



## Technical and scale efficiency of Irish dairy farms – what is the optimum scale for producers

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## Overview

Background

Objectives

Methodology

- Technical and scale efficiency
- Data Envelopment Analysis (DEA)
- Second stage analysis
- Models
- Results

Conclusion



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## Background



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## Background

Rising costs of inputs

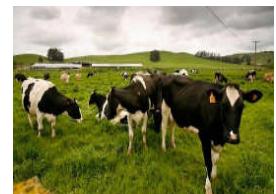
Volatile prices

Policy changes

- Quota removal
- Subsidies

Need to increase efficiency

Will efficiency increase at larger scales?



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## Objectives



## Objectives

- Estimate the levels of technical and scale efficiency
- Determine optimum scale for producers identifying factors contributing to having optimum scale
- Did technical and scale efficiency increase with differing levels of
  - Farm size
  - Intensification
  - Specialisation

## Efficiency measurement



## Definitions of Efficiency (Fried 2008)

- **Technical:** ability to maximise output from the current level of inputs
- **Scale:** indication of the amount that productivity could increase by moving to a point of technically optimal scale

## Data Envelopment Analysis (DEA)



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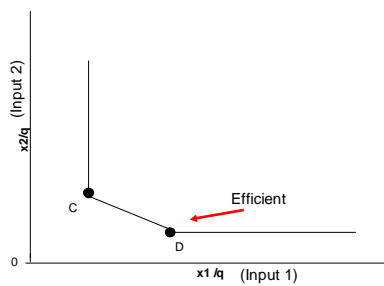
## Data Envelopment Analysis (DEA)

- Developed by Charnes et al., (1978)
  - Non-parametric methods
  - Deterministic
  - Linear programming
- Efficiency scores range between 0 and 1



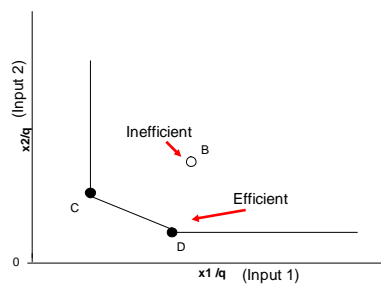
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## DEA Frontier



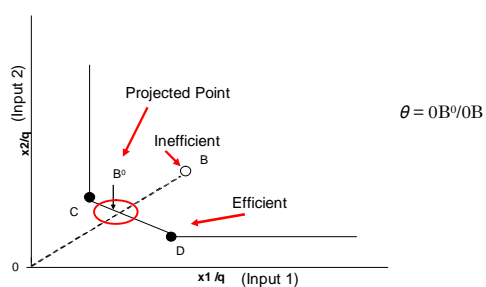
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## DEA Frontier



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## DEA Frontier



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## Data Envelopment Analysis (DEA)

- Technical efficiency models
  - TEvrs= Variable returns to scale (VRS)
  - TEcrs= Constant returns to scale (CRS)
- Scale efficiency= TEvrs - TEcrs
  - Scale efficient = optimum scale
  - Scale inefficient
    - Increasing returns to scale (sub optimum)
    - Decreasing returns to scale (supra optimum)



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## Efficiency Models

- Dataset
  - National Farm Survey (NFS), 2008
    - Annual survey of Irish dairy farms
    - Over 300 farms
- Input Variables
  - Land, quota (litres), labour (FTE), concentrate (kg), fertiliser (kg), other direct and overhead costs
- Output Variables
  - Milk (Litres) and value of other farm output



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## Second Stage Analysis

- Comparison of means of producers at optimum, sub optimum and supra optimum scale
- Comparison of producers at different measures of
  - Size
  - Intensification
  - Dairy specialisation



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## Results



**Table 1: DEA Efficiency scores**

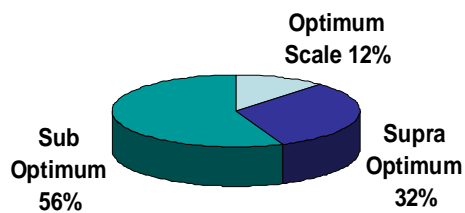
	TEcrs <sup>1</sup>	TEvrs <sup>2</sup>	SE <sup>3</sup>
Average	0.7574	0.7992	0.9495
Minimum	0.3320	0.4510	0.3370
Maximum	1.0000	1.0000	1.0000
St Dev	0.1476	0.1428	0.0836

<sup>1</sup>TE: constant returns to scale technical efficiency score

<sup>2</sup>TE: variable returns to scale technical efficiency score

<sup>3</sup>SE: scale efficiency score

Percentage of sample operating at Optimum, sub optimum and supra optimum scale



## Producers at optimum, sub optimum and supra optimum levels of scale

- 12% of the sample at optimum scale and will therefore get no gains from getting larger
- Huge potential to increase efficiency by increasing farm size with 56% at sub optimum scale
- 32% could increase efficiency by getting smaller
- Constraints to farm size such as quota which is preventing producers from gaining economies of scale
- Need to focus on factors affecting optimum scale

## Comparison of Producers at optimum, sub optimum and supra optimum levels of scale



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**Table 2: Optimal, sub optimum and supra optimum scales of production**

Variable	Optimum Scale (n=31)	Supra Optimum Scale (n=86)	Sub Optimum Scale (n=149)	Significance <sup>1</sup>
Land (ha)	41.36 <sup>a</sup>	50.64 <sup>b</sup>	25.78 <sup>c</sup>	***
Cow	80 <sup>a</sup>	86 <sup>a</sup>	47 <sup>b</sup>	***
Land Rented %	0.05 <sup>a</sup>	0.09 <sup>b</sup>	0.07 <sup>c</sup>	*
Dairy Labour Units (FTE)	1.29 <sup>a</sup>	1.40 <sup>b</sup>	0.97 <sup>c</sup>	***
Family Labour %	0.73 <sup>a</sup>	0.82 <sup>b</sup>	0.94 <sup>c</sup>	***
Hired Labour %	0.24 <sup>b</sup>	0.18 <sup>a</sup>	0.06 <sup>ab</sup>	***
Quota litres	385,102 <sup>a</sup>	462,565 <sup>b</sup>	247,321 <sup>c</sup>	***
Mik Solids per Ha	607	711	616	NS
Mik Solids per Cow	311	326	320	NS
Grazing Days	231 <sup>a</sup>	230 <sup>a</sup>	222 <sup>b</sup>	*
TEvs <sup>2</sup>	0.935 <sup>a</sup>	0.803 <sup>b</sup>	0.767 <sup>c</sup>	***
TEcrs <sup>3</sup>	0.935 <sup>a</sup>	0.775 <sup>b</sup>	0.710 <sup>c</sup>	***
SE <sup>4</sup>	1.000 <sup>a</sup>	0.967 <sup>b</sup>	0.929 <sup>c</sup>	***

<sup>1</sup>Significance - PROC GLM SAS (2006), \*\*\* <0.001, \*\*0.001-0.01, \*0.01-0.05, +0.05-0.1, NS>0.1

<sup>2</sup>TEvs: overall technical efficiency score

<sup>3</sup>TEcrs: pure technical efficiency score

<sup>4</sup>SE: scale efficiency score

## Affect of farm size measures on technical and scale efficiency



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**Table 3: Comparison of efficiency scores at different measures of farm size**

Variable	Technical Efficiency	Scale Efficiency
<b>Land (ha)</b>		
<20	0.805 <sup>a</sup>	0.985 <sup>a</sup>
<30	0.772 <sup>b</sup>	0.965 <sup>b</sup>
<50	0.795 <sup>a</sup>	0.982 <sup>a</sup>
>50	0.841 <sup>b</sup>	0.962 <sup>b</sup>
Significance	<.0001	<.0001
<b>Cow</b>		
<50	0.757 <sup>a</sup>	0.913 <sup>a</sup>
50 - 80	0.802 <sup>b</sup>	0.975 <sup>b</sup>
>80	0.867 <sup>c</sup>	0.972 <sup>b</sup>
Significance	<.0001	<.0001
<b>Milk (l)</b>		
135,000-250,000	0.755 <sup>a</sup>	0.921 <sup>a</sup>
250,000 - 320,000	0.796 <sup>b</sup>	0.972 <sup>b</sup>
320,000 - 500,000	0.822 <sup>c</sup>	0.974 <sup>b</sup>
>500,000	0.901 <sup>d</sup>	0.975 <sup>b</sup>
Significance	<.0001	<.0001

## Affect of intensification measures on technical and scale efficiency



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**Table 4:** Comparison of efficiency scores at different measures of intensification

Variable	Technical Efficiency	Scale Efficiency
<b>Stocking Rate</b>		
<1.50 LU/ha	0.729 <sup>a</sup>	0.943
1.50 – 2.00 LU/ha	0.803 <sup>b</sup>	0.953
>2.00LU/ha	0.851 <sup>c</sup>	0.953
Significance	<.0001	NS
<b>Quota per ha</b>		
<5,000 l/ha	0.775 <sup>a</sup>	0.933
5000-10,000 l/ha	0.762 <sup>a</sup>	0.944
>10,000 l/ha	0.857 <sup>b</sup>	0.961
Significance	<.0001	NS



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## Affect of dairy specialisation on technical and scale efficiency



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**Table 5:** Comparison of efficiency scores at different measures dairy specialisation

Variable	Technical Efficiency	Scale Efficiency
<b>Dairy Specialisation</b>		
<66%	0.747 <sup>a</sup>	0.941 <sup>a</sup>
66-75%	0.829 <sup>b</sup>	0.968 <sup>b</sup>
>75%	0.851 <sup>c</sup>	0.943 <sup>a</sup>
Significance	<.0001	<.0001



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## Conclusions



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## Conclusion

- Irish dairy farmers have potential to improve technical and scale efficiency
- 56% can increase productivity through increasing scale
- Optimum scale associated with
  - Larger owned land area (less rented land)
  - Increased amounts of hired labour
  - Higher quantity of quota
  - Longer grazing season.



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## Conclusion

- Greater technical and scale efficiency associated with
  - Increased size
  - Intensification
  - Dairy specialisation



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## Future work

- Measure productivity over a period of time e.g. 10 years



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**Thank you for your attention!**



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