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## Introduction

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This document provides the technical details about the calculations used for institution level estimates from the Employer Satisfaction Survey (ESS). It is intended for an audience with some technical and data background who wish to understand the statistical details of the calculations.

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## Data sources, variables and coverage

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### Data sources

#### *Employer Satisfaction Survey (ESS)*

The ESS is Australia's first national survey that directly links the experiences of graduates to the views of their supervisors. Employed graduates who participated in the Graduate Outcomes Survey are asked to provide the contact details of their supervisor for follow up. The following ESS data are used:

- *Overall satisfaction (item)*: the proportion of supervisors who expressed overall satisfaction with their graduate;
- *Foundation skills (scale)*: the proportion of supervisors who were satisfied with the foundation skills of their graduates measured by the items in the foundation skills scale;
- *Adaptive skills (scale)*: the proportion of supervisors who were satisfied with the adaptive skills of their graduate as measured by the items in the adaptive skills scale;
- *Collaborative skills (scale)*: the proportion of supervisors who were satisfied with the collaborative skills of their graduate as measured by the items in the collaborative skills scale;
- *Technical skills (scale)*: the proportion of supervisors who were satisfied with the technical skills of their graduate as measured by the items in the technical skills scale; and
- *Employability skills (scale)*: the proportion of supervisors who were satisfied with the employability skills of their graduate as measured by the items in the employability skills scale.

When calculating institution level indicators, ESS indicators are calculated from three years of pooled data. This incorporates the most recent year of published data and the two immediately preceding years. For example, institution level indicators released in association with the 2019 ESS were based on results from the 2019, 2018 and 2017 surveys. In this paper these years are notated as Y1, Y2 and Y3, where Y1 is the most recent year of published data.

The variables that were used to filter the data can be found in Table 1 below. The coverage for each variable is applied before the calculation of the indicators and the SAS code used is provided in brackets after each variable in the table. The full code to create the indicators is available from the Social Research Centre (SRC) on request.

**Table 1: Data coverage for the ESS based indicators**

Variables (coverage)	Indicators					
	Overall Satisfaction	Foundation skills	Adaptive skills	Collaborative skills	Technical skills	Employability skills
<i>ESS Survey data file:</i>						
Undergraduate level (if e310 in (8,9,10,13,20,21,22))	X	X	X	X	X	X
Postgraduate coursework level (if e310 in (4,5,6,7,11,12,14))	X	X	X	X	X	X
Postgraduate research level (if e310 in (1,2,3))	X	X	X	X	X	X
In scope including different study areas for double degree students (if analysis in (1,2))	X	X	X	X	X	X
Valid likelihood of hiring another graduate with the same qualification from the same institution (ehire in (1,2,3,4,5))	X					
Valid foundation skills scale score (if egfound in (0,100))		X				
Valid adaptive skills scale score (if egadapt in (0,100))			X			
Valid collaborative skills scale score (if egcollb in (0,100))				X		
Valid technical skills scale score (if egtech in (0,100))					X	
Valid employability skills scale score (if egempty in (0,100))						X
Total minimum sample size of 25 (if n ≥ 25)	X	X	X	X	X	X

X Indicates that the restriction is applied to the data before a particular indicator is calculated.

### Data variability

As the ESS sampling fraction, the proportion of the population sampled, is relatively small, there is no need to apply Finite Population Correction (FPC) to the standard error, and the 90% confidence interval calculations, as opposed to other QILT related surveys.

In order to calculate the standard errors for the survey estimates, no non-response bias was assumed and the Agresti-Coull method for confidence intervals for proportions was used.

The general formula used for confidence intervals for proportions was:

$$CI\ bound(\hat{p}) = \tilde{p} \pm z_{\frac{\alpha}{2}} \times SE(\tilde{p}) = \tilde{p} \pm z_{0.05} \times \sqrt{\frac{\tilde{p}(1 - \hat{p})}{\tilde{n}}}$$

$$\tilde{p} = \frac{\tilde{y}}{\tilde{n}}$$

$$\tilde{y} = y + \frac{z^2_{\frac{\alpha}{2}}}{2} = y + \frac{z^2_{0.05}}{2}$$

$$\tilde{n} = n + z^2_{\frac{\alpha}{2}} = n + z^2_{0.05}$$

Where:

$\hat{p}$  is the estimated proportion from the survey data

$\tilde{p}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution ~ N(0,1)

$y$  is the number with the characteristic in question in the sample in the relevant strata over the three pooled years

$n$  is the number in the sample in the relevant strata over the three pooled years

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## Calculation of indicators and confidence intervals

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### Overall satisfaction

The overall satisfaction indicator is defined as the proportion of supervisors who indicated they were likely or very likely to consider hiring another graduate from the same course and institution. The indicator can be expressed as ‘the proportion of supervisors who expressed overall satisfaction with their graduate’.

The overall satisfaction indicator is calculated as follows:

$$OS_{pooled} = \frac{\text{Number of supervisors satisfied overall with their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid reponse}_{Y3-Y1}}$$

Where:

*Number of supervisors satisfied overall with their graduate*<sub>Y3-Y1</sub> is the total number of supervisors who responded with a 4 or 5 (likely to consider or very likely to consider) to the overall satisfaction item ‘Based on your experience with this graduate, how likely are you to consider hiring another graduate from the same course and institution, if you had a relevant vacancy?’ in the three pooled years, after filters are applied. It should be noted that this item is reported on a five point scale

*Number of supervisors with a valid response*<sub>Y3-Y1</sub> is the total number of supervisors who responded to the overall satisfaction item in the three pooled years, after filters are applied

The 90% confidence interval for the overall satisfaction indicator is calculated as follows:

$$90\%CI_{OS} = \bar{OS}_{pooled} \pm \frac{z_{\alpha}}{2} \times SE_{\bar{OS}}$$

$$= \bar{OS}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\bar{OS}_{pooled} \times (1 - \bar{OS}_{pooled})}{\tilde{n}}}$$

$$\bar{OS}_{pooled} = \frac{\tilde{y}}{\tilde{n}}$$

$$\tilde{y} = \text{Number of supervisors satisfied overall with their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2}$$

$$= \text{Number of supervisors satisfied overall with their graduate}_{Y3-Y1} + \frac{1.645^2}{2}$$

$$\tilde{n} = \text{Number of supervisors with valid reponse}_{Y3-Y1} + z^2_{0.05}$$

$$= \text{Number of supervisors with valid reponse}_{Y3-Y1} + 1.645^2$$

Where:

$\bar{OS}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution  $\sim N(0,1)$

The restrictions for this indicator can be found in Table 1.

### Foundation skills

The foundation skills indicator is defined as the proportion of supervisors who indicated they were satisfied with the foundation skills of their graduate. The indicator can be expressed as ‘the proportion of supervisors who were satisfied with the foundation skills of their graduate’.

The foundation skills indicator is calculated as follows:

$$FS_{pooled} = \frac{\text{Number of supervisors satisfied with the foundation skills of their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid response}_{Y3-Y1}}$$

Where:

*Number of supervisors who were satisfied with the foundation skills of their graduate*<sub>Y3-Y1</sub> is the total number of supervisors whose foundation skills scale score was at least 55 out of 100 (**foundation\_skills=100**) in the three pooled years, after filters are applied  
*Number of supervisors with a valid response*<sub>Y3-Y1</sub> is the total number of supervisors who had a valid response (**foundation\_skills in (0,100)**), i.e. responded to at least six of the eight foundation skills items in the three pooled years, after filters are applied

The 90% confidence interval for the foundation skills indicator is calculated as follows:

$$90\%CI_{FS} = \widetilde{FS}_{pooled} \pm z_{\frac{\alpha}{2}} \times SE_{\widetilde{FS}}$$

$$= \widetilde{FS}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\widetilde{FS}_{pooled} \times (1 - \widetilde{FS}_{pooled})}{\tilde{n}}}$$

$$\widetilde{FS}_{pooled} = \frac{\tilde{y}}{\tilde{n}}$$

$$\tilde{y} = \text{Number of supervisors satisfied with the foundation skills of their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2}$$

$$= \text{Number of supervisors satisfied with the foundation skills of their graduate}_{Y3-Y1} + \frac{1.645^2}{2}$$

$$\tilde{n} = \text{Number of supervisors with valid response}_{Y3-Y1} + z^2_{0.05}$$

$$= \text{Number of supervisors with valid response}_{Y3-Y1} + 1.645^2$$

Where:

$\widetilde{FS}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution ~ N(0,1)

The data sources and restrictions for this indicator can be found in Table 1.

### Adaptive skills

The adaptive skills indicator is defined as the proportion of supervisors who were satisfied with the adaptive skills of their graduate. The indicator can be expressed as ‘the proportion of supervisors who were satisfied with the adaptive skills of their graduate’.

The adaptive skills indicator is calculated as follows:

$$AS_{pooled} = \frac{\text{Number of supervisors satisfied with the adaptive skills of their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid response}_{Y3-Y1}}$$

Where:

*Number of supervisors satisfied with the adaptive skills of their graduate<sub>Y3-Y1</sub>* is the total number of supervisors whose adaptive skills scale score was at least 55 out of 100 (**adaptive\_skills=100**) in the three pooled years, after filters are applied

*Number of supervisors with a valid response<sub>Y3-Y1</sub>* is the total number of supervisors who had a valid response (**adaptive\_skills in (0,100)**), i.e. responded to at least four of the six adaptive skills items in the three pooled years, after filters are applied

The 90% confidence interval for the adaptive skills indicator is calculated as follows:

$$90\%CI_{AS} = \widetilde{AS}_{pooled} \pm \frac{z_{\alpha}}{2} \times SE_{\widetilde{AS}}$$

$$= \widetilde{AS}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\widetilde{AS}_{pooled} \times (1 - \widetilde{AS}_{pooled})}{\tilde{n}}}$$

$$\widetilde{AS}_{pooled} = \frac{\tilde{y}}{\tilde{n}}$$

$$\tilde{y} = \text{Number of supervisors satisfied with the adaptive skills of their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2}$$

$$= \text{Number of supervisors satisfied with the adaptive skills of their graduate}_{Y3-Y1} + \frac{1.645^2}{2}$$

$$\tilde{n} = \text{Number of supervisors with valid response}_{Y3-Y1} + z^2_{0.05}$$

$$= \text{Number of supervisors with valid response}_{Y3-Y1} + 1.645^2$$

Where:

$\widetilde{AS}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution  $\sim N(0,1)$

The restrictions for this indicator can be found in Table 1.

### **Collaborative skills**

The collaborative skills indicator is defined as the proportion of supervisors who indicated they were satisfied with the collaborative skills of their graduate. The indicator can be expressed as 'the proportion of supervisors who were satisfied with the collaborative skills of their graduate'.

The collaborative skills indicator is calculated as follows:

$$CS_{pooled} = \frac{\text{Number of supervisors satisfied with the collaborative skills of their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid response}_{Y3-Y1}}$$

Where:

*Number of supervisors who were satisfied with the collaborative skills of their graduate<sub>Y3-Y1</sub>* is the total number of supervisors whose collaborative skills scale score was at least 55 out of 100 (**collaborative\_skills = 100**) in the three pooled years, after filters are applied

*Number of supervisors with a valid response<sub>Y3-Y1</sub>* is the total number of supervisors who had a valid response (**collaborative\_skills in (0,100)**), i.e. responded to at least three of the five collaborative skills items in the three pooled years, after filters are applied

The 90% confidence interval for the collaborative skills indicator is calculated as follows:

$$90\%CI_{CS} = \widetilde{CS}_{pooled} \pm \frac{z_{\alpha}}{2} \times SE_{\widetilde{CS}}$$

$$= \widetilde{CS}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\widetilde{CS}_{pooled} \times (1 - \widetilde{CS}_{pooled})}{\tilde{n}}}$$

$$\widetilde{CS}_{pooled} = \frac{\tilde{y}}{\tilde{n}}$$

$$\begin{aligned} \tilde{y} &= \text{Number of supervisors satisfied with the collaborative skills of their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2} \\ &= \text{Number of supervisors satisfied with the collaborative skills of their graduate}_{Y3-Y1} + \frac{1.645^2}{2} \end{aligned}$$

$$\begin{aligned} \tilde{n} &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + z^2_{0.05} \\ &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + 1.645^2 \end{aligned}$$

Where:

$\widetilde{CS}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution  $\sim N(0,1)$

The restrictions for this indicator can be found in Table 1.

### Technical skills

The technical skills indicator is defined as the proportion of supervisors who were satisfied with the technical skills of their graduate. The indicator can be expressed as ‘the proportion of supervisors who were satisfied with the technical skills of their graduate’.

The technical skills indicator is calculated as follows:

$$TS_{pooled} = \frac{\text{Number of supervisors satisfied with the technical skills of their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid reponse}_{Y3-Y1}}$$

Where:

*Number of supervisors satisfied with the technical skills of their graduate*<sub>Y3-Y1</sub> is the total number of supervisors whose technical skills scale score was at least 55 out of 100

**(technical\_skills = 100)** in the three pooled years, after filters are applied

*Number of supervisors with a valid response*<sub>Y3-Y1</sub> is the total number of supervisors who had a valid response **(technical\_skills in (0,100))**, i.e. responded to at least four of the six technical skills items in the three pooled years, after filters are applied

The 90% confidence interval for the technical skills indicator is calculated as follows:

$$\begin{aligned} 90\%CI_{TS} &= \widetilde{TS}_{pooled} \pm z_{\alpha} \times SE_{\widetilde{TS}} \\ &= \widetilde{TS}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\widetilde{TS}_{pooled} \times (1 - \widetilde{TS}_{pooled})}{\tilde{n}}} \\ \widetilde{TS}_{pooled} &= \frac{\tilde{y}}{\tilde{n}} \end{aligned}$$

$$\begin{aligned} \tilde{y} &= \text{Number of supervisors satisfied with the technical skills of their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2} \\ &= \text{Number of supervisors satisfied with the technical skills of their graduate}_{Y3-Y1} + \frac{1.645^2}{2} \end{aligned}$$

$$\begin{aligned} \tilde{n} &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + z^2_{0.05} \\ &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + 1.645^2 \end{aligned}$$

Where:

$\widetilde{TS}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution  $\sim N(0,1)$

The restrictions for this indicator can be found in Table 1.

### **Employability skills**

The employability skills indicator is defined as the proportion of supervisors who indicated they were satisfied with the employability skills of their graduate. The indicator can be expressed as ‘the proportion of supervisors who were satisfied with the employability skills of their graduate’.

The employability skills indicator is calculated as follows:

$$ES_{pooled} = \frac{\text{Number of supervisors satisfied with the employability skills of their graduate}_{Y3-Y1}}{\text{Number of supervisors with valid reponse}_{Y3-Y1}}$$

Where:

*Number of supervisors satisfied with the employability skills of their graduate*<sub>Y3-Y1</sub> is the total number of supervisors whose employability skills scale score was at least 55 out of 100 (**employability\_skills = 100**) in the three pooled years, after filters are applied

*Number of supervisors with a valid response*<sub>Y3-Y1</sub> is the total number of supervisors who had a valid response (**employability\_skills in (0,100)**), i.e. responded to at least six of the eight employability skills items in the three pooled years, after filters are applied

The 90% confidence interval for the employability skills indicator is calculated as follows:

$$\begin{aligned} 90\%CI_{ES} &= \widetilde{ES}_{pooled} \pm z_{\frac{\alpha}{2}} \times SE_{\widetilde{ES}} \\ &= \widetilde{ES}_{pooled} \pm z_{0.05} \times \sqrt{\frac{\widetilde{ES}_{pooled} \times (1 - \widetilde{ES}_{pooled})}{\tilde{n}}} \\ \widetilde{ES}_{pooled} &= \frac{\tilde{y}}{\tilde{n}} \end{aligned}$$

$$\begin{aligned} \tilde{y} &= \text{Number of supervisors satisfied with the employability skills of their graduate}_{Y3-Y1} + \frac{z^2_{0.05}}{2} \\ &= \text{Number of supervisors satisfied with the employability skills of their graduate}_{Y3-Y1} + \frac{1.645^2}{2} \end{aligned}$$

$$\begin{aligned} \tilde{n} &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + z^2_{0.05} \\ &= \text{Number of supervisors with valid reponse}_{Y3-Y1} + 1.645^2 \end{aligned}$$

Where:

$\widetilde{ES}_{pooled}$  is an adjusted estimated proportion used only in confidence interval calculations

$z_{0.05}$  is the 95<sup>th</sup> quantile from the standard Normal distribution ~ N(0,1)

The restrictions for this indicator can be found in Table 1.