

Demographic impacts on the future supply of vocational skills: Support document

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Appendix A:

Employment share projection: Growth curve fitting models

The class of functions called growth curves or S-shaped curves is motivated by the fact that rates must be in the range $[0,1]$ and therefore cannot grow as polynomials or exponentials. Since it is not possible to implement full modelling of all the demographic, economic, political, social, cultural or even natural influences on the occupational employment shares, we find the curve that best fits the historical data and extrapolate along this curve under the assumption that the present trends capture the sum of these effects and will continue in the future. This means we do not predict turning points – changes from growth to decline or the other way around. Only curves that are monotone increasing or monotone decreasing are considered. A monotone and bounded range $[0,1]$ implies S-shaped curves. There are many types of S-shaped curves. Richards curves are the simplest curves that satisfy all the properties above yet do not require symmetry (Richards 1959). Richards curves provide flexible representations with series describing demographic, economic as well as technological change. With Richards curves it is possible to model any growth in the sigmoid form and distinguish the three phases that underlie these evolutions: emergent, inflexion and saturation, as well as the periods of expansion and contraction of economic phenomena.

The occupational employment shares for each occupation and for each age group were modelled as Richards curves. These shares were predicted separately using non-linear least squares curve fitting techniques applied to data on the level of employment in each of the main occupations, by age. Projections directly focused on finding the best fits of Richards curves to the data comprising the employment share for each occupation and for each age group between 1996 and 2005. The projected employment shares for each occupation and for each age group were applied to the predicted overall employment and disaggregated employment by age group to compute the absolute numbers of employed persons in each occupation and in each age group. The Richards functions take the form:

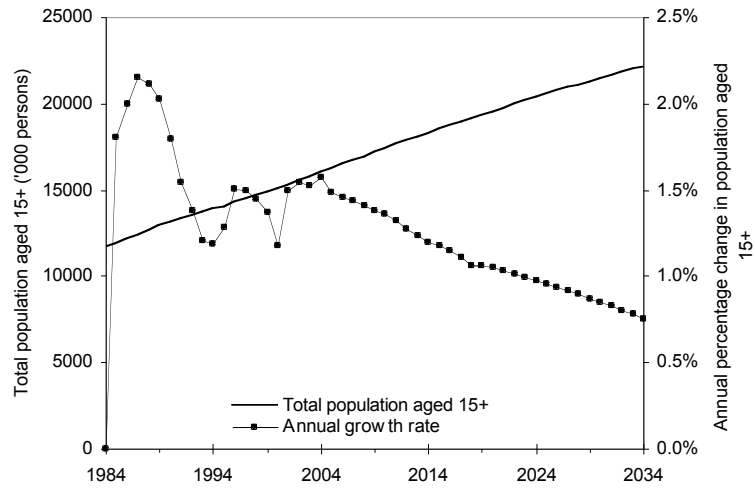
$$y_t = c + a \times (1 + b e^{g t})^\lambda \quad [1]$$

Some restrictions for the parameters were set up over the parameters $a+c$, b , c , g , and lambda (λ). The reason is that the limits at upper and lower infinity are $a+c$ and c , so that in constraining these to $[0,1]$, which ensures that the curve stays in this range, b is also constrained to $[0,1]$. Lambda is constrained to $[-1, -20]$, g is constrained to either $[-20,0]$ or $[0,20]$, depending on whether the curve is nominally increasing (e.g., employment share for ‘Associate professionals’) or decreasing (e.g., employment share for ‘Tradespersons and related workers’).

The ceiling ($a+c$) is the maximum occupational level either attainable in the past and present economic paradigm or to be reached in the future, whilst the floor (c) represents the minimum level, which might have been reached in the preceding paradigm or may be reached in the future. For most occupations and age groups, there was only one trend for the whole measured data set and the results for these cases were soundly projected. Richards curves for each occupation and for each age cohort have different coefficients, reflecting dynamics of occupational evolution and disparities in the employment experience and conditions of people involved in the occupations. The changes and parametric values vary by occupation and by age. The projected shares for occupations and shares within an occupation by age group are normalised, forcing the shares to add to one. The normalised shares provide the proportion of employment in each class (e.g., occupation or age group) at any point in time.

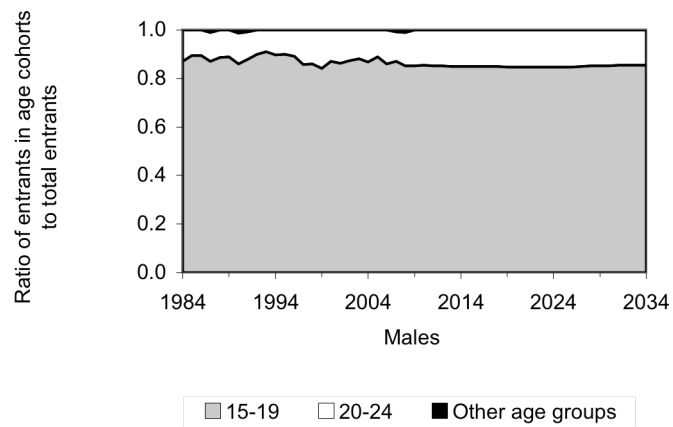
Appendix B: Figures

Figure 1: Total Working Age Population and Annual Percentage Change, Australia 1984 to 2034

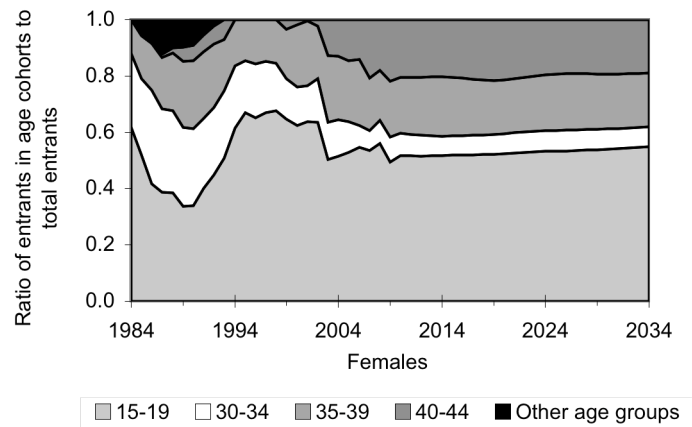


Data sources: Population projections of the Productivity Commission (2005) for 2004 to 34; ABS Australian Population Statistics (cat. no. 3105.0.65.001) for earlier years.

Figure 2: 'Entrants', by Age, by Sex, Australia 1984 to 2034



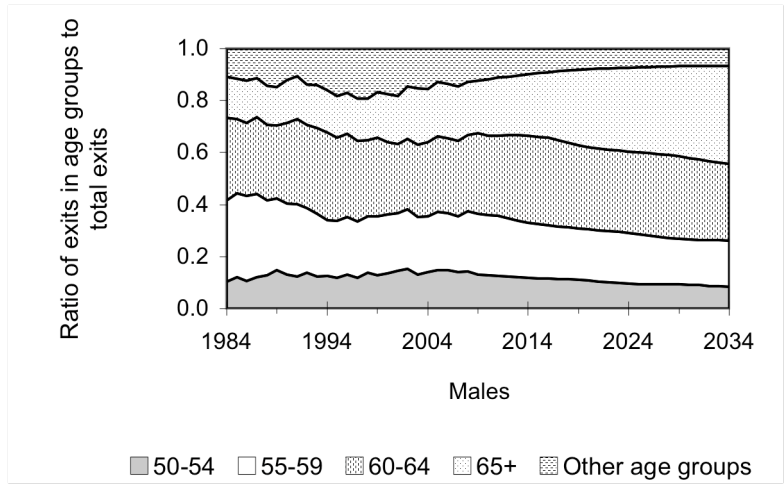
a.



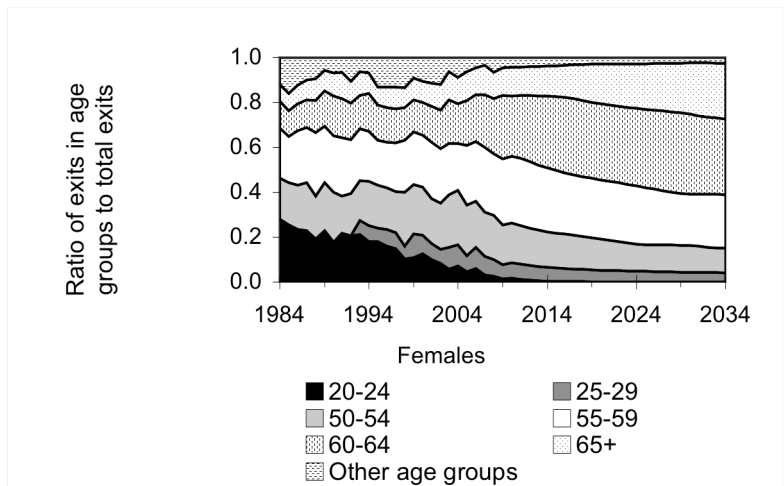
b.

Data sources: predicted from the labour force projections of the Productivity Commission (2005); ABS Labour Force, Australia, Detailed (cat. no. 6291.0.55.001) for earlier years.

Figure 3: 'Exits', by Age, by Sex, Australia 1984 to 2034



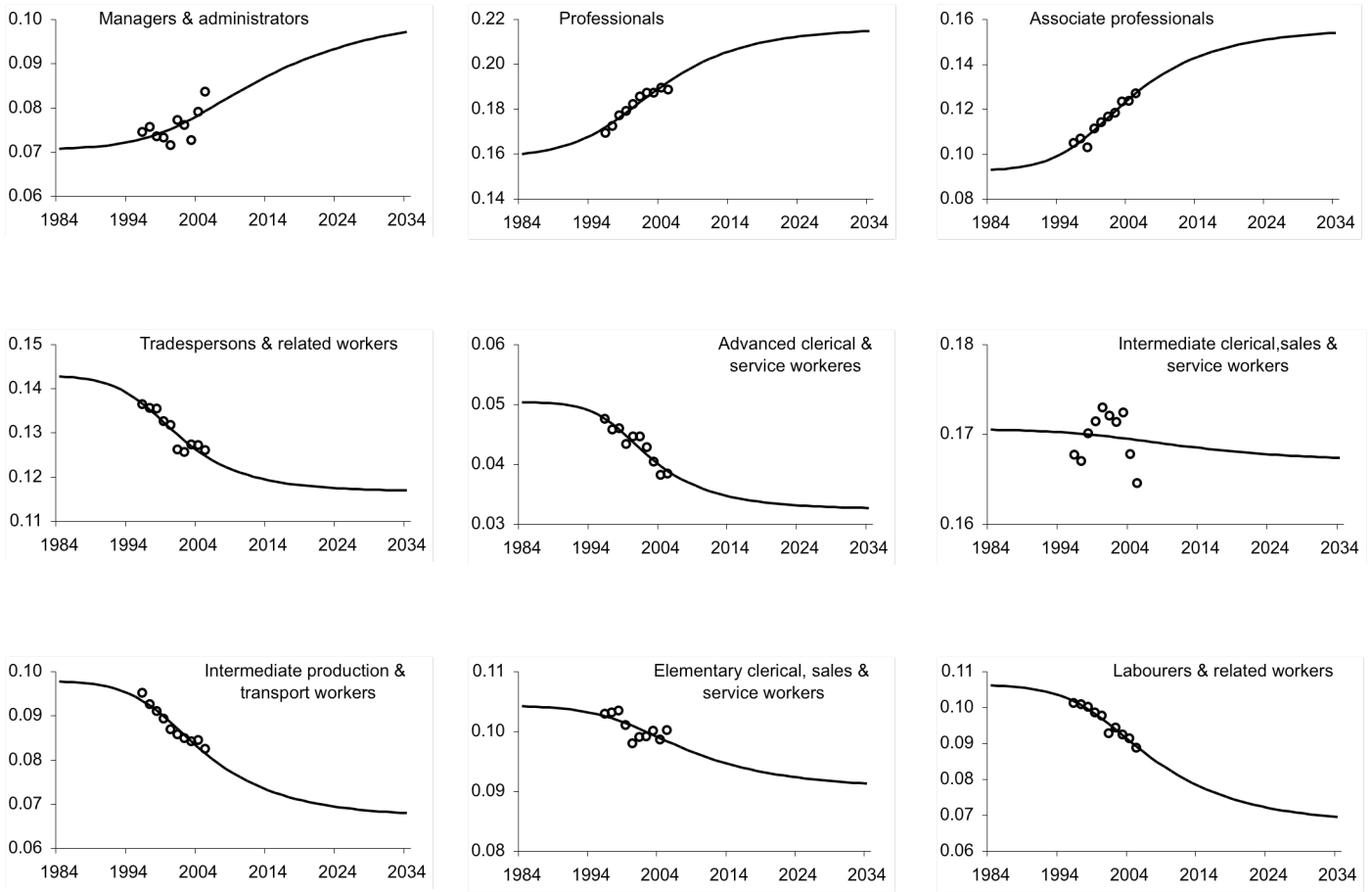
a.



b.

Data sources: predicted from the labour force projections of the Productivity Commission (2005); ABS Labour Force, Australia, Detailed (cat. no. 6291.0.55.001) for earlier years.

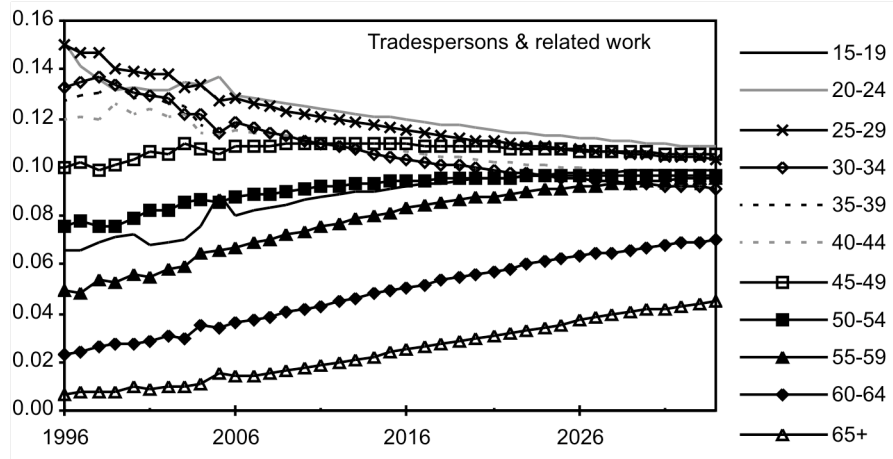
Figure 4: Employment Share, by Occupation, Australia 2006 to 2020



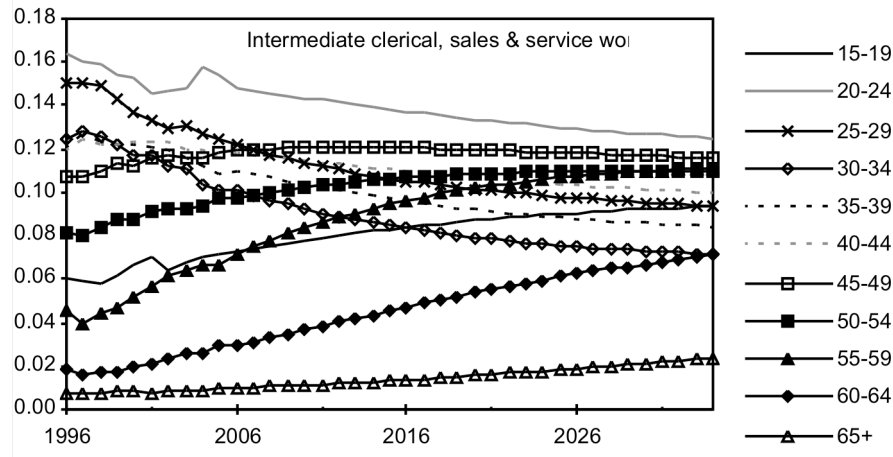
- Predicted employment share
- Measured data that were used to fit the Richards curve to the recent trend

Data sources: Authors' projections; ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube, E07 (cat.no.6291.0.55.001).

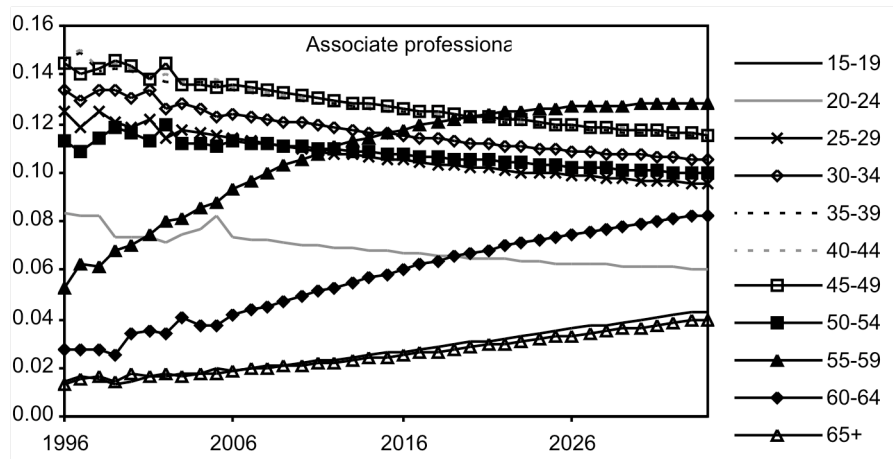
Figure 5: Employment Shares of VET-related Occupations, by Age Group



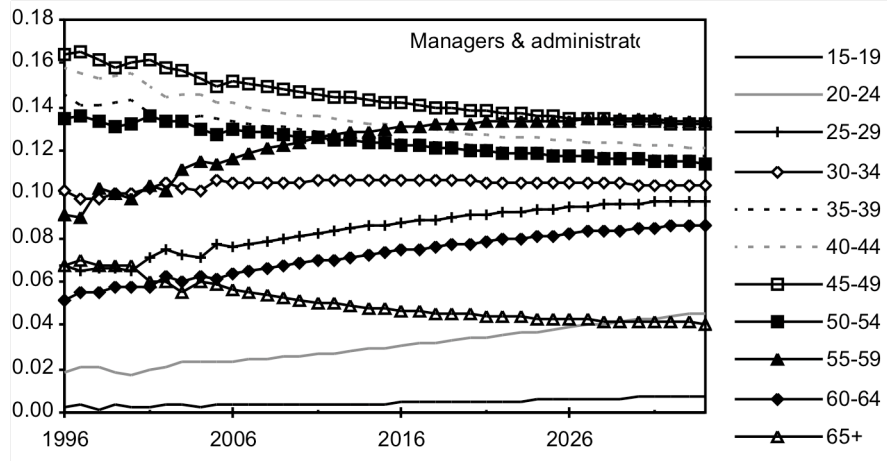
a.



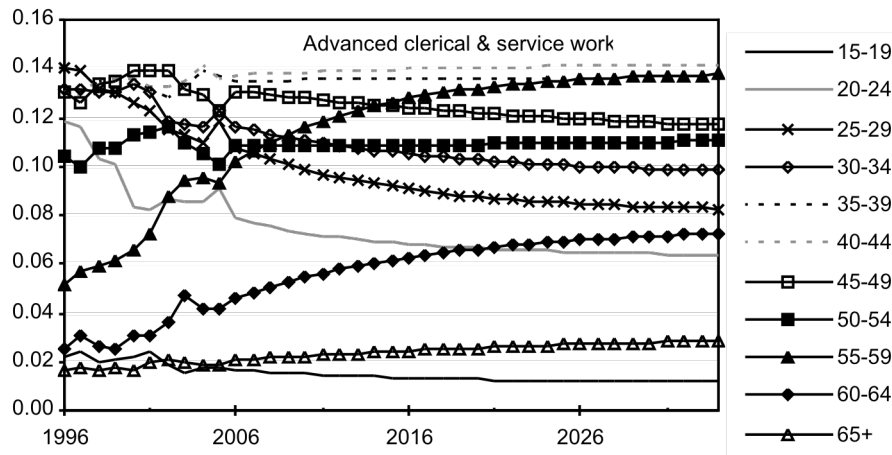
b.



c.



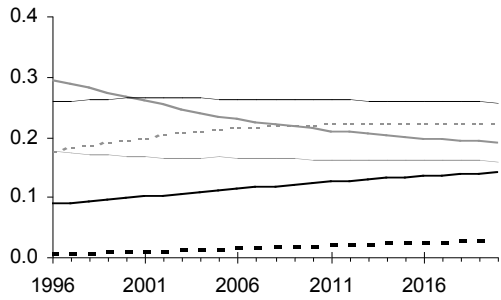
d.



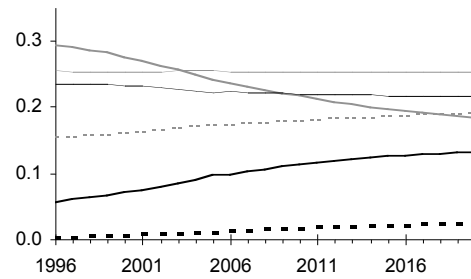
e.

Data sources: Authors' projections; ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube, E07 (cat.no.6291.0.55.001).

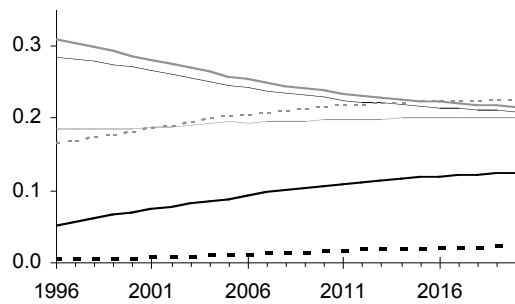
Figure 6: Employment Share, by Age Group: 2-digit Occupations within 'Tradespersons and Related Workers'



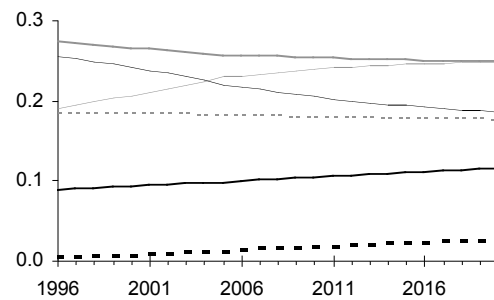
a. Mechanical & fabrication engineering tradespersons



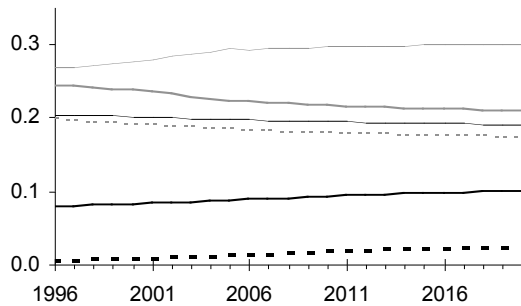
b. Automotive tradespersons



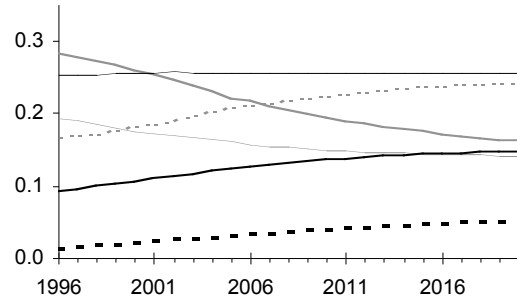
c. Electrical & electronics tradespersons



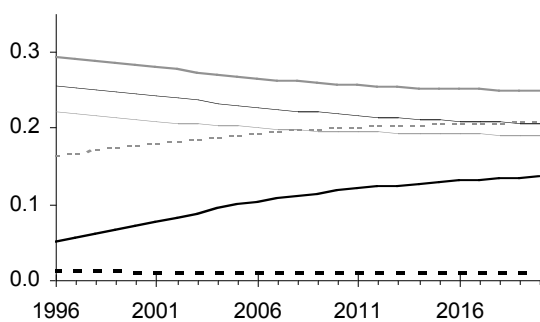
d. Construction tradespersons



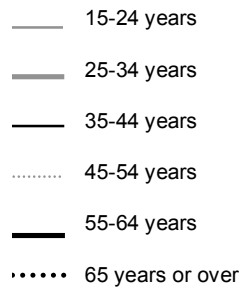
e. Food tradespersons



f. Skilled agricultural & horticultural workers



g. Other tradespersons & related workers



Data sources: Authors' projections; 1996-2005 data are derived from ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube, E07 (cat.no.6291.0.55.001).

Appendix C:

Projected VET-related occupational employment

Table 1: Employed Persons: VET-related Occupations

	Managers & administrators	Associate professionals	Tradespersons & related workers	Advanced clerical & service workers	Intermediate clerical, sales & service workers	Total
1996	622500	874850	1139600	397050	1400050	4434050
1998	630775	882825	1161225	394375	1458250	4527450
2000	640900	1021600	1179325	399925	1548725	4790475
2002	704150	1094800	1161675	396550	1584975	4942150
2004	761575	1191150	1225950	368650	1616650	5163975
2006	791624	1278821	1224208	377060	1672874	5344587
2008	833314	1359914	1243241	375283	1718982	5530734
2010	873908	1433797	1262154	374747	1761112	5705719
2012	912472	1499804	1280347	375099	1798935	5866655
2014	947384	1556285	1295995	375636	1830429	6005728
2016	979796	1606048	1310924	376734	1858683	6132185
2018	1008144	1647291	1323069	377660	1881218	6237383
2020	1033933	1683125	1334345	378849	1901147	6331399

Data sources: Authors' projections; 1996-2005 data are derived from ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube, E07 (cat.no.6291.0.55.001).

Table 2: Employed Persons: 'University' or 'No Post-school' Occupations

	Professionals	Intermediate production & transport workers	Elementary Clerical, Sales & Service Workers	Labourers & related workers	Sub-total	Total: 9 1-digit occupations
1996	1414100	794700	858950	845200	3912950	8347000
1998	1518600	780950	886900	858450	4044900	8572350
2000	1631850	777425	877275	874275	4160825	8951300
2002	1731175	785000	917500	872225	4305900	9248050
2004	1826925	814175	950175	881050	4472325	9636300
2006	1918083	793341	967241	866232	4544897	9889484
2008	2010822	793188	985162	862233	4651404	10182138
2010	2095750	793532	1001235	857835	4748352	10454071
2012	2171925	794345	1015477	853469	4835216	10701872
2014	2236788	794667	1026874	848457	4906786	10912515
2016	2294163	795654	1037187	844271	4971275	11103460
2018	2341274	795999	1045006	839673	5021951	11259334
2020	2382291	796791	1052019	835897	5066998	11398397

Data sources: Authors' projections; 1996-2005 data are derived from ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube, E07 (cat.no.6291.0.55.001).

Table 3: Employed Persons, by Age Group: VET-related Occupations

	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65+	Total	Total employment
	%	%	%	%	%	%	%	%	%	%	%	%	(persons)
1996	4.1	12.0	13.2	12.6	13.2	13.1	12.3	9.6	5.5	2.7	1.7	100.0	4434050
1998	4.1	11.4	13.0	12.7	13.2	13.1	12.3	9.7	5.9	2.8	1.8	100.0	4527450
2000	4.5	10.7	12.3	12.2	13.2	13.2	12.5	10.0	6.4	3.1	1.9	100.0	4790475
2002	4.2	10.4	11.9	11.9	12.8	13.0	12.8	10.4	7.3	3.4	2.0	100.0	4942150
2004	4.6	10.8	11.7	11.4	12.5	12.8	12.5	10.2	8.0	3.7	1.9	100.0	5163975
2006	4.7	10.3	11.3	11.2	12.3	12.6	12.6	10.4	8.5	4.0	2.1	100.0	5344587
2008	4.9	10.0	11.1	10.9	12.0	12.5	12.6	10.5	9.0	4.4	2.1	100.0	5530734
2010	5.0	9.8	10.8	10.7	11.8	12.3	12.5	10.6	9.5	4.7	2.2	100.0	5705719
2012	5.1	9.7	10.6	10.5	11.6	12.1	12.5	10.7	10.0	5.0	2.3	100.0	5866655
2014	5.3	9.5	10.5	10.3	11.4	12.0	12.4	10.7	10.3	5.3	2.4	100.0	6005728
2016	5.4	9.4	10.3	10.1	11.2	11.8	12.3	10.7	10.6	5.7	2.5	100.0	6132185
2018	5.5	9.2	10.2	9.9	11.0	11.7	12.2	10.7	10.9	6.0	2.6	100.0	6237383
2020	5.6	9.1	10.1	9.8	10.9	11.6	12.1	10.7	11.1	6.2	2.7	100.0	6331399
% change: 2004-20	1.0	-1.7	-1.6	-1.6	-1.6	-1.2	-0.3	0.5	3.1	2.5	0.8		22.6

Note: * The percentage change for each age group is calculated on the basis of the employed persons in each age group relative to the total employed persons in the five VET or VET-associated occupations over the period 2004 to 2020.

Data sources: Authors' projections; 1996-2005 data are derived from ABS Labour Force, Australia, Detailed – Electronic Delivery, Quarterly, data cube E07 (cat.no.6291.0.55.001).

Table 4: Projected VET Qualifications Employed in VET-related Occupations, by sex

	Tradespersons & Related Workers			Intermediate Clerical, Sales & Service Workers			Associate professionals		
	Male	Female	Sub-total	Male	Female	Sub-total	Male	Female	Sub-total
2004	735315	60492	795808	181198	504198	685396	292070	175447	467517
2006	734270	60406	794677	187500	521733	709233	313567	188360	501928
2008	745686	61346	807032	192668	536113	728781	333451	200305	533756
2010	757030	62279	819309	197390	549252	746642	351567	211187	562755
2012	767942	63176	831118	201629	561048	762678	367752	220909	588662
2014	777328	63949	841276	205159	570871	776030	381602	229229	610830
2016	786282	64685	850967	208326	579683	788009	393803	236558	630362
2018	793567	65285	858851	210852	586711	797563	403916	242633	646549
2020	800330	65841	866171	213086	592926	806012	412703	247911	660614
Increase to 2020	65,015	5,349	70,363	31,888	88,728	120,616	120,633	72,464	193,097
	Managers & Administrators			Advanced Clerical & Service Workers			5 VET or VET-associated occupations		
	Male	Female	Sub-total	Male	Female	Sub-total	Male	Female	Total
2004	191613	39645	231257	15175	143764	158939	1415371	923545	2338917
2006	199173	41209	240382	15521	147043	162564	1450032	958752	2408783
2008	209662	43379	253041	15448	146350	161798	1496915	987492	2484408
2010	219876	45492	265368	15426	146141	161567	1541289	1014352	2555641
2012	229578	47500	277078	15440	146279	161719	1582342	1038912	2621254
2014	238362	49317	287679	15462	146488	161950	1617913	1059853	2677766
2016	246517	51004	297521	15508	146916	162424	1650436	1078847	2729283
2018	253649	52480	306129	15546	147277	162823	1677530	1094386	2771916
2020	260138	53822	313960	15595	147741	163336	1701851	1108242	2810092
Increase to 2020	68,525	14,177	82,703	420	3,977	4,397	286,480	184,697	471,177

Data sources: Authors' estimates; ABS CURF data from the Education and Work Survey (2003).

Table 5: Projected VET Qualifications in 2-digit VET or VET-associated Occupations, by Age Group, 2004 to 2020

ASCO code	Occupations	Aged 15-24		Aged 25-34		avg. % growth of VET skills p.a. 2004 to 2020	Net increase by 2020	avg. % growth of VET skills p.a. 2004 to 2020
		2004	Net increase by 2020	2004	Net increase by 2020			
11	Generalist managers	0	0	6855	7802	4.9		
12	Specialist managers	2738	5612	35337	6005	1.0		
13	Farmers & farm managers	887	-146	15977	-11180	-7.2		
31	Science, engineering & related associate professionals	0	3603	26584	-3185	-0.8		
32	Business & administration associate professionals	20157	9576	34748	9137	1.5		
33	Managing supervisors	10892	7170	35327	11868	1.8		
34	Health & welfare associate professionals	2422	-198	16791	-7635	-3.7		
39	Other associate professionals	3243	-1244	15571	-62	0.0		
41	Mechanical & fabrication engineering tradespersons	9584	2549	34823	-5177	-1.0		
42	Automotive tradespersons	13315	-756	29114	-8210	-2.0		
43	Electrical & electronics tradespersons	20088	-3632	38947	-4684	-0.8		
44	Construction tradespersons	13741	15449	41869	10430	1.4		
45	Food tradespersons	3647	1421	4974	2806	2.8		
46	Skilled agricultural & horticultural workers	9021	-4017	10321	-1146	-0.7		
49	Other tradespersons & related workers	11153	11768	46276	-561	-0.1		
51	Secretaries & personal assistants	8940	-4640	3675	3535	4.3		
59	Other advanced clerical & service workers	3871	-214	16047	108	0.0		
61	Intermediate clerical workers	59171	-14784	34746	12450	1.9		
62	Intermediate sales & related workers	3640	1467	13296	4247	1.7		
63	Intermediate service workers	56771	-5177	44762	3295	0.4		
	Total	253181	23807	506040	29844	0.4		

ASCO code	Occupations	Aged 15-24			Aged 25-34		
		Net increase by 2004	avg. % growth of VET skills p.a. 2004 to 2020	2004	Net increase by 2020	avg. % growth of VET skills p.a. 2004 to 2020	2004
11	Generalist managers	16617	2.0	13814	16862	5.1	
12	Specialist managers	39097	1.1	22806	12224	2.7	
13	Farmers & farm managers	11794	-4.7	21392	-13435	-6.0	
31	Science, engineering & related associate professionals	20058	1.3	3325	10927	9.5	
32	Business & administration associate professionals	30152	3.6	13552	31929	7.9	
33	Managing supervisors	39151	0.8	23061	16716	3.5	
34	Health & welfare associate professionals	12229	3.0	2640	5503	7.3	
39	Other associate professionals	7235	-0.2	4480	2396	2.7	
41	Mechanical & fabrication engineering tradespersons	42641	0.0	11038	11156	4.5	
42	Automotive tradespersons	15656	2.4	4909	11445	7.8	
43	Electrical & electronics tradespersons	44296	-1.1	8831	9994	4.8	
44	Construction tradespersons	51048	-0.2	12834	10763	3.9	
45	Food tradespersons	2307	4.4	1829	2613	5.7	
46	Skilled agricultural & horticultural workers	14590	0.2	5421	1734	1.7	
49	Other tradespersons & related workers	25679	0.4	11413	9358	3.8	
51	Secretaries & personal assistants	4551	1.4	2210	1574	3.4	
59	Other advanced clerical & service workers	16106	-0.1	4813	-22	0.0	
61	Intermediate clerical workers	57750	1.0	18300	8684	2.5	
62	Intermediate sales & related workers	8637	1.5	1639	7644	11.4	
63	Intermediate service workers	58888	0.0	17449	15463	4.0	
	Total	518482	0.7	205756	173526	3.9	

Data source: Authors' estimates; Figures for baseline year 2004 were derived from HILDA data in 2004.

Table 6: Occupational Inflows and Outflows, 2005-15 and 2010-2020

ASCO code	Occupations	Age cohort at beginning of period									
		2005-2015									
		15-24	25-34	35-44	45-54	55-64	65+				
11	Generalist managers	13132	11830	2787	9684	-10426	-4637				
12	Specialist managers	33502	17874	8375	-3428	-17271	-1404				
13	Farmers & farm managers	4401	-3731	-7005	-1774	-11776	-4651				
31	Science, engineering & related associate professionals	19037	1230	1750	-7630	-8525	0				
32	Business & administration associate professionals	25134	19666	12096	3764	-16428	-2592				
33	Managing supervisors	33673	5408	1444	-6746	-21638	-4680				
34	Health & welfare associate professionals	6314	7026	1792	-7663	-4091	-237				
39	Other associate professionals	13659	1787	-8919	-200	-3323	-123				
41	Mechanical & fabrication engineering tradespersons	18119	10067	-3000	-18567	-12747	-2083				
42	Automotive tradespersons	8829	-6115	-2756	-6691	-12113	-375				
43	Electrical & electronics tradespersons	19790	-3793	-2368	-14433	-8820	-1886				
44	Construction tradespersons	26691	3227	-6647	-24723	-12455	-2871				
45	Food tradespersons	2582	-153	-5331	-995	-3192	-699				
46	Skilled agricultural & horticultural workers	4918	4661	2279	-3127	-1357	-1593				
49	Other tradespersons & related workers	22469	-15603	-4738	-4432	-12818	-1317				
51	Secretaries & personal assistants	1458	-2219	-4093	-3660	-2907	-257				
59	Other advanced clerical & service workers	12341	1251	-774	-9546	-2935	-217				
61	Intermediate clerical workers	6473	8825	9283	-32380	-17545	-1539				
62	Intermediate sales & related workers	13155	2818	-5693	-633	-6379	0				
63	Intermediate service workers	5052	16298	1051	-13142	-17893	-897				

		2010-2020										
		15-24	25-34	35-44	45-54	55-64	65+					
11	Generalist managers	14657	12220	3264	12013	-13313	-5557					
12	Specialist managers	36489	17646	8421	-2283	-22284	-1537					
13	Farmers & farm managers	3516	-2514	-4420	-904	-9614	-3858					
31	Science, engineering & related associate professionals	19989	732	2984	-7680	-10914	0					
32	Business & administration associate professionals	22697	18313	8480	2589	-25174	-3726					
33	Managing supervisors	32764	3809	-834	-4278	-27253	-4975					
34	Health & welfare associate professionals	6778	7286	3263	-8867	-5442	-363					
39	Other associate professionals	13613	2196	-9580	229	-4557	-206					
41	Mechanical & fabrication engineering tradespersons	17876	13877	-1545	-17658	-13832	-3030					
42	Automotive tradespersons	7896	-2448	-1091	-5798	-13512	-551					
43	Electrical & electronics tradespersons	18858	-1546	1196	-15223	-10822	-2861					
44	Construction tradespersons	26414	2655	-2696	-23203	-12820	-4334					
45	Food tradespersons	2344	10	-5055	-655	-3168	-944					
46	Skilled agricultural & horticultural workers	4820	6012	2555	-4291	-1805	-2340					
49	Other tradespersons & related workers	23512	-14575	-2559	-4224	-15480	-1388					
51	Secretaries & personal assistants	2219	-190	-3403	-2611	-3119	-306					
59	Other advanced clerical & service workers	12496	1752	-1068	-10036	-3688	-200					
61	Intermediate clerical workers	4481	11203	9493	-35879	-21155	-1529					
62	Intermediate sales & related workers	12964	2946	-7106	-886	-7743	0					
63	Intermediate service workers	1348	16836	-218	-17549	-23764	-1160					