change in Cattle Numbers, 2004-2007

% Change
-20% -19.9% -15% -14.9% -10% -9.5% -5% -4.9% -2% -1.9% -2% 2.1% -7% >7%

Only regions containing 5 or more holdings with cattle have been included to meet disclosure requirements.

Source: PIREAD, Arch Agriculture and Horticulture Census of Scotland.
Change in Cattle Numbers, 1999-2007

% Change

-20%
-19.9% - -15%
-14.9% - -10%
-9.9% - -5%
-4.9% - -2%
-1.9% - 2%
2.1% - 7%
>7%

Only regions containing 5 or more holdings with cattle have been included to meet disclosure requirements.
Source: RICSAE June Agriculture and Horticulture Census of Scotland
• This paper presents preliminary analysis of whether the reaction to policy changes is similar across Scotland
• By undertaking a regional analysis
Methods

• Data collected from various government sources from 1959

• Definitions of regions and cattle classifications have changed over time
  – 11 regions were used
  – Certain categories were taken out
What does our data look like?
• Simple regression techniques used
• Given the issues of interest chose two models
  – First really to examine whether or not the shares of the cattle numbers across regions has changed as policy has changed
  – Second allows us to consider long term trends and assesses the degree of similarity in way regions evolve over time
(1) \[
Y_{it} = \sum_{k=1}^{K} \beta_k X_{k, it} + V_i + U_t + \epsilon_{it}
\]
\[
i = 1, \ldots, 11; t = 1, \ldots, 50
\]

Where

- \( Y_{it} \) is the share of beef cattle in region \( i \) in year \( t \),
- \( X_{k, it} \) represent \( k \) exogenous variables affecting the share of cattle in region \( i \).
- \( \beta_k \) are the coefficients associate with the explanatory variables.
- \( V_i \) is the time-invariant, unobserved region-specific effect;
- \( U_t \) is the region-invariant, unobserved time-specific effect and
- \( \epsilon_{it} \) is the random disturbance term.
\[ y_{it+1} = x_i + (1 - \beta) y_{it} + \varepsilon_{it} \] 

Where

\[ y_{it} = \ln \left( \frac{Q_{it}}{Q_t} \right) \] is the natural logarithm of the beef cattle stock in region i at time t normalised by the mean of the variable in the period.

\( x_i \) summarises the determinants of the growth in beef cattle in region i and \( \varepsilon_{it} \) is the independent and identically distributed random disturbance term.
Equation (2) can also be written in terms of first differences as in (3)

\[ (3) \quad \Delta y_{it} = x_i + \beta y_{it} + \epsilon_{it} \]

Where \( \Delta y_{it} = y_{it+1} - y_{it} \) is approximately equal to the growth rate of the beef cattle stock in region \( i \), measured in deviation from the average growth of the sample.

\[ (4) \quad y^*_i = \frac{x_i}{\beta} \quad \text{Steady state value is given by (4)}: \]

Taking expectations for both sides of (2), given initial conditions \( y_{i0} \) we get the non-stochastic equation in expected beef cattle stock \( y_{eit} \) as in (5)

\[ (5) \quad y_{eit} = y^*_i + \left( y_{i0} - y^*_i \right)(1-\beta)^t \]
## Results (1)

<table>
<thead>
<tr>
<th>Region</th>
<th>Regional Share</th>
<th>Change after Accession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shetland islands</td>
<td>0.003</td>
<td>-0.001</td>
</tr>
<tr>
<td>Orkney islands</td>
<td>0.05</td>
<td>0.005</td>
</tr>
<tr>
<td>Highland</td>
<td>0.097</td>
<td>-0.01</td>
</tr>
<tr>
<td>North East Grampian</td>
<td>0.292</td>
<td>-0.038</td>
</tr>
<tr>
<td>Tayside</td>
<td>0.159</td>
<td>-0.07</td>
</tr>
<tr>
<td>Fife</td>
<td>0.037</td>
<td>-0.004</td>
</tr>
<tr>
<td>Lothian</td>
<td>0.032</td>
<td>-0.002</td>
</tr>
<tr>
<td>Borders</td>
<td>0.075</td>
<td>0.007</td>
</tr>
<tr>
<td>Central</td>
<td>0.028</td>
<td>0.005</td>
</tr>
<tr>
<td>Strathclyde</td>
<td>0.115</td>
<td>0.051</td>
</tr>
<tr>
<td>Dumfries and Galloway</td>
<td>0.113</td>
<td>0.056</td>
</tr>
</tbody>
</table>

- **t-stat over 1.5**
- **t-stat over 2**
- **t-stat over -2**

550 Observations

$R^2 = 0.9793$

$R^2$ adj. = 0.9785
Results (2)

- Effectively four sets of results
  - Allowing for fixed effects only
  - Allowing for differences pre and post accession
  - Allowing for differences between regions
  - Allowing for differences between regions and pre and post accession
<table>
<thead>
<tr>
<th>Region</th>
<th>Deviation</th>
<th>Change after Accession</th>
<th>Convergence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shetland islands</td>
<td>-0.915</td>
<td>-0.06</td>
<td>0.721</td>
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<tr>
<td>Orkney islands</td>
<td>-0.067</td>
<td>0.01</td>
<td>0.882</td>
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<tr>
<td>Highland</td>
<td>-0.004</td>
<td>-0.003</td>
<td>0.901</td>
</tr>
<tr>
<td>North East Grampian</td>
<td>0.028</td>
<td>0.002</td>
<td>0.968</td>
</tr>
<tr>
<td>Tayside</td>
<td>0.041</td>
<td>-0.064</td>
<td>0.899</td>
</tr>
<tr>
<td>Fife</td>
<td>-0.139</td>
<td>-0.006</td>
<td>0.864</td>
</tr>
<tr>
<td>Lothian</td>
<td>-0.363</td>
<td>-0.017</td>
<td>0.662</td>
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<tr>
<td>Borders</td>
<td>-0.026</td>
<td>0.015</td>
<td>0.874</td>
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<tr>
<td>Central</td>
<td>-0.242</td>
<td>0.035</td>
<td>0.794</td>
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<tr>
<td>Strathclyde</td>
<td>0.045</td>
<td>0.011</td>
<td>0.919</td>
</tr>
<tr>
<td>Dumfries and Galloway</td>
<td>0.044</td>
<td>0.009</td>
<td>0.93</td>
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</tbody>
</table>
### Steady state values

<table>
<thead>
<tr>
<th>Region</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shetland island</td>
<td>0.033</td>
<td>0.032</td>
<td>0.030</td>
<td>0.032</td>
</tr>
<tr>
<td>Orkney island</td>
<td>0.596</td>
<td>0.624</td>
<td>0.616</td>
<td>0.609</td>
</tr>
<tr>
<td>Highland</td>
<td>0.909</td>
<td>0.911</td>
<td>0.941</td>
<td>0.935</td>
</tr>
<tr>
<td>North East Grampian</td>
<td>2.680</td>
<td>2.658</td>
<td>2.717</td>
<td>2.563</td>
</tr>
<tr>
<td>Tayside</td>
<td>0.808</td>
<td>0.808</td>
<td>0.824</td>
<td>0.565</td>
</tr>
<tr>
<td>Fife</td>
<td>0.339</td>
<td>0.322</td>
<td>0.344</td>
<td>0.347</td>
</tr>
<tr>
<td>Lothian</td>
<td>0.322</td>
<td>0.311</td>
<td>0.320</td>
<td>0.328</td>
</tr>
<tr>
<td>Borders</td>
<td>0.926</td>
<td>0.904</td>
<td>0.920</td>
<td>0.908</td>
</tr>
<tr>
<td>Central</td>
<td>0.329</td>
<td>0.360</td>
<td>0.369</td>
<td>0.353</td>
</tr>
<tr>
<td>Strathclyde</td>
<td>2.002</td>
<td>2.120</td>
<td>1.945</td>
<td>2.086</td>
</tr>
<tr>
<td>Dumfries and Galloway</td>
<td>2.055</td>
<td>2.182</td>
<td>1.988</td>
<td>2.166</td>
</tr>
</tbody>
</table>

Note: Values are ratios with respect to the mean.
Initial findings

• Aggregated cattle figures for Scotland for more than a century show that cattle numbers react strongly to agricultural policy.
• Agricultural policy is an important driver of both trends and structural change and also a source of divergence amongst regions.
• Two major periods: before and after the accession to the European Community. Further reforms not significant?
• Accession implied changes in the regional shares in regions.
• In terms of the convergence analysis, accession to the EC affected the steady state values for beef cattle expected for the regions.
Developments

• Preliminary work has looked at changes in numbers
• Issue is the extent to which this has occurred through:
  – downsizing
  – exit from the industry
  – Change in breeds etc
  – Other policy changes – extensification; LFA; SBCS etc
Analysis of change has concentrated on June census figures

However marked variation within year

That is the cows are not in the same region during the year

How do changes in one region impact on the other?

Source Thomson (2008)
Sheep and Interactions

Change in Sheep Numbers 1999 - 2007

Change in Sheep No.

-80.3% - -60%
-60% - -40%
-40% - -20%
-20% - -10%
-10% - 0%
0% - 10%
10% - 20%
20% - 30%
30% - 40%
40% - 50%
50% - 60%

Sheep numbers 1866-2008

Years

Only Parishes containing 5 or more units with sheep have been included to meet disclosure requirements.
Source: RER/AD June Agriculture and Horticulture Census of Scotland.
• **The engineering** definition of resilience can be summarised as: Resilience is the reciprocal of the time taken for a system to return to its starting state if perturbed. That is, if the system is given a shock at time, $t$ and returns to its initial state at time $t + dt$, engineering resilience can be defined as $[t/(t+dt)]$. Thus as the return time ($dt$) tends to zero the numerator and denominator of the ratio equal $t$ and resilience equals 1. As $dt$ grows the denominator exceeds $t$ and the ratio falls below 1; for large values of $dt$ relative to $t$, the ratio becomes very small.

• **The ecosystem-based** (or adaptive) definition of resilience can be summarised as follows: Resilience is the size of perturbation (or shock) a system can absorb without changing its internal functioning so that its structure and functions are qualitatively different from those present prior to the shock.