Using Data Envelopment Analysis to Measure Logging Contractor Performance

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Introduction

▶ Benchmarking - Need for continuous measurement and improvement

▶ Logging industry – continuous changes in business environment

▶ Data envelopment analysis (DEA):

▪ Utilizes production data to identify 'best performers' among entities.

▪ DEA – an established approach in estimating performance.
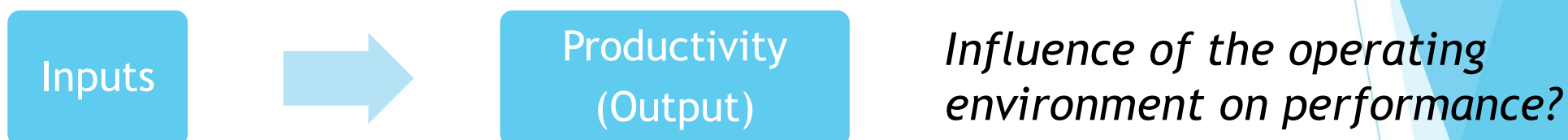
Reliable performance estimates?
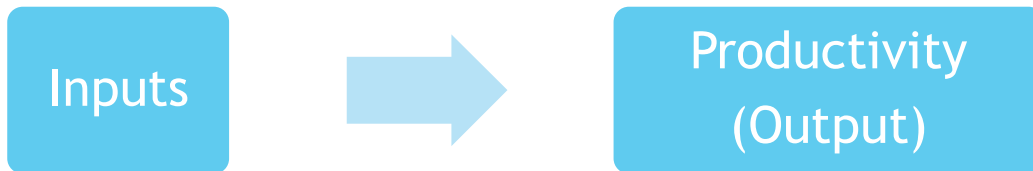
Benchmarking procedures often relate:

Inputs ➡ Productivity (Output)

Influence of the operating environment on performance?

Reliable performance estimates?

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Influence of the operating environment on performance?
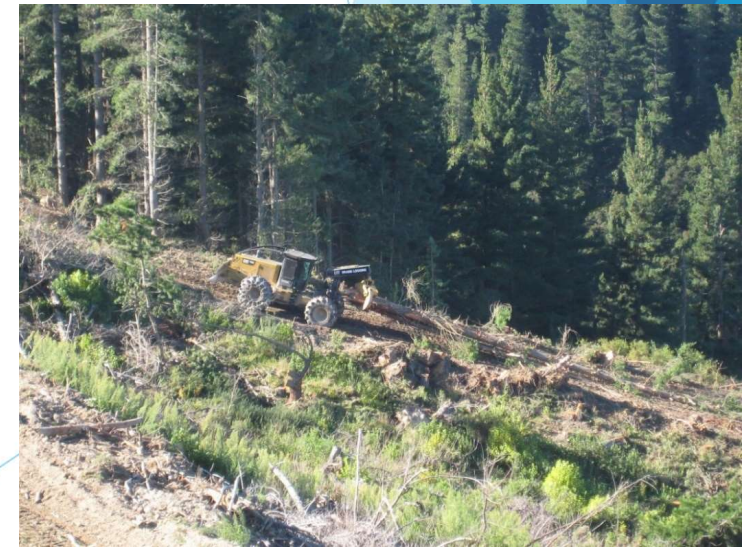
▶ Two-stage DEA procedure – identifies influential external factors

- *Technical efficiency is estimated – performance metric*

- *Efficiency is regressed against a set of exogenous factors*

    - Direction and size effect of these factors on efficiency is

    obtained from the regression coefficients.

NZ cost & productivity database

▶ Production data based on UC-FGR benchmark database

▶ Over 1000 unique entries on completed harvest operations

▶ Inputs – harvest days, machines, area size, no. of crews, and work hours/day

▶ Output – system productivity

▶ Operating environment – forest region, size of operation, terrain slope, log sorts and piece size

Influence of the operating environment

Table 1. Exogenous determinants of harvesting efficiency

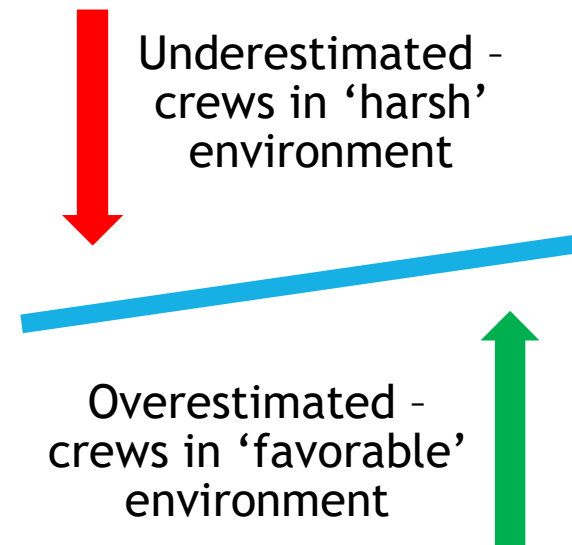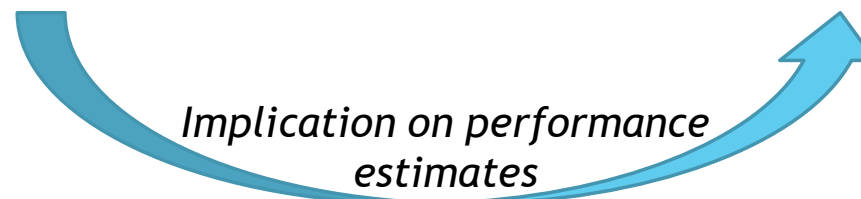| Factors	Coefficient	*p*-value
Constant	0.29	0.00
Region	0.0037	0.48
Size of operation	0.0014	0.00
Terrain slope	-0.0022	0.00
Log sorts	-0.011	0.00
Piece size	0.023	0.00
Likelihood ratio	891	0.00

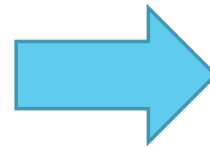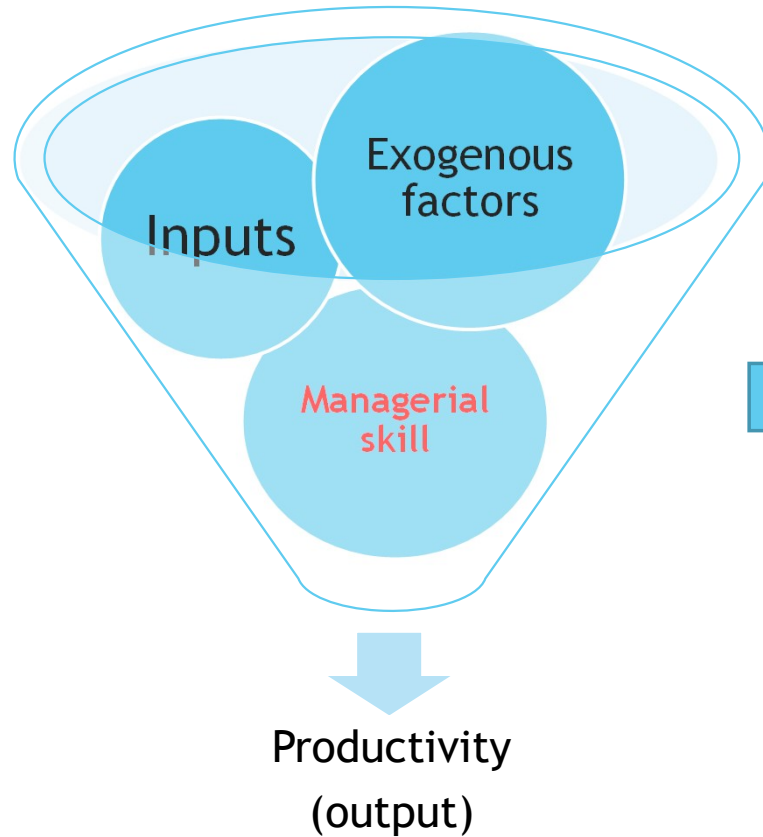Probability level, α = 1 %

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Probability level, α = 1 %

Underestimated – crews in 'harsh' environment

Overestimated – crews in 'favorable' environment

Implication on performance estimates

Unbiased harvesting performance estimates

Inputs

Exogenous factors

Managerial skill

Productivity
(output)

Four-stage DEA procedure

[Includes exogenous factors and adjusts input data to reflect the operating environment]

DEA four-stage procedure (Fried et al.,1999)

- *Identifies excess use of inputs by the crews – 'slacks'*

- *Quantifies the effect of exogenous factors slacks*

- *Initial input data are adjusted to reflect external influence*

- *New input dataset is used to obtain an unbiased harvesting performance estimate*

▶ Company specific data - contracted harvesting operations

▶ 67 independent harvesting crews

▶ 7 inputs; 3 exogenous factors; 1 output (system productivity)

Results of multi-step DEA

Table 2. Statistics on the estimated efficiency (*n* = 67)

Statistics	DEA	4-stage DEA
Mean	79.4	90
SD	15.8	9.5

▶ Improved performance estimate

▶ Less variability

Table 3. DEA efficiency ranking (*n* = 67)

Efficiency ranking	% Crews	
	DEA	4-stage DEA
100%	27	34
80 – 99%	21	48
60 – 79%	43	18
40 – 59%	9	

▶ Exogenous factors have significant influence on outcome!

▶ This can be accounted for in the four-stage DEA process

Conclusions

▶ Harvesting efficiency of crews is influenced by external factors, and that these can be accounted for when using DEA.

▶ By collecting the right data, companies can evaluate and rate harvesting system performance, provide a metric for continuous improvement, as well as identify and promote excellence in harvesting operations.