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The STEM Labour Market in Australia

Dr Josh Healy
Professor Kostas Mavromaras
Dr Rong Zhu
National Institute of Labour Studies (NILS)
Flinders University

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Defining STEM qualifications and occupations

STEM qualifications are defined for the purposes of this report as those at a Bachelor Degree level or higher in one of the following fields:

- Natural and Physical Sciences (**NPS**) (ASCED code 01);
- Information Technology (**IT**) (ASCED code 02);
- Engineering and Related Technologies (**ERT**) (ASCED code 03).

A person is defined as 'STEM-qualified' if their highest completed qualification is a Bachelor Degree or higher level university qualification in one of these fields. Some figures presented here relate to the combination of these three fields, referred to as 'Total STEM'. The data come from the 2011 Census. The Census (and most other data sources) asks people for their highest qualification, not for all their qualifications. This will generally lead to some under-estimation of the number of persons with a given type of qualification. For instance, a person who completes an undergraduate degree in a STEM field, but then goes on to complete a higher degree in a non-STEM field, would not be counted as 'STEM-qualified' due to this data limitation. It is clear from an examination of the data for people with mathematics or science qualifications that this poses a particular problem with respect to teachers. A high proportion of secondary school teachers has a graduate diploma or masters degree in education. Being 'higher degrees', these displace the bachelor degree and cause many teachers with maths and science degrees to be recorded as being qualified in education rather than STEM. The numbers are likely to be large—perhaps 80,000 or more. The Census data record only 6,483 secondary school teachers as having a Natural or Physical Sciences degree (out of a total of 174,910 NPS graduates who are in the workforce). The figures that follow are therefore under-estimates of the size of the STEM workforce.

STEM occupations are those in which large proportions of STEM-qualified people find employment. These occupations are identified later in this report.

Overview of the STEM-qualified population

We begin with summary information about the demographic characteristics of persons with a STEM qualification in 2011, and provide comparisons of their characteristics with the Australian population with a university degree. We consider differences in sex, age composition and level of qualification.

Table 1 shows a range of summary statistics for the group of persons with a STEM qualification, as defined above, and comparable figures for the whole university-qualified Australian population. The data source is the August 2011 Australian Census of Population and Housing.

Table 1: Selected demographic characteristics of the STEM-qualified population, by field, and the whole Australian tertiary-qualified population in 2011: population aged 15 and over

	NPS	IT	ERT	Total STEM	All fields
Number (000s)	232	161	257	651	3269
Sex (%)					
Male	53	75	86	72	45
Female	47	25	14	28	55
Age (%)					
20-29 years	22	26	20	22	22
30-39 years	27	41	30	32	29
40-49 years	23	21	23	22	22
50-59 years	17	10	17	15	17
60-69 years	11	3	10	8	10
Qualification level (%)					
Bachelor Degree	70	67	78	72	72
Graduate Dip./Cert.	3	7	3	4	9
Postgraduate Degree	28	26	20	24	19

Source: ABS 2011 Census of Population and Housing.

There were 651,000 people with a STEM qualification in August 2011. This number corresponds to 20 per cent of the Australian population with a Bachelor Degree or higher qualification in any field. The STEM-qualified group is thus a significant component of the whole university-qualified Australian population.

The STEM-qualified population is constituted as follows according to the field of education in which the highest qualification was obtained:

- ERT (257,000 persons; 40% of the total);
- NPS (232,000; 36%);
- IT (161,000; 25%).

The STEM-qualified population is much more male-dominated than the university-qualified Australian population, with men representing 72 per cent of the former group compared to 45 per cent of the latter group. Of the specific STEM fields, ERT is the most male-dominated (86%) and NPS is the most gender-balanced (53% male).

The STEM-qualified population is slightly younger than the university-qualified Australian population. IT is an especially young field, with 67 per cent of its graduates (in the age range from 20-69 years) being less than 40 years old.

The average qualification level of the STEM-qualified population is somewhat higher than that of the whole university-qualified Australian population. This is largely due to the higher proportion of STEM graduates with Postgraduate Degrees, which are especially common among NPS graduates (28%).

Labour force participation of the STEM-qualified population

We next examine labour force participation patterns among persons with a STEM qualification in 2011. We provide information about employment, unemployment and non-participation rates. We distinguish between men and women, and between persons who are and are not currently studying.

Table 2 provides information about the labour force status of persons with a STEM qualification. The information is shown separately for each STEM field of education, and is also shown separately for all persons, men only, and women only. The data source again is the 2011 Australian Census.

Table 2: Labour force status of the STEM-qualified population, by field and by sex, in 2011: population aged 15 and over

Labour force status (%)	NPS	IT	ERT	Total STEM
All Persons				
Full-time work only	49	67	65	60
Full-time work and study	4	4	4	4
Part-time work only	14	10	8	11
Part-time work and study	4	2	2	3
Other employed	4	3	3	3
Unemployed only	2	3	2	3
Unemployed and study	1	1	1	1
Not in the labour force only	16	7	12	12
Not in the labour force and study	6	3	3	4
Total (excluding status not stated)	100	100	100	100
Males				
Full-time work only	58	74	68	67
Full-time work and study	4	4	4	4
Part-time work only	9	7	7	8
Part-time work and study	3	2	2	2
Other employed	3	3	3	3
Unemployed only	2	3	2	2
Unemployed and study	1	1	1	1
Not in the labour force only	15	4	12	11
Not in the labour force and study	5	2	2	3
Total (excluding status not stated)	100	100	100	100
Females				
Full-time work only	39	49	48	43
Full-time work and study	4	3	4	4
Part-time work only	20	16	15	18
Part-time work and study	6	3	3	5
Other employed	5	4	4	5
Unemployed only	2	4	3	3
Unemployed and study	1	1	1	1
Not in the labour force only	16	16	16	16
Not in the labour force and study	7	4	6	6
Total (excluding status not stated)	100	100	100	100

Source: ABS 2011 Census of Population and Housing.

Employment rates are high among all STEM-qualified people (81%). Of those not working, 3[1] per cent are unemployed (i.e. looking for work) and 16 per cent are outside the labour force (i.e. not looking for work). The unemployment rate among STEM-qualified people remains low (just under 4 per cent) when calculated in the normal way to exclude people outside the labour force.

The most common labour force activity of STEM-qualified people is full-time employment. Sixty per cent of all STEM-qualified people work full-time exclusively, and another 4 per cent combine it with study. Some differences in full-time employment patterns are evident across the three major STEM fields of education. NPS graduates are less likely than other STEM graduates to be in full-time work (53% compared to 69% for ERT and 71% for IT). The difference is reflected in higher part-time employment rates, and a higher incidence of labour force non-participation, among NPS graduates.

There are also marked differences in labour force participation patterns between male and female STEM graduates, as shown in the second and third panels of data in Table 2. Part-

[1] This and subsequent figures may not exactly match those in Table 2, which have been rounded.

time employment is much more prevalent among female STEM graduates (22%) than among their male counterparts (10%). Part-time employment is particularly common for female NPS graduates (25%).

Private returns to STEM qualifications

We explain the way in which the private returns to formal qualifications are generally measured. Then we focus on few Australian studies that provide estimates of the private rates of return to university degrees, making the distinction between STEM qualifications and some comparators.

The predominant method for calculating the private returns to education is the calculation of the internal rate of return (IRR), which measures the difference between the cost of and the benefit from completing a qualification. The IRR is the rate of interest that makes the present value of the cost equal to the present value of the benefit. If the return is positive, the investment is worthwhile, and vice versa. The advantage of this method is that it considers both the costs and benefits involved in the decision to study, and allows for the possibility that the returns to a degree may be negative; e.g. for some degrees there may be a surplus of skills.

Intuitively put, the comparison that is made is between two streams of income. First, if person chooses to not study, we take the income that they can expect as a non-graduate for a complete working life. Second, if a person chooses to study we take the income they can expect as a graduate for a shorter working life (the total minus the length of study) minus the cost of the study. The interest rate that sets these two equal is the rate of return of the education in question. Of course, the difference between the two streams of income could be expressed in monetary terms, but the rate of return allows the comparison of human capital investment with other types of investment, and places the calculation in the context of the broader lifecycle investment decisions made by people. The two streams of income will not only depend on the wage (which is higher for graduates), but also on the probability of encountering unemployment (which is lower for graduates, for both labour demand and supply reasons). It is argued that the total returns to education are higher than the private returns, as the social returns (or externalities) are positive.[2] It has also been argued that a calculation which only encompasses the wage associated with a qualification and/or the occupations to which it leads may be too narrow, as jobs have other non-pecuniary attributes that play a role in education decisions.

What should be borne in mind is that rates of return estimates are typically *averages*, so it is not only the *level* of the average return that matters but also the *dispersion* (or riskiness) around that average, which reflects the degree to which individual returns may be expected to differ between people. The dispersion will reveal to prospective students how likely it is that their own outcome will differ substantially from the average. For prospective students with higher risk aversion, this may influence their educational choices in many ways, including in the choice of course and in attitudes towards student loans.

Furthermore, the calculations used to produce IRR estimates will typically make the assumption that surrounding economic circumstances remain unchanged, an assumption that may be hard to sustain in many instances. For example, predicting the wages of a specific set of skills over the lifetime of a prospective graduate requires that we know whether the set of skills this graduate will acquire is going to be in shortage or in surplus for the complete working lifetime of that graduate. It is difficult to make such predictions with any accuracy for the next decade, let alone for the full working life of a new graduate. A crucial

[2] Norton (2012) considers several of these potential public benefits, including reduced reliance on the social welfare system, higher civic engagement, and lower crime rates among graduates.

distinction for making predictions is between specific and transferable skills, and how much these differ by qualification and over time; transferable skills typically do better over time and in changing environments.

Another neglected aspect in the standard rate-of-return methodology is that it does not account for the quality differences between graduate and non-graduate jobs. Historically, it has been assumed that graduate jobs are better jobs, not only because they confer higher wages and lower probability of unemployment, but also because they also offer superior non-pecuniary benefits. In the last decade, and especially since the GFC, these assumptions have not been sustained. Graduate unemployment has been rising, and graduates also find that when they get a job, it may not be of the quality that historic evidence had led them to expect. To complicate matters, there is evidence that some graduate qualifications manage the cyclical and structural change introduced by the GFC better than other graduate qualifications. There appears to be a distinction between 'soft' and 'hard' subjects, which is not always based on robust, long-term evidence, possibly because some of the 'new' degrees do not have a long history on which to judge their performance. This complicates attempts to measure IRR for different qualifications.

A final caveat is that the data used for IRR calculations are based on observed differences between those who did, and those who did not, choose to enrol and complete a university degree. We know that people self-select into university education (based on their ability and intentions); hence, the assumption that these two groups of people may derive the same potential benefit from higher education is likely to overestimate returns to education.
With these caveats in mind, we now consider the differing estimates of IRR in the contemporary Australian labour market.

There are few studies specific to Australian rates of return to university qualifications. Borland (2002) provides a carefully prepared and informative study, which calculates the average rate of return at 14.5 per cent. This is equivalent to a total net monetary gain from having a university degree in Australia of $380,958. Although the data from the study are relatively dated and the study offers little information on specific degrees, it illustrates the robustness of the IRR method, discusses its sensitivity to the various underlying assumptions, and contains much other useful material.

Using more recent data from the 2006 Australian Census, Wei (2010) presents estimates that are similar to Borland for the private rate of return to a bachelor degree in Australia: 15.3 per cent for men, and 17.3 per cent for women. Wei (2010) applies this same methodology to earlier years of Census data and estimates that the average male rate of return has increased slightly from 13.1 per cent in 1981, while the average female rate of return declined slightly from 18.0 per cent in 1981.

The most recent Australian study is by Daly et al. (2011), who provide estimates disaggregated by field of study. Table 3 (below) reproduces two IRR calculations, separately by gender, from the Daly et al. (2011) study. The first two columns present the IRR calculations that assume the study was completed in the permitted minimum number of years, still recognising that some degrees have a longer minimum duration (e.g. the engineering degree calculation is based on 4 years of study). The second two columns present the IRR for those who have spent an additional year to complete their degree. As expected, these rates of return are lower.

The majority of the cases have not studied an additional year, so we focus on the first two columns under IRR. Only selected fields of study are shown in Table 3, so it cannot be generalised. However, it can be useful for comparing STEMs with some of the most prevalent non-STEM qualifications.

Table 3: Internal Rate of Return for Australian Bachelor Degrees

Field of study	IRR		IRR (+ 1 year study)	
	Males	Females	Males	Females
Humanities	3	9	2	7
Education	11	10	9	8
Architecture	9	6	8	5
Science	10	11	8	9
Maths and Statistics	13	12	11	9
IT	17	15	14	12
Engineering	15	14	12	9
Medicine	16	15	14	13
Allied Health	13	14	10	11
Nursing	17	14	11	9
Commerce	17	15	14	10
Law	17	15	14	13
Economics	18	15	15	11
All	**15**	**12**	**12**	**8**

Source: Daly et al. (2011), Tables 2 and 4.

We make the following observations on Table 3:

- The overall estimates are similar to those offered earlier in the literature (e.g. by Borland, 2002 who found an average of 14.5% for all Bachelor degrees), indicating that the private returns have remained high in a period of considerable expansion in higher education.
- Females generally appear to have much lower private returns to higher education, both in STEM and non-STEM subjects. The average male IRR is on par with the results presented by Wei (2010) using 2006 Census data. The average female IRR reported by Daly et al. (2011) is approximately five percentage points lower than that reported by Wei (2010).
- Science shows the lowest returns among the STEMs (10% and 11% for males and females, respectively). Returns to Maths and Stats are higher (13% and 12%), Engineering is higher again (15% and 14%), and at the top comes IT (17% and 15%).
- The ranking of STEMs in terms of IRR is the same for males and females.
- The IRR for Maths and Stats, and for Science, are the lowest among all STEMs
- Engineering follows with an average IRR for men and above average for women. There is considerable diversity within engineering, which is concealed in this calculation. Further detail in the data would be needed to quantify this.
- IT is the best performing STEM according to the calculations of Daly et al. (2011), which accords with intuition, as this is a sector with both high pay and very low unemployment.
- The health-related stream (Medicine, Allied Health and Nursing) appears to have similar, if not somewhat higher, IRR estimates than STEMs.
- The conventional ‘blue-chip’ degrees of Commerce, Law, and Economics do better than all STEM degrees.
- Humanities and Architecture offer considerably lower IRRs than the other fields of study in Table 3, although Education has a similar return to Science.

Key finding: Overall, these rate-of-return estimates suggest that STEM qualifications are among the better degrees available and lead to good labour market outcomes.

Linking STEM qualifications with STEM occupations

There is no one-to-one correspondence between qualifications and occupations. We examine what the main occupations are for those who complete a STEM qualification. The correspondence will depend on the detail of the occupational classification we use. We use detailed ABS Census (2011) data to present 2-digit and 4-digit results and we report on the top 8 occupations that employ 75 per cent of all STEM qualifications.

In which occupations do STEM graduates find employment? This question is important in terms of understanding graduate labour market destinations and prospects, but also because it allows us to utilise data on employer demand and skill shortages which are only collected at the occupation (and not the qualification) level. . Recall that teaching will be seriously under-represented in the picture given below, because STEM graduates with a post-graduate teaching qualification will mostly have their field of study recorded as Education, rather than STEM.

The Australian Standard Classification of Occupations (ANZSCO) has various levels of detail at which the linkage between STEM qualifications and STEM occupations can be examined. The sub-major (or 2-digit) level has 51 categories, and the unit-group (or 4-digit) level has 474 categories.[3] We can use these categories to 'map' the occupations of STEM graduates in employment and, thus, to rank the relative importance of each occupation as an employer of persons with STEM qualifications.

We begin by analysing 2-digit occupations. At this level, STEM graduates are quite concentrated in a few key occupations (Table 4). Some 128,000 STEM graduates (25% of all employed STEM graduates) work as 'Design, Engineering, Science and Transport Professionals'. Two-thirds (66%) of all employed STEM graduates work in the first five occupations listed in Table 4; and three-quarters of them work in the first eight occupations listed. Other occupations that employ STEM graduates intensively are 'ICT Professionals' (17%) and 'Specialist Managers' (13%). The latter category suggests that many STEM graduates move into management careers after a period of professional employment in their chosen field.

3 These figures include 'not further defined' cases where broad categories cannot be further disaggregated due to the limited information that is provided by individual respondents.

Table 4: Occupations at sub-major (2-digit) level that employ STEM graduates intensively in 2011

Occupations ranked by importance to STEM	Number employed (000s)	% of all STEM graduates in employment	Cumulative % of STEM graduates in employment
Design, Engineering, Science and Transport Professionals	128	25	25
ICT Professionals	88	17	42
Specialist Managers	65	13	55
Business, Human Resource and Marketing Professionals	32	6	61
Engineering, ICT and Science Technicians	26	5	66
Education Professionals	24	5	70
Office Managers and Program Administrators	13	2	73
Hospitality, Retail and Service Managers	12	2	75
Sales Assistants and Salespersons	10	2	77
Chief Executives, General Managers and Legislators	9	2	79

Source: ABS 2011 Census of Population and Housing.

As well as being important destinations for STEM graduates in general, the top-five occupations listed in Table 4 are also important employers of graduates from each STEM field. Specifically, these occupations take 53 per cent of employed NPS graduates; 72 per cent of employed IT graduates; and 72 per cent of employed ERT graduates.

A similar but more detailed analysis can be carried out using the 4-digit occupational categories. At this level, there is greater diversity in the occupational destinations of STEM graduates, with lower proportions concentrated in any one occupation (see Table 5). The single most important occupation is ‘Software and Applications Programmer’, which contains 8 per cent of employed STEM graduates. Less than one-third (31%) of employed STEM graduates are found in the first 10 occupations ranked in Table 5; and less than one-half (47%) are found in the first 20 occupations shown.

Table 5: Occupations at unit group (4-digit) level that employ STEM graduates intensively in 2011

Occupations ranked by importance to STEM	Number employed (000s)	% of all STEM graduates in employment	Cumulative % of STEM graduates in employment
Software and Applications Programmers	41	8	8
Civil Engineering Professionals	23	4	12
ICT Managers	16	3	15
Engineering Professionals (not further defined)	14	3	18
Industrial, Mechanical and Production Engineers	12	2	21
Medical Laboratory Scientists	12	2	23
ICT Professionals (not further defined)	11	2	25
University Lecturers and Tutors	11	2	27
ICT Support Technicians	11	2	29
Contract, Program and Project Administrators	10	2	31
Engineering Managers	10	2	33
ICT Business and Systems Analysts	9	2	35
Database & Systems Administrators; ICT Security Specialists	9	2	37
Electrical Engineers	8	2	38
Management and Organisation Analysts	8	2	40
Geologists and Geophysicists	8	2	41
Professionals (not further defined)	8	2	43
Secondary School Teachers	8	1	44
Other Specialist Managers	7	1	46
Computer Network Professionals	7	1	47

Source: ABS 2011 Census of Population and Housing.

Comparing Tables 4 and 5 shows that there is significant occupational ‘bunching’ among employed STEM graduates at a broad level, but more diversity in employment at a detailed level within these broad categories.

Key finding: There is significant occupational 'bunching' at a broad level, with eight occupations taking 75 per cent of employed STEM graduates. There is greater occupational diversity at a more detailed level, suggesting that STEM graduates move into jobs that are best suited to their particular qualification.

STEM skill shortages and surpluses

Having defined the core occupations that employ STEM qualifications, we now examine the evidence of skill shortages and skill surpluses in STEM occupations. Shortages and surpluses are best traced by observing the relevant flows in the labour market. Here, we provide evidence of changes between 2007 and 2011 in: (1) the STEM labour market, (2) STEM employers' recruitment experiences, (3) the responses of STEM students, and (4) the experiences of new graduates with STEM qualifications.

Our approach to detecting evidence of current and emerging skills imbalances (shortage or surplus) for STEM skills involves focusing on changes in indicators for different stages of the education-work nexus. We consider changes in students' educational preferences, how graduates from particular fields of study fare in the labour market immediately after graduating, and how the total demand for particular occupations is changing in terms of hours worked, wages, and job vacancies. Our approach – using indicators of change – represents a compelling alternative to workforce planning methods, which attempt to forecast (project) demand and supply changes.[4]

Changes in the STEM labour market

To simplify our analysis and the results, we focus this analysis on the top eight 2-digit occupations (Table 4), which together account for 75 per cent of employed STEM-qualified people. We present our comparisons in Table 6. The last row under each heading reports the national benchmark for all occupations to provide national context.

Total Employed: Growth in the total number of people employed in the Australian economy has been subdued since the GFC. From 2007 to 2011, the total growth across all occupations nationally was 8.1 per cent. The top-eight STEM occupations exceeded the national rate, growing by 11.1 per cent on average. The strongest growth in employment among the STEM occupations was for Design, Engineering, Science and Transport Professionals (24.7%) and for ICT Professionals (13.8%).

Total Hours Worked: Trends in (headcount) employment can be misleading if large numbers of people are hired on a part-time basis or converted from full-time to part-time status during a downturn. It is thus useful also to consider trends in the total volume of hours worked. From 2007 to 2011, there was 6.3 per cent growth in this measure of employment nationally. Again, the key STEM occupations exceeded this rate, expanding their average volume of hours worked by 9.2 per cent. The strongest growth was again for Design, Engineering, Science and Transport Professionals (23.1%) and ICT Professionals (14.3%).

Full-time Mean Weekly Earnings: Average weekly earnings are an important indicator of demand pressures, since shortages of important skills will encourage employers to pay higher rates to recruit workers who possess the skills. Average full-time weekly earnings exceeded the national average level ($1305 in 2011) for all but one of the key STEM occupations (Hospitality, Retail and Service Managers). However, the rate of *growth* in average full-time earnings since 2007 has been slower in most STEM occupations than the national average of 15.9 per cent. The exceptions are Education Professionals (17.5%);

[4] For a more detailed discussion of the underlying methodology, see Healy et al. (2011) and NILS (forthcoming).

Office Managers and Program Administrators (17.4%); and Engineering, ICT and Science Technicians (16.7%).

Table 6: Labour market change for occupations that employ STEM skills most intensively: 2007-11

Occupations ranked by importance to STEM	2007	2008	2009	2010	2011	% Change: 2007-2011
Total Employed (000s)						
Design, Engineering, Science and Transport Professionals	311	341	345	361	388	24.7
ICT Professionals	189	202	208	208	215	13.8
Specialist Managers	586	611	625	651	650	10.9
Business, Human Resource and Marketing Professionals	551	588	565	587	607	10.3
Engineering, ICT and Science Technicians	216	222	221	226	225	4.1
Education Professionals	447	468	455	493	489	9.4
Office Managers and Program Administrators	244	232	237	249	253	3.5
Hospitality, Retail and Service Managers	459	464	466	487	510	11.0
Total of the above STEM occupations	*3004*	*3127*	*3120*	*3261*	*3337*	*11.1*
National Benchmark: All occupations	10549	10836	10920	11215	11400	8.1
Total Hours Worked % Change on Previous Year						
Design, Engineering, Science and Transport Professionals	-0.2	9.4	0.3	5.1	6.7	23.1
ICT Professionals	6.3	6.9	-1.2	2.9	5.1	14.3
Specialist Managers	2.9	3.6	1.6	5.6	-1.9	9.0
Business, Human Resource and Marketing Professionals	5.3	6.3	-4.0	4.4	2.8	9.5
Engineering, ICT and Science Technicians	3.6	3.3	-3.0	3.7	-0.8	2.9
Education Professionals	2.3	3.5	-0.9	6.0	-1.4	7.2
Office Managers and Program Administrators	11.4	-4.2	-0.6	4.9	-0.7	-0.8
Hospitality, Retail and Service Managers	4.7	0.0	-1.5	3.9	4.9	7.4
Total of the above STEM occupations	*4.1*	*3.6*	*-1.0*	*4.8*	*1.6*	*9.2*
National Benchmark: All occupations	3.2	2.5	-1.0	3.4	1.4	6.3
Full-time Mean Weekly Earnings in Main Job ($)						
Design, Engineering, Science and Transport Professionals	1511	1529	1625	1636	1741	15.2
ICT Professionals	1549	1624	1549	1618	1691	9.2
Specialist Managers	1715	1637	1822	1822	1857	8.3
Business, Human Resource and Marketing Professionals	1415	1481	1545	1535	1539	8.8
Engineering, ICT and Science Technicians	1195	1244	1366	1455	1395	16.7
Education Professionals	1203	1243	1294	1306	1413	17.5
Office Managers and Program Administrators	1181	1258	1352	1310	1387	17.4
Hospitality, Retail and Service Managers	1046	1073	1103	1160	1198	14.5
National Benchmark: All occupations	1126	1160	1219	1263	1305	15.9
Proportion of Total Employed Aged 55+ years						
Design, Engineering, Science and Transport Professionals	15	13	15	15	16	
ICT Professionals	6	6	8	9	9	
Specialist Managers	17	17	18	18	18	
Business, Human Resource and Marketing Professionals	14	14	15	14	15	
Engineering, ICT and Science Technicians	13	13	17	15	16	
Education Professionals	18	20	22	21	22	
Office Managers and Program Administrators	15	15	17	18	18	
Hospitality, Retail and Service Managers	18	17	18	19	19	
Average of the above STEM occupations	*15*	*15*	*17*	*17*	*17*	
National Benchmark: All occupations	15	15	16	17	17	

Sources: ABS Labour Force Survey Data Cubes ‘E07_aug96’ and ‘E08_aug96’ for employment, hours worked, and age data (cat. no. 6291.0.55.003); Survey of Employee Earnings, Benefits and Trade Union Membership Data Cube ‘63100TS0002’, Table 6 for mean weekly earnings data (cat. no. 6310.0).

Proportion of Total Employed Aged 55+ years: A final useful indicator of the state of the labour market is the proportion of workers aged 55 years and over, who are nearing retirement. The proportion across all occupations nationally was 17 per cent in 2011, and the same average figure was observed for the key STEM occupations. As indicated earlier, ICT Professionals are considerably younger on average than the whole workforce (9% aged 55 years or older in 2011), while Education Professionals are somewhat older than average (22% aged 55 years or older). The older-worker shares of both these occupations have risen; from 6 and 18 per cent, respectively, in 2007. The STEM workforce is ageing at approximately the same rate as the whole Australian workforce.

Key finding: From 2007-2011, both headcount and total hours of employment of STEM graduates grew more quickly than the national average. Full-time average weekly earnings remained above the national average, but generally grew at a slower rate.

Employers’ STEM recruitment experiences

We focus this analysis on selected occupations that represent large proportions of employed STEM graduates and for which the required data are available.[5]

Two key data sources provide information about employers’ experiences in recruiting STEM skills. Both are indicative of labour market conditions, but have limitations. The first is the DEEWR ‘Survey of Employers who have Recently Advertised’ (SERA). This covers a range of skilled occupations, but relatively few of these use STEM skills intensively. Those that are most relevant to STEM (see Table 5) include Civil Engineer, Electrical Engineer, and Medical Laboratory Scientist.

Table 7 provides evidence from the SERA data about employers’ recent recruitment experiences in these selected STEM occupations.

[5] NILS (forthcoming) discusses the capacities and limitations of the recruitment experience data in detail.

Table 7: Recruitment experiences of employers that use STEM skills intensively: 2007-11

ANZSCO code	Occupation name	2007	2008	2009	2010	2011
Proportion of vacancies unfilled six weeks after advertising (%)						
2332	Civil Engineer	67	69	45	62	60
233512	Mechanical Engineer	66	70	32	49	68
233513	Production or Plant Engineer	58	39	67	13	n/a
234611	Medical Laboratory Scientist	26	38	36	14	18
133211	Engineering Manager	62	54	31	47	50
233311	Electrical Engineer	55	86	44	49	62
234411	Geologist	49	75	41	71	67
241411	Secondary School Teacher	14	16	5	15	13
233611	Mining Engineer (excluding Petroleum)	69	85	46	66	58
233612	Petroleum Engineer	n/a	100	45	66	100
Average number of total applicants per vacancy						
2332	Civil Engineer	5.9	2.9	7.5	14.0	9.4
233512	Mechanical Engineer	11.2	7.3	27.3	27.3	12.5
233513	Production or Plant Engineer	17.2	17.7	15.0	41.0	n/a
234611	Medical Laboratory Scientist	16.3	6.6	6.2	27.0	16.1
133211	Engineering Manager	9.7	8.0	13.9	11.7	14.5
233311	Electrical Engineer	9.3	2.7	14.3	23.3	13.7
234411	Geologist	2.5	2.3	16.2	10.0	12.1
241411	Secondary School Teacher	7.8	6.7	10.8	10.8	9.4
233611	Mining Engineer (excluding Petroleum)	1.6	2.9	5.2	9.5	11.6
233612	Petroleum Engineer	n/a	4.0	10.8	5.1	42.5
Average number of suitable applicants per vacancy						
2332	Civil Engineer	0.9	0.8	1.0	0.9	1.2
233512	Mechanical Engineer	1.6	1.0	3.6	1.6	0.6
233513	Production or Plant Engineer	1.4	1.9	1.5	5.5	n/a
234611	Medical Laboratory Scientist	2.9	1.2	1.9	5.9	3.1
133211	Engineering Manager	1.5	1.3	2.3	1.1	1.4
233311	Electrical Engineer	1.1	0.4	1.7	1.9	1.5
234411	Geologist	0.9	0.5	2.7	0.9	0.5
241411	Secondary School Teacher	2.4	2.7	3.9	2.8	2.4
233611	Mining Engineer (excluding Petroleum)	0.7	0.4	1.2	0.7	0.8
233612	Petroleum Engineer	n/a	0.5	1.7	1.0	0.0

Source: DEEWR Survey of Employers who have Recently Advertised (SERA). Data are shown here only for the occupations that have a close relationship to STEM qualifications, as determined in the preceding Census data analysis. SERA data are not available for some other occupations that use STEM skills intensively.

There is strong suggestive evidence of skill shortages for Engineers. These occupations (including Civil, Mining, Mechanical and Electrical Engineers) generally have low vacancy fill rates and few suitable applicants per vacancy (candidates' 'suitability' is determined by employers).

The evidence from the SERA data for skill shortages in other STEM related occupations is less clear. In the occupation of Medical Laboratory Scientists, for instance, vacancy fill rates and the number of suitable applicants per vacancy are considerably higher than in Engineering. This occupation is not one that DEEWR currently regards as being in national shortage based on its labour market research.

A second source of recruitment data is the Graduate Outlook Survey (GOS) conducted by Graduate Careers Australia, which relates to employers' experiences in hiring new tertiary graduates. Table 8 presents the most relevant GOS data. The GOS cannot be used to derive more precise quantitative estimates, due to the way the data are collected and the small underlying sample sizes.

Table 8: Disciplines areas in which employers report graduate recruitment difficulties (proportion of employers with recruitment difficulties): 2009 to 2011

Discipline area	2009	2010	2011
Resource Engineering; Earth Sciences	26	18	4
Other Engineering	14	15	17
Other Sciences	4	5	3
Accounting	7	12	5
Business and Economics	22	19	12
Information Technology	19	19	30
Health; Social Sciences	12	11	10
Mathematics; Statistics	2	4	3
Other	13	12	12

Source: Graduate Careers Australia, Graduate Outlook Survey (GOS).

The GOS suggests that employers with recruitment difficulties in 2011 were most likely to see IT as the branch of STEM skills creating the greatest recruitment difficulties. Thirty per cent of employers with recruitment difficulties said they were finding it difficult to recruit IT graduates. In contrast, few employers with recruitment difficulties (3%) were finding it difficult to recruit the required numbers of mathematics or statistics graduates in 2011.

Key finding: Data on employers' recruitment experiences suggest difficulties in Engineering, but the evidence is mixed for other occupations that use STEM graduates intensively.

STEM student responses

Data on university entrance scores, and commencements and completions provide further information about the ways that the tertiary education system is responding to a changing labour market for STEM skills.

If there are strong signals of increasing demand for graduates with these skills, we would expect these to be reflected in rising demand for STEM courses, which would in turn exhibit higher numbers of commencements, completions and (subject to certain assumptions) higher Australian Tertiary Admission Rank (ATAR) scores for those courses.

Table 9 presents the average ATAR scores for relevant STEM fields of study over the years 2007 to 2010. The final row shows the national average ATAR for all university courses. Average admission scores for most tertiary STEM courses are above the national average ATAR of 81 in 2011. The entrance scores are particularly high in some NPS courses, such as Mathematical and Physical Sciences, as well as in some Engineering courses, such as Process/Resources and Aerospace. There are signs of increasing competition for university places in Mathematics, Physics and Chemical Sciences, with the average ATARs for entry into each of these courses increasing strongly since 2007. In contrast, the demand for Information Systems courses has been declining relative to the supply of tertiary places, as suggested by a relatively low and (since 2008) falling average ATAR.

Table 9: Average Australian Tertiary Admission Rank (ATAR) of first-year domestic undergraduate students enrolled in STEM courses, by detailed field of education: 2007 to 2010*

Field of Education	2007	2008	2009	2010
Natural and Physical Sciences				
Mathematical Sciences	83	86	87	87
Physics and Astronomy	81	82	82	87
Chemical Sciences	77	79	83	85
Earth Sciences	82	80	82	81
Biological Sciences	81	78	80	80
Information Technology				
Computer Science	78	76	78	79
Information Systems	74	74	72	71
Engineering and Related Technologies				
Manufacturing Engineering and Technology**	90	74	82	75
Process and Resources Engineering	88	87	89	89
Automotive Engineering and Technology**	80	78	79	78
Mechanical and Industrial Engineering and Technology	86	86	87	86
Civil Engineering	87	87	86	85
Geomatic Engineering	78	77	75	77
Electrical and Electronic Engineering and Technology	84	82	83	83
Aerospace Engineering and Technology	89	89	87	88
Maritime Engineering and Technology	72	75	75	80
All Fields of Education (including non-STEM)	**81**	**81**	**81**	**81**

Source: Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE) Higher Education statistics, customised data. Notes: (*) ATARs available only for first-year domestic undergraduate students who completed secondary school. (**) Figures should be interpreted with caution due to low numbers of enrolments in these fields of education.

Table 10 provides information about changes in the number of first-year commencements and final year completions in STEM courses.

Since 2007, the number of STEM domestic undergraduate commencements has increased strongly. Interesting, there was almost no change in commencement numbers during the height of the GFC in 2007-08. In those years, commencements in STEM courses were stable at approximately 34,000 per year. Since then, however, the number has risen rapidly, to almost 45,000 in 2011. Growth has been especially strong in NPS courses, which may help to explain the increase in the average ATAR scores for some of these courses (as shown in Table 9).

The pattern of STEM course completions in Table 10 is perhaps even more instructive. This number declined between 2007 and 2009 and then began to recover. The STEM number of completions in 2011 (22,400) exceeded the number in 2007 for the first time. ERT completions have been the most resilient to the economic downturn, rising year-on-year, in contrast to reductions in numbers for other STEM fields, particularly IT.

Table 10: Domestic undergraduate commencements and completions in STEM fields: 2007-10

Field of education	2007	2008	2009	2010	2011	% Change: 2007-2011
Commencements						
Natural and Physical Sciences	17714	17513	19919	22820	24477	38
Information Technology	5930	5659	6264	6713	7247	22
Engineering and Related Technologies	12093	12326	13200	14186	14689	21
Total STEM	34441	34447	38269	42367	44992	31
Completions						
Natural and Physical Sciences	11651	11640	11355	11970	12662	9
Information Technology	4185	3577	3159	3050	3240	-23
Engineering and Related Technologies	6153	6290	6428	6668	7077	15
Total STEM	21441	20976	20469	21084	22404	4

Source: DIISRTE Higher Education Statistics Data Cube http://www.highereducationstatistics.deewr.gov.au/

Key finding: There are signs of increasing competition for university places in Mathematics, Physics and Chemical Sciences. Entrance scores for Engineering are well above national average and remain high. Annual undergraduate commencements in STEM courses were stable during 2007-08 and have risen rapidly since, to almost 45 thousand. STEM course completions declined between 2007 and 2009 and then began to recover. Engineering completions have been the most resilient, rising since 2007, compared with reductions for other STEM fields, particularly IT.

New entrants to the STEM labour market

Another way of examining the STEM labour market is to consider the experiences of new entrants: those who have recently graduated from relevant university degrees. We use data from the large, national Graduate Destination Survey (GDS). The data are collected four months after graduation. Results are shown in Table 11.

Table 11: Changes in selected labour market outcomes for recent university STEM graduates, four months after completion: 2007 to 2011

Field of education	2007	2008	2009	2010	2011
Full-time Employed as % of All Employed					
Natural and Physical Sciences	92	91	90	89	86
Information Technology	96	95	95	93	94
Engineering and Related Technologies	98	97	96	95	96
Total STEM	96	95	94	93	92
Not Employed as % of Total					
Natural and Physical Sciences	32	27	28	31	31
Information Technology	15	15	17	21	20
Engineering and Related Technologies	12	11	14	18	16
Total STEM	22	20	22	25	25
Mean Full-time Hours Worked Per Week					
Natural and Physical Sciences	40.0	40.0	40.3	38.6	41.8
Information Technology	39.8	39.8	39.8	39.3	39.6
Engineering and Related Technologies	41.8	41.9	42.0	41.5	42.1
Total STEM	40.7	40.8	41.0	40.1	41.2
Mean Full-time Annual Salary ($ 000s)					
Natural and Physical Sciences	47.1	49.5	51.8	53.4	55.3
Information Technology	50.2	53.3	56.8	55.0	58.7
Engineering and Related Technologies	55.0	58.9	62.1	61.6	64.8
Total STEM	51.5	54.7	57.8	58.0	60.9
Education Well-Matched to Job (%)					

Natural and Physical Sciences	n/a	49	44	43	44
Information Technology	n/a	60	59	59	60
Engineering and Related Technologies	n/a	80	79	76	79
Total STEM	n/a	61	58	57	60

Source: Graduate Careers Australia, Graduate Destination Survey (GDS) unit record files

Employment Rates: The overwhelming majority of STEM graduates who find employment after four months are in full-time work (92% in 2011). This proportion has reduced slightly in recent years (from 96% in 2007) but remains very high. The easing in STEM full-time employment rates has been most pronounced for NPS graduates (down from 92% in 2007 to 86% in 2011).

Annual Salaries: Mean annual salaries for STEM graduates in full-time jobs have increased rapidly and consistently since 2007, suggesting continuing or expanding strong demand for these skills. The mean full-time post-graduation salary for STEM graduates was $60,900 in 2011, up from $51,500 in 2007. There are quite noticeable differences in starting salaries across the three STEM sub-fields. ERT graduates have the highest immediate returns on their skills ($64,800) while NPS graduates are less highly remunerated after graduation ($55,300).

Education-Job Match: There are also important differences between the STEM fields in terms of the proportions of graduates who say their first post-graduation job is well matched to their completed educational qualification. On average, 60 per cent of STEM graduates said they were well-matched in 2011. But this average conceals a wide difference between ERT (79%) and NPS (44%) graduates.

Key finding: The labour market experience for Engineering graduates is more favourable than for Natural and Physical Science graduates, in terms of full-time employment rates, annual earnings and the match between education and job. The demand for Engineers appears to be resilient, while the demand for Physical Science graduates is weaker, and has perhaps declined further in recent years.

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