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THE RAI'S METHOD FOR ASSESSING REGIONAL JOB VULNERABILITY TO AUTOMATION

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SUMMARY

- The Regional Australia Institute (RAI) approach adopts a conservative version of Frey and Osborne's research into the statistical probability of occupations being eliminated by automation, taking into account concerns raised by a range of analysts, including those at the Organisation for Economic Cooperation and Development (OECD).
- The RAI vulnerability index (0, 0.5, 1) is constructed using the Edmonds and Bradley (2015) automation scores for Australian occupations (using Australia New Zealand Standard Classification of Occupations codes). The RAI assigns a 0 (low vulnerability code) to jobs which have an automation score below 40, a 0.5 (medium vulnerability code) to jobs which have an automation score at or above 40 and at or below 80, and a 1 (high vulnerability code) to jobs which have an automation score above 80.
- For occupations not coded by Edmonds and Bradley (2015), scores are assigned based on like occupations (with like ANZSCO codes). All scores are averaged up at the 3 digit level for ease of calculation. Occupations listed on the census as 'not further defined (nfd)' are given scores based on the average of occupations in the same code category.

The RAI's assessment of job vulnerability to automation is broadly based on Frey and Osborne's 2013 US-based assessment outlined in *The future of employment: How susceptible are jobs to computerisation*.¹ This research examined the statistical susceptibility of each occupation in the American labour market to automation and concluded that 47% of jobs in the U.S. were at high risk of being eliminated due to computerisation or automation. Their methodology was also used to examine occupations in the European and Australian labour markets.

The RAI approach was established using 2011 Census data, with analysis later revised following the release of the 2016 Census occupation. Both assess data at the 4-digit (most detailed) ANZSCO level then aggregate up to the 1-digit (broadest) level.

Under the RAI approach, occupations follow the same general 0-1 coding metric as Frey and Osborne to indicate opposite ends of the vulnerability scale (not vulnerable and vulnerable). The difference with the RAI approach is that it includes a middle (0.5) value, rather than a binary 0-1 distribution.

Though Frey and Osborne do not include a 0.5 code for occupations, they do use a 'low, medium, high' vulnerability score to determine the allocation of 0s and 1s. These scores (ranging from 0 to 100) are ascribed to all US occupations. Occupations with scores below 30 are considered at low risk of change through automation, scores between 30 and 70 (inclusive) are considered at moderate risk of change through automation, and scores over 70 are considered at high risk of change through automation.

In combining this clustered automation descriptor with the 0-1 vulnerability classification, the RAI adopts a refined coding approach that considers 0 (low vulnerability), 0.5 (moderate vulnerability) and 1 (high vulnerability) to represent low-medium-high automation scores respectively.

This three-tiered coding approach includes an Australian-specific occupation classification, with the RAI taking into consideration various published reports in determining its own approach to calculating job vulnerability to automation.

One report is the PwC Australia 2015 report, *A smart move*.ⁱⁱ Another is Durrant-Whyte et al's 2015 report, *The impact of computerisation and automation on future employment*.ⁱⁱⁱ Both reports use Frey and Osborne as their inspiration, with Durrant-Whyte et al estimating that 40%, or five million, Australian jobs vulnerable to change as the result of automation. The PwC Australia estimate is slightly higher, at around 44%.

Another estimate of Australian job vulnerability to automation at 44% comes from Edmonds and Bradley's 2015 report for the Department of Industry, Innovation and Science and the Office of the Chief Economist, *Mechanical boon: will automation advance Australia?*^{iv} This report provides automation scores for all Australian occupations at the 4 digit level (based on the Frey and Osborne method).

Viewing Edmonds and Bradley's automation scores alongside 'low, medium, high' vulnerability descriptors, various scenarios for future job vulnerability can be ascertained. The RAI has assessed two different scenarios that vary according to different thresholds for what constitutes 'low' and 'high' vulnerability to change through automation.

The first scenario is based on Frey and Osborne's existing 30-70 thresholds. Here, a 0 (low vulnerability code) is assigned to jobs which have an automation score below 30, a 0.5 (medium vulnerability code) assigned to jobs which have an automation score at or above 30 and at or below 70, and a 1 (high vulnerability code) assigned to jobs which have an automation score above 70. An assessment of six selected LGAs according to the 30-70 thresholds produces proportions of jobs 'highly vulnerable' to automation that are in line with the national estimate proposed by Durrant-Whyte et al (2015), PwC Australia (2015) and Edmonds and Bradley (2015) – around 40-44% (see Table 1).

The second scenario draws on the reasoning of Arntz, Gregory and Zierahn.^v In their 2016 OECD Working Paper, Arntz et al argue that automation vulnerability estimates based on Frey and Osborne's specific method are far too high and fail to account for task variation within occupations. Compared with Frey and Osborne's estimate that up to 47% of US occupations are at risk of change through automation, Arntz, Gregory and Zierahn say it could be more like 9%.

In a quest to incorporate this more conservative assessment of automation's disruptive potential, the RAI has opted to combine the two scenarios outlined above. In the RAI approach, Frey and Osborne's general classifications are viewed alongside Edmonds and Bradley's automation scores, but the threshold for vulnerability has been shifted up by 10. This means that, compared with Frey and Osborne's 30-70 threshold, the RAI approach uses a 40-80 threshold. This allows more occupations to be included in the 'safe/low risk' category and fewer occupations to be included in the 'unsafe/high risk' category. This methodology has been used in recognition that, rather than being completely eliminated, many jobs will remain but be changed to a greater or lesser extent by automation.

Under this relatively conservative approach, the RAI assigns a 0 (low vulnerability code) to jobs which have an automation score below 40, a 0.5 (medium vulnerability code) to jobs which have an

automation score at or above 40 and at or below 80, a 1 (high vulnerability code) to jobs which have an automation score above 80.

As shown in Table 2, this 40-80 threshold puts 'high vulnerability' proportions below the other assessments of national job vulnerability. However, given there is a finer grade of distinction in the RAI's assessment of vulnerability (where the discussion is around low/moderate/high vulnerability instead of just vulnerable/not vulnerable), this outcome is expected, and is cognisant of the OECD's hesitation about potential overestimation of the automation 'problem'.

According to the RAI approach, occupations with automation scores of below 40 (coded as 0) are mostly professionals (the lowest being medical and other healthcare professionals and teachers), managers (with the exception of farmers and farm managers) and community and personal service workers who work in childcare or health and welfare support, community safety or sport and leisure (see Table 3).

Unlike other manager level occupations, farmers and farm managers (with an automation score of 44.65) are coded as 0.5. They sit alongside other occupations that have automation scores between 40 and 80; a mixture of community and personal service workers (those employed as assistants or aides or in security), technicians and trades workers, general labourers, machine operators, clerks, and sales workers. Occupations with scores above 80 (coded as 1) are predominantly the general office and accounting workers, and food and factory process workers.

In general, occupations that revolve around low-skilled, routine manual labour are far more susceptible to automation than occupations that are non-routine and require a high level of skill, personal contact and care. Automation scores averaged up to the 1 digit level reflect this summary of the 3 digit level, with occupations ranked from lowest to highest vulnerability shown in Table 5.

Scores for the 'nfd' ANZSCO categories (and others not listed in the Edmonds and Bradley report) are calculated as the average of all relevant occupations. For example, the automation score for 'general clerical workers nfd' (ANZSCO 530) is calculated as the average of all occupations starting with '53': 'general clerks' (ANZSCO 531) and 'keyboard operators' (ANZSCO 532). All of these clerical categories have automation scores above 80 and so are coded as 1.

Overall, the RAI approach for assessing job vulnerability to automation incorporates a range of published views on the 'future of work'. The RAI approach uses Australian-specific automation scores at a higher level of detail than many have used previously (4 digits, which can be averaged up to 3 digits). It also applies a three point vulnerability index (0, 0.5, 1) across all occupations, rather than a binary index (0, 1). While relying heavily on the approach of Frey and Osborne (as many others have), by adopting more conservative thresholds for vulnerability (40-80), the RAI approach also acknowledges some of the claims that Frey and Osborne's approach may overestimate the degree to which some occupations are susceptible to automation.

APPENDIX – EXPLANATORY TABLES

Table 1. Assessment of occupation vulnerability based on Frey and Osborne 30-70 threshold (2011 Census data)

	Charters Towers	Launceston	Mildura	Serpentine-Jarrahdale	Uralla	Victor Harbor	Total
	LGA32310	LGA64010	LGA24780	LGA57700	LGA17650	LGA48050	Total
	Heartland Region	Regional City	Industry & Service Hub	Connected Lifestyle Area	Heartland Region	Connected Lifestyle Area	
Total known job count	4,229	3,1840	18,606	3,139	1,421	3,955	9,869,352
Low vulnerability	1,098	10,717	5,483	723	329	1,243	3,355,464
Moderate vulnerability	1,316	6,714	5,045	1,052	612	969	2,223,697
High vulnerability	1,815	14,409	8,078	1,364	480	1,743	4,290,191
% Low vulnerability	25.96%	33.66%	29.47%	23.03%	23.15%	31.43%	34.00%
% Moderate vulnerability	31.12%	21.09%	27.11%	33.51%	43.07%	24.50%	22.53%
% High vulnerability	42.92%	45.25%	43.42%	43.45%	33.78%	44.07%	43.47%
% TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 2. Revised RAI vulnerability analysis based on RAI's 40-80 threshold (2011 Census data)

	Charters Towers	Launceston	Mildura	Serpentine-Jarrahdale	Uralla	Victor Harbor	Total
	LGA32310	LGA64010	LGA24780	LGA57700	LGA17650	LGA48050	Total
	Heartland Region	Regional City	Industry & Service Hub	Connected Lifestyle Area	Heartland Region	Connected Lifestyle Area	
Total known job count	4,229	31,840	18,606	3,139	1,421	3,955	9,869,352
Low vulnerability	1,254	12,653	6,464	869	386	1,445	4,050,798
Moderate vulnerability	1,946	9,436	6,623	1,464	738	1,241	3,144,806
High vulnerability	1,029	9,751	5,519	806	297	1,269	2,673,748
% Low vulnerability	29.65%	39.74%	34.74%	27.68%	27.16%	36.54%	41.04%
% Moderate vulnerability	46.02%	29.64%	35.60%	46.64%	51.94%	31.38%	31.86%
% High vulnerability	24.33%	30.63%	29.66%	25.68%	20.90%	32.09%	27.09%
% TOTAL	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 3. Occupations (ANZSCO 3 digit level) ranked by automation score (2011 Census data)

ANZSCO	Occupation	Automation score	VI
253	Medical Practitioners	Least vulnerable 0.5	0
254	Midwifery and Nursing Professionals	0.5	0
252	Health Therapy Professionals	1.2	0
131	Advertising, Public Relations and Sales Managers	1.5	0
134	Education, Health and Welfare Services Managers	2.0	0
263	ICT Network and Support Professionals	2.7	0
262	Database and Systems Administrators, and ICT Security Specialists	3.0	0
241	School Teachers	3.0	0
135	ICT Managers	3.5	0
250	Health Professionals nfd	4.9	0
242	Tertiary Education Teachers	5.3	0
240	Education Professionals nfd	5.5	0
233	Engineering Professionals	6.1	0
271	Legal Professionals	6.3	0
270	Legal, Social and Welfare Professionals nfd	6.4	0
272	Social and Welfare Professionals	6.5	0
260	ICT Professionals nfd	7.7	0
421	Child Carers	8.4	0
223	Human Resource and Training Professionals	9.2	0
249	Miscellaneous Education Professionals	9.8	0
211	Arts Professionals	11.3	0
210	Arts and Media Professionals nfd	14.0	0
111	Chief Executives, General Managers and Legislators	14.0	0
130	Specialist Managers nfd	14.0	0
261	Business and Systems Analysts, and Programmers	14.3	0
230	Design, Engineering, Science and Transport Professionals nfd	14.4	0
200	Professionals nfd	14.5	0
441	Defence Force Members, Fire Fighters and Police	14.8	0
232	Architects, Designers, Planners and Surveyors	14.9	0
391	Hairdressers	15.8	0
142	Retail Managers	16.1	0
452	Sports and Fitness Workers	16.5	0
251	Health Diagnostic and Promotion Professionals	16.6	0
132	Business Administration Managers	16.8	0
141	Accommodation and Hospitality Managers	17.0	0
212	Media Professionals	18.5	0
310	Engineering, ICT and Science Technicians nfd	18.6	0
234	Natural and Physical Science Professionals	19.2	0
139	Miscellaneous Specialist Managers	19.4	0
100	Managers nfd	20.2	0

133	Construction, Distribution and Production Managers	21.0	0
231	Air and Marine Transport Professionals	22.8	0
140	Hospitality, Retail and Service Managers nfd	24.1	0
411	Health and Welfare Support Workers	26.6	0
341	Electricians	27.7	0
225	Sales, Marketing and Public Relations Professionals	28.3	0
300	Technicians and Trades Workers nfd	29.0	0
512	Office and Practice Managers	30.8	0
450	Sports and Personal Service Workers nfd	31.8	0
149	Miscellaneous Hospitality, Retail and Service Managers	32.8	0
222	Financial Brokers and Dealers, and Investment Advisers	33.4	0
511	Contract, Program and Project Administrators	34.7	0
220	Business, Human Resource and Marketing Professionals nfd	35.9	0
440	Protective Service Workers nfd	36.4	0
340	Electrotechnology and Telecommunications Trades Workers nfd	36.8	0
224	Information and Organisation Professionals	38.4	0
342	Electronics and Telecommunications Trades Workers	39.1	0
420	Carers and Aides nfd	39.4	0
451	Personal Service and Travel Workers	39.5	0
334	Plumbers	40.3	0.5
400	Community and Personal Service Workers nfd	41.3	0.5
423	Personal Carers and Assistants	43.0	0.5
121	Farmers and Farm Managers	44.7	0.5
510	Office Managers and Program Administrators nfd	51.6	0.5
313	ICT and Telecommunications Technicians	52.1	0.5
312	Building and Engineering Technicians	55.6	0.5
311	Agricultural, Medical and Science Technicians	55.9	0.5
422	Education Aides	56.0	0.5
361	Animal Attendants and Trainers, and Shearers	59.4	0.5
360	Skilled Animal and Horticultural Workers nfd	59.5	0.5
362	Horticultural Trades Workers	59.5	0.5
321	Automotive Electricians and Mechanics	62.2	0.5
323	Mechanical Engineering Trades Workers	62.9	0.5
393	Textile, Clothing and Footwear Trades Workers	63.3	0.5
811	Cleaners and Laundry Workers	65.6	0.5
841	Farm, Forestry and Garden Workers	66.0	0.5
611	Insurance Agents and Sales Representatives	67.0	0.5
442	Prison and Security Officers	68.9	0.5
639	Miscellaneous Sales Support Workers	69.6	0.5
610	Sales Representatives and Agents nfd	70.2	0.5
891	Freight Handlers and Shelf Fillers	70.4	0.5
390	Other Technicians and Trades Workers nfd	71.7	0.5
320	Automotive and Engineering Trades Workers nfd	71.7	0.5
712	Stationary Plant Operators	72.6	0.5

399	Miscellaneous Technicians and Trades Workers	73.1	0.5
890	Other Labourers nfd	73.1	0.5
630	Sales Support Workers nfd	73.5	0.5
899	Miscellaneous Labourers	73.8	0.5
541	Call or Contact Centre Information Clerks	74.1	0.5
330	Construction Trades Workers nfd	74.7	0.5
800	Labourers nfd	75.6	0.5
324	Panelbeaters, and Vehicle Body Builders, Trimmers and Painters	76.2	0.5
741	Storepersons	76.4	0.5
600	Sales Workers nfd	76.7	0.5
710	Machine and Stationary Plant Operators nfd	77.1	0.5
331	Bricklayers, and Carpenters and Joiners	77.6	0.5
832	Packers and Product Assemblers	77.7	0.5
332	Floor Finishers and Painting Trades Workers	77.9	0.5
733	Truck Drivers	78.4	0.5
351	Food Trades Workers	78.5	0.5
732	Delivery Drivers	78.7	0.5
730	Road and Rail Drivers nfd	78.8	0.5
731	Automobile, Bus and Rail Drivers	78.9	0.5
700	Machinery Operators and Drivers nfd	79.1	0.5
711	Machine Operators	79.4	0.5
591	Logistics Clerks	79.4	0.5
612	Real Estate Sales Agents	79.5	0.5
821	Construction and Mining Labourers	79.7	0.5
540	Inquiry Clerks and Receptionists nfd	79.9	0.5
333	Glaziers, Plasterers and Tilers	80.3	1
831	Food Process Workers	81.9	1
590	Other Clerical and Administrative Workers nfd	82.1	1
500	Clerical and Administrative Workers nfd	82.2	1
392	Printing Trades Workers	82.6	1
599	Miscellaneous Clerical and Administrative Workers	82.8	1
621	Sales Assistants and Salespersons	82.8	1
431	Hospitality Workers	83.4	1
851	Food Preparation Assistants	83.8	1
830	Factory Process Workers nfd	84.9	1
221	Accountants, Auditors and Company Secretaries	85.3	1
322	Fabrication Engineering Trades Workers	85.4	1
721	Mobile Plant Operators	86.3	1
561	Clerical and Office Support Workers	87.6	1
839	Miscellaneous Factory Process Workers	89.6	1
521	Personal Assistants and Secretaries	90.3	1
394	Wood Trades Workers	91.0	1
542	Receptionists	91.6	1
552	Financial and Insurance Clerks	93.5	1

532	Keyboard Operators	95.1	1
550	Numerical Clerks nfd	95.4	1
530	General Clerical Workers nfd	95.6	1
531	General Clerks	96.0	1
631	Checkout Operators and Office Cashiers	96.9	1
551	Accounting Clerks and Bookkeepers	97.3 Most vulnerable	1

Table 4. Occupations (1 digit level) ranked by average automation score (2011 Census data)

Occupation (ANZSCO 1 digit)	Automation score
Professionals	Least vulnerable 14.85388
Managers	17.63166
Community and personal service workers	38.91457
Technicians and trades workers	59.93344
Labourers	76.83014
Sales workers	77.02654
Machinery operators and drivers	78.58042
Clerical and administrative workers	79.99267 Most vulnerable

ⁱ Frey, C.B. and Osborne, M.A. (2013). *The future of employment: How susceptible are jobs to computerisation?* Available at: http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

ⁱⁱ PwC Australia (2015). *A Smart move: Future-proofing Australia's workforce by growing skills in science, technology, engineering and maths.* Available at: <https://www.pwc.com.au/pdf/a-smart-move-pwc-stem-report-april-2015.pdf>

ⁱⁱⁱ Durrant-Whyte, H.; McCalman, L.; O'Callaghan, S.; Reid, A. and Steinberg, D. (2015). The impact of computerisation and automation on future employment. In *Australia's future workforce?* (pp. 56-64). Melbourne: Committee for Economic Development of Australia

^{iv} Edmonds, D. and Bradley, T. (2015). *Mechanical boon: will automation advance Australia?* Canberra: Department of Industry, Innovation and Science.

^v Arntz, M.; Gregory, T. and Zierahn, U. (2016). The risk of automation for jobs in OECD countries: a comparative analysis. *OECD Social, Employment and Migration Working Papers*, No. 189. Paris: OECD Publishing. Available at http://www.oecd-ilibrary.org/social-issues-migration-health/the-risk-of-automation-for-jobs-in-oecd-countries_5ilz9h56dva7-en