

Deloitte Access Economics

# The economic contribution of international students

Australian Council for  
Private Education and  
Training

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# Glossary

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ABS	Australian Bureau of Statistics
ACPET	Australian Council for Private Education and Training
AEI	Australian Education International
DEEWR	Department of Education, Employment and Workplace Relations
DIAC	Department of Immigration and Citizenship
EBITDA	Earnings before interest, tax, depreciation and amortisation
ELICOS	English Language Intensive Courses for Overseas Students
FTE	Full time equivalent
GDP	Gross Domestic Product
GSM	General Skilled Migration (program)
GSP	Gross State Product
GOS	Gross Operating Surplus
IO	Input Output (table)
NCVER	National Centre for Vocational Education Research
TRA IVS	Tourism Research Australia's International Visitor Survey
VET	Vocational education and training

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## Executive Summary

The international education sector has recently faced a number of challenges such as changes to education visa requirements and the General Skilled Migration program as well as the relative strength of the Australian dollar.

This report provides an estimate of the economic contribution of international students and their visiting friends and relatives for the calendar year 2011 and an overview of developments in global demand for international education, including in Australia, and Australia's role in the world market.

This report updates analysis undertaken in 2009 for the 2007-08 financial year.

### Student activity

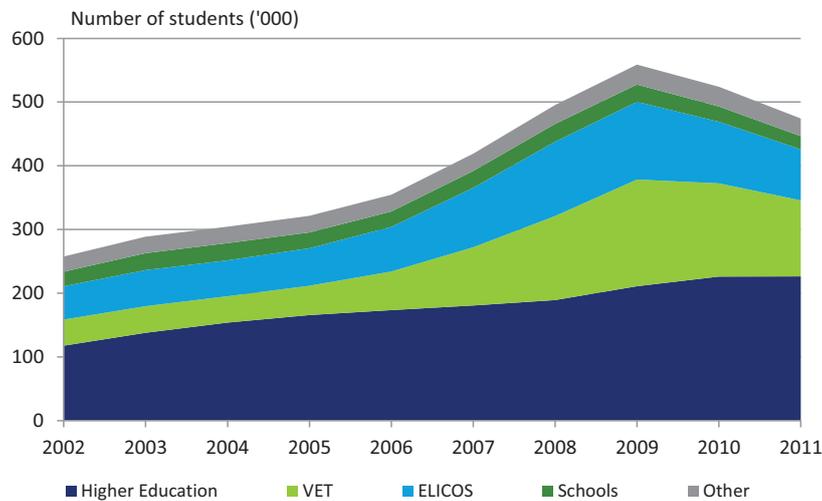
The number of international students in Australia increased at an average annual rate of 8% over the last decade (see Chart i). While the Vocational Education and Training (VET) and English Language Intensive Courses for Overseas Students (ELICOS) sectors grew at the fastest rate, the higher education sector experienced the highest growth in student numbers over this time. Demand for Australian higher education places continued to grow during the global financial crisis, with the sector gaining an additional 15,500 students (or 7%) between 2009 and 2011.

In contrast to the steady growth in higher education, the VET and ELICOS sectors experienced volatility in student numbers. Those markets have declined sharply, by around one third, since 2009. This decline in the VET and ELICOS sectors ensured the international education market, in total, declined by around 7% per annum since 2009.

Changes to migration rules and regulations, the rise of the Australian dollar, the rise of competitor countries and negative reputational factors may have contributed to this downturn in international student demand. The rapid increase and subsequent decline in the VET sector may indicate the sensitivity of demand for this sector to changes in the General Skilled Migration program (occupations eligible for unsponsored skilled migration).

In the calendar year 2011 there were 426,748 international students (554,601 enrolments) studying in Australia. This compares with 468,694 in 2010 (a 9% reduction) and 491,176 in 2009. The previous report was based on the 2007-08 financial year – in the 2008 calendar year there were 434,155 international students and in 2007 there were 370,249 students. Therefore, student numbers in the current analysis (2011 calendar year) were higher than the beginning of the previous study (2007) but lower than the end period (2008).

**Chart i: Number of students, by type of education**



Source: Australian Education International

### Australia in the international market

A high proportion of international students in Australia come from China, accounting for almost 30% of total international student enrolments in 2011. Indian students accounted for a further 10% of enrolments. Other countries in relatively close geographic proximity to Australia like South Korea, Malaysia, Viet Nam, Thailand and Indonesia also provided significant student numbers in Australia.

A further factor posited as having an influence on demand from international students is the unfavourable international media attention regarding the perceived safety of students from India studying in Australia. While there has been a general decline in the number of visa applications over the medium term, the number of applications from Indian nationals halved to about 40,000 in 2011 from a peak of almost 80,000 in 2008-09. This predominantly affected demand for the VET sector.

The latest comparative cross country data on international student numbers is for the year 2009. Since this time, trends in international student numbers in Australia have changed considerably (as explained above). As a result, the exact size of Australia's *current* international education market in comparison to other competitor countries is unclear. However, the 2009 data presented here are included to provide an update on trends in the international education market since the release of our previous report.

Australia's share of the international education market, as defined by UNESCO, remained relatively steady over the period 2006 to 2009, at about 7.6% of the market.

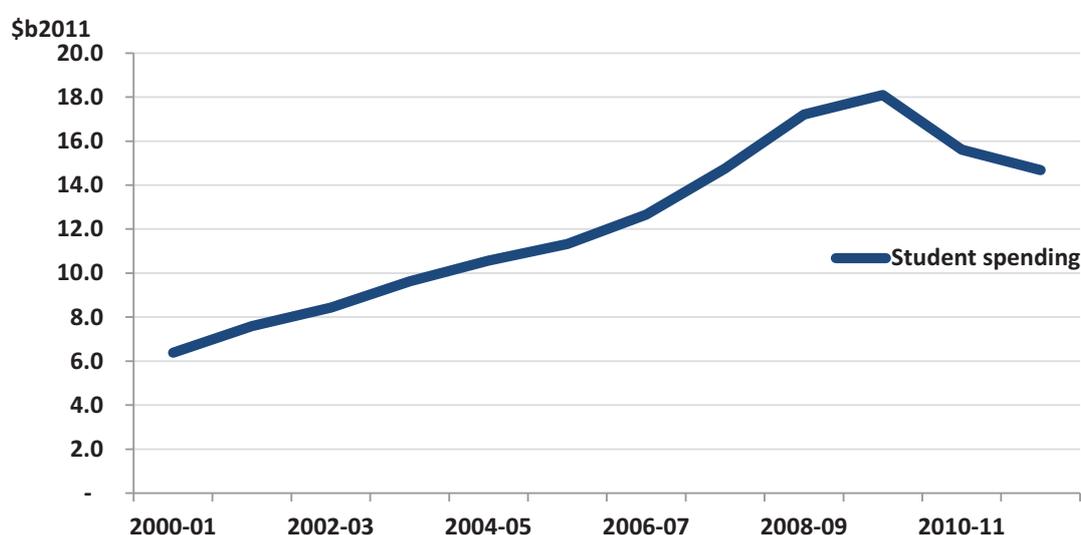
Australia's inbound mobility rate (the share of international students to total students) was 21.5% in 2009; about 1 in 5 tertiary students in Australia in 2009 were from overseas. Compared to the UK, which has a mobility rate of 15.3%, Australia had a higher share of international to domestic students. In contrast, the United States had just over 660,000 international students, but a mobility rate of just 3.5%.

Australia plays a significant role in providing education services to many of our Asian and Pacific neighbours. Of the 510,000 Chinese students that studied abroad in 2009, Australia hosted just over 70,000 or about 15%. Australia was the number one destination for students from Hong Kong, Indonesia, Malaysia and Singapore in 2009.

### Trends in student expenditure

Since the last report, student spending increased from \$14.8 billion in 2007-08 to a peak of \$18.1 billion in 2009-10, see Chart ii. After this point, there has been a downward trend in student expenditure. The 2011-12 financial year reported student expenditure of \$14.7 billion, a reduction of about 19% from the peak.

**Chart ii: Student expenditure, 2000-01 – 2011-12, financial year, \$b2011**



Source: ABS cat. no. 5368.0.55.003

The analysis outlined in this report is based on the 2011 calendar year, to reflect the most recent AEI data. The ABS reports activity for both the calendar and financial years. Student expenditure for the 2011 calendar year was \$15.1 billion, where the 2011-12 financial year activity is reported by the ABS at \$14.7 billion.

### Economic contribution

Since our previous report (covering the modelling period 2007-08), the total economic contribution of international student-related activity grew slightly from \$13,535 million to \$13,935 million in value added in 2011 (in 2011 prices). The increase in the economic contribution has been driven by two opposing factors; a 6.1% increase in the number of students (largely experienced in the higher education sector) and a 4.7% reduction in expenditure per student (in real terms).

In 2011, international students spent \$15,127 million, while their visiting friends and relatives spent an additional \$317 million (see Table ii). On the back of this expenditure, the sector was estimated to have contributed just over 130,000 FTE workers.

It is important to note that not all of this expenditure translates into value added for the Australian economy. Economic contribution estimates typically exclude expenditure incurred on the import component of goods services. Often common student purchases such as textbooks, fuel and electronics have a high degree of international content.

**Table ii: Economic contribution of students and visiting friends and relatives, 2011**

	Students	Visiting friends and relatives	Total 2011	Total 2007-08	% change
Students			426,748	402,202	6.1
Expenditure (\$m)	15,127	317	15,444	15,359	0.6
Expenditure per student (\$)			35,447	37,196	-4.7
Value added (\$m)	13,657	278	13,935	13,535	3.0
Employment (FTE)	126,886	3,227	130,113	126,240	3.1

Source: Deloitte Access Economics estimates

In 2011, Australian GDP was just over \$1,441 billion. As a result international students are estimated to have contributed approximately 0.97% of Australia's GDP.

With value added of just below \$9.0 billion, higher education provides two thirds of the economic contribution (see Table iii), despite accounting for just over half the international students in 2011.

**Table iii: Economic contribution of international students, by student type, 2011**

	Higher education	VET	Schools	ELICOS	Other	Total
<b>Total</b>						
Expenditure (\$m)	9,927	3,110	655	675	760	15,127
Value added (\$m)	8,980	2,785	590	612	690	13,657
Employment (FTE)	82,509	27,060	5,535	5,565	6,217	126,886
<b>Per student</b>						
Number of students	226,420	119,318	20,727	79,997	251,018	426,748
Expenditure (\$)	43,843	26,065	31,601	8,438	3,028	35,447
Value added (\$)	39,660	23,343	28,484	7,646	2,748	32,002

Source: Deloitte Access Economics estimates

Contributing to the size of the higher education sector is the relatively high expenditure per student of about \$43,800 compared to the average of about \$35,400.

In 2011, NSW had the largest number of international student enrolments, with 37% of all Australian enrolments, followed by Victoria and Queensland with 30% and 16% respectively.

Reflecting the high concentration of international student activity, NSW was modelled to have benefitted from the largest proportion of international student economic activity of all the states, with \$4.9 billion in value added and almost 46,000 FTEs in 2011.

**Table iv: State contribution of international students, 2011**

<b>State</b>	<b>Value added (\$m)</b>	<b>Employment (FTE)</b>
NSW	4,916	45,720
Vic	4,092	38,063
Qld	2,175	20,197
SA	840	7,784
WA	1,115	10,342
Tas	143	1,315
NT	34	312
ACT	343	3,154
<b>Australia</b>	<b>13,657</b>	<b>126,886</b>

Source: Deloitte Access Economics estimates

**Deloitte Access Economics**

# 1 Background

The Australian Council for Private Education and Training (ACPET) commissioned Deloitte Access Economics to update the 2009 report *The Australian education sector and the economic contribution of international students*. The purpose of the update is to incorporate the latest information and more recent developments in the higher education sector when assessing the significance of international students to the domestic economy. Ultimately, the updated report will support ACPET's broader advocacy and stakeholder engagement objectives.

The update report includes:

- A profile the higher education sector, drawing out the changing dynamics within post-compulsory education.
- A breakdown of international student expenditure.
- An estimation of the economic contribution of the export education market, both at a national and state level. Including:
  - Direct value added and employment; and
  - Indirect value and employment.
  - Flow-on effects of visiting friends and family.
- A comparison of the economic contribution of international students between 2008 and 2011, identifying the sources driving change.

Since the previous report much of the information has been updated. This includes information provided by Australian Education International (AEI) on the number of international students, enrolments and commencements. The report makes use of the most recent Australian Bureau of Statistics (ABS) input-output table and trade data.

In a change from the data used in the previous report, the ABS now publishes international students' education related expenditure by type of study and disaggregates fees and other goods and services expenditure. As a result, the expenditure breakdown takes into account both the information from the ABS on expenditure and Tourism Research Australia data to breakdown the other expenditure (similar to the previous report).

The report also makes use of the most up to date UNESCO reporting on the international education sector. *The Global Education Digest 2011, Comparing Education Statistics Across the World*, UNESCO Institute for Statistics, provides a snapshot of the education sector as at 2009.

## 2 Australia’s international education sector

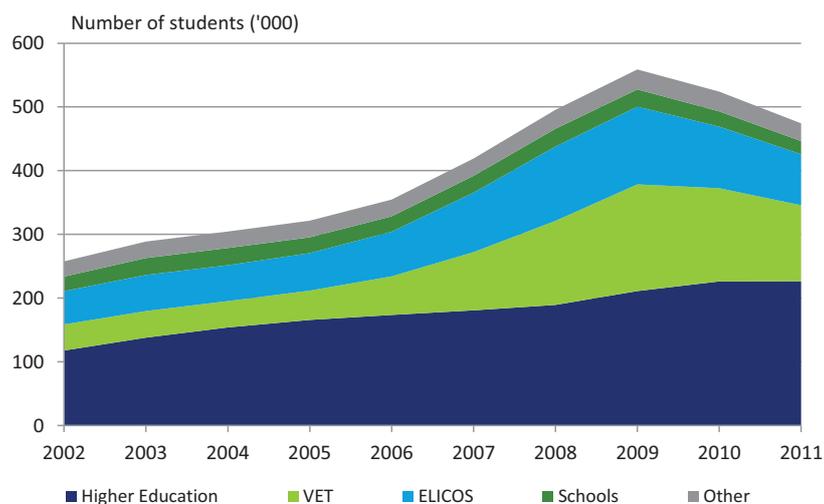
Australia has a sizeable international education sector, both in absolute numbers and relative to the domestic education sector. International students provide an important contribution to Australia, both financially (as provided in Chapter 4) and socially. With international students representing approximately 1 in 5 students studying in Australia (in 2009), it is critical to understand underlying trends in the sector and recent drivers of change.

Going some way to aid this understanding, this chapter provides an overview of Australia’s international education sector, focusing on trends in visa applications through to commencements and total enrolments.

### 2.1 Student Numbers

In the calendar year 2011 there were 426,748 international students studying in Australia (see Chart 2.1). Over the period 2002 to 2009, the number of international students increased sharply, at an average annual rate of 12%. Over this period the largest sector – Higher Education – grew at the industry average, with VET and ELICOS growing at an average annual rate of 24% and 13% respectively. At its peak in 2009 there were just over 491,000 international students in Australia.

**Chart 2.1: Number of students, by type of education**



Source: Australian Education International

Since 2009 there has been a decline in the number of international students studying in Australia. Much of the decline, accounting for about 90,000 students, has come from the

VET and ELICOS sectors. Counter to the wider industry trend, the higher education sector grew from almost 211,000 students in 2009 to about 226,400 in 2011.

Demand for the VET sector is particularly exposed to changes to the rules for the General Skilled Migration program, including addition and subtraction of occupations eligible for unsponsored migration and restrictions on the pathway to permanent residency. The announcement of prospective changes to General Skilled Migration visas in early 2010 generated considerable uncertainty for international students, immediately affecting demand for Australian education places, particularly in the VET sector. Furthermore, the new Skilled Occupation List which came into effect on 1 July 2010 was significantly more limited than the previous Migration Occupation in Demand List.

## 2.2 Student visas

International students must have a valid visa for the duration of their studies in Australia (DIAC 2012). There are eight types of student visas:

- English Language Intensive Course for Overseas Students (ELICOS) visa;
- Schools visa;
- Vocation Education and Training (VET) visa;
- Higher Education (HE) visa;
- Postgraduate Research visa;
- Non Award visa;
- AusAID or Defence visa; and
- Student Guardian visa.

It should be noted that there is no quota on the number of student visas, but applicants must satisfy a number of financial, security and health conditions. In 2011-12, 90.1% of student visa applicants were granted a visa.

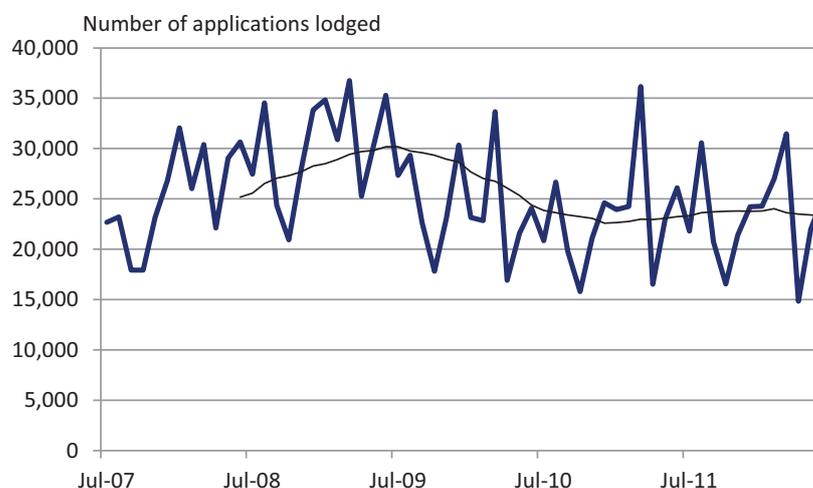
### 2.2.1 Visa applications

At the end of June 2012 there were more than 307,000 student visa holders in Australia, of which, 36% were from China or India.

As illustrated in Chart 2.2, there was a stabilisation in student visa applications lodged in 2011-12 following a sizeable decline over the 2009-10 financial year.

The higher Australian dollar, uncertain economic times, negative perceptions of the Australian education sector and increased competition combined to result in a drop in annual applications of more than 83,000 (or 23%) between 2008-09 and 2010-11.

**Chart 2.2: Number of student visa applications lodged**



Source: Department of Immigration and Citizenship, 2012

## 2.2.2 Applications by provider type (visa subclass)

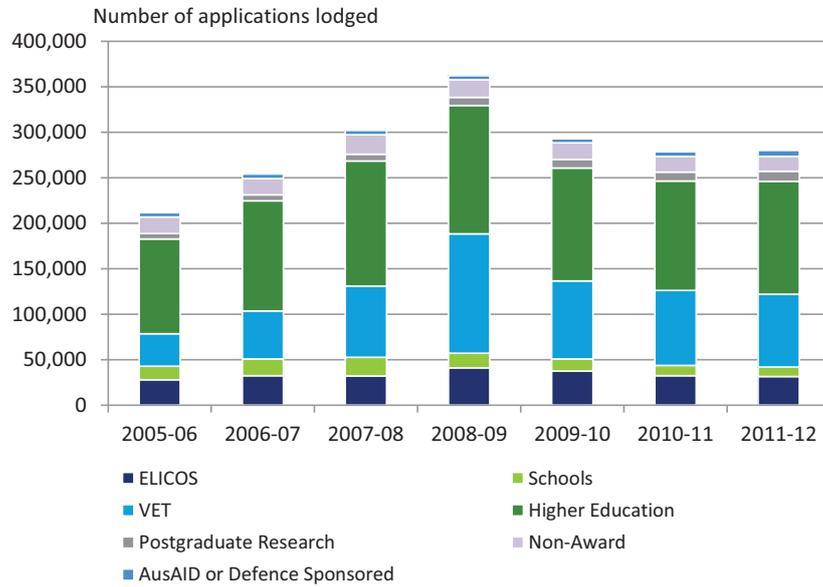
Applications for student visas are dominated by those wanting to study in Australia’s Higher Education and VET sectors – in 2011-12, application lodgements for Higher Education (43%) and VET visas (30%) represented almost three quarters of total student visa applications (see Chart 2.3).

The decline in student visa applications from 2008-09 was most prominent in the VET sector, which, after 150% growth between 2006-07 and 2008-09, declined by 37% between 2008-09 and 2010-11.

A contributing factor to this decline was modifications to the General Skilled Migration program which restricted the transition from international student to permanent resident (DIAC 2012).

A further factor posited as contributing to the decline in student visas in recent years was the international media attention regarding incidents of violence against international students studying in Australia (DIAC 2012). As illustrated below in Chart 2.4, the effect on applications from Indians was substantial – declining by more than half between 2008-09 and 2011-12 from 79,759 applications to 39,048 applications.

**Chart 2.3: Number of student visa applications lodged by visa subclass**

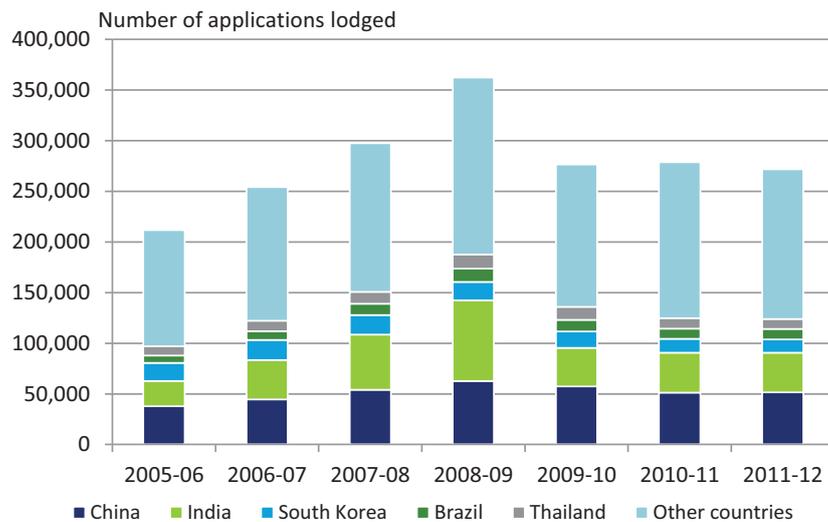


Source: Department of Immigration and Citizenship, 2012

### 2.2.3 Applications by country of citizenship

China is the largest single nation contributor to Australia’s international student population (as illustrated in Chart 2.4). While not as marked as the decline in applications from Indian students, there was a decline in applications from Chinese students of 11,000 between 2008-09 and 2011-12 (about 4% of 280,000 total applications).

**Chart 2.4: Number of student visa applications lodged by citizenship country (top 5 countries)**

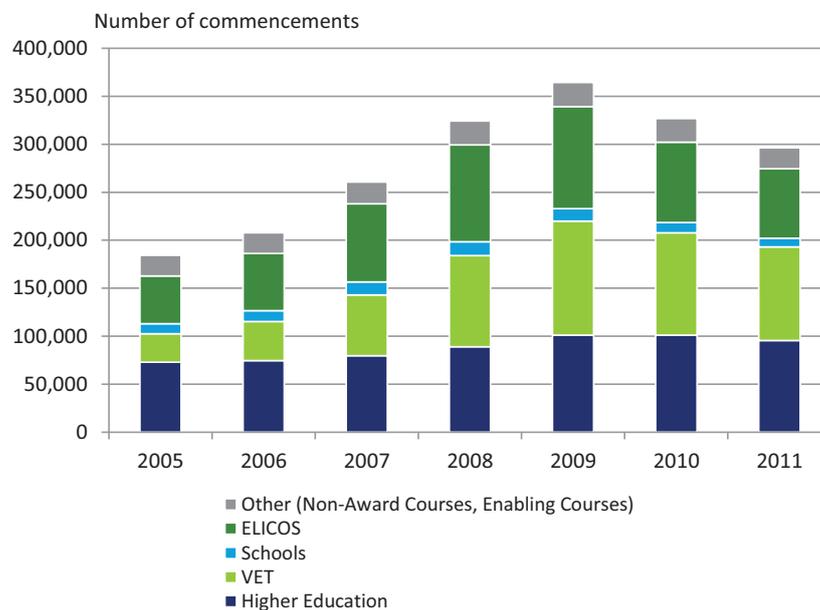


Source: Department of Immigration and Citizenship, 2012

## 2.3 International enrolments and commencements

Trends in student visa applications are paralleled in international student enrolment and commencement trends. In 2011, 296,000 international students commenced at Australian education institutions, down from a high of 364,000 in 2009. The decline was most marked in commencements in VET and ELICOS programs (Chart 2.5). Commencements in schools also experienced a substantial decline, but this was from a very low base.

**Chart 2.5: International commencements by education sector**

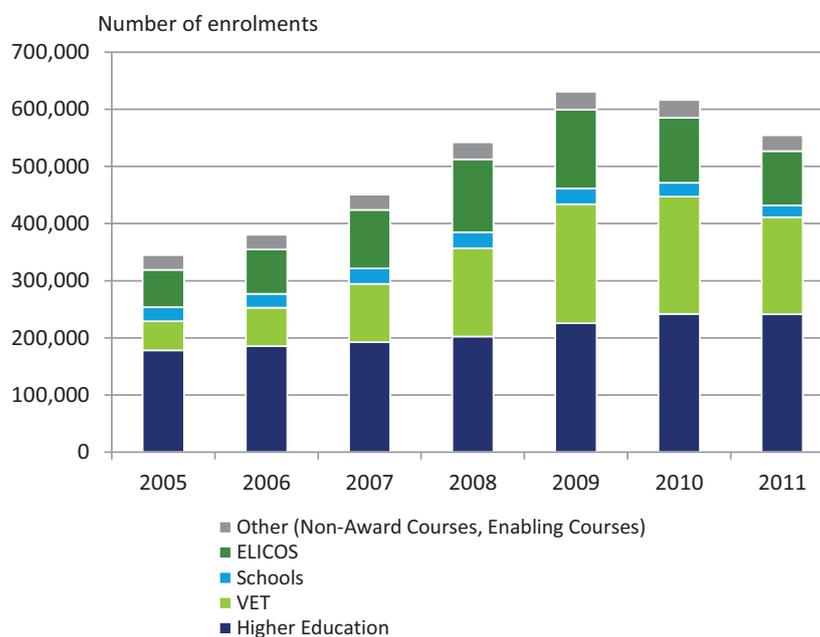


Source: Australian Education International

Note: 'Higher education other' includes non-award courses and enabling courses

2011 saw a continuation in the decline in enrolments by international students. The decline in enrolments is due in some part to the high number of students who commenced in 2009 leaving Australian education institutions following completion of their studies. However, the number of enrolments in 2011 (554,601) was still higher than enrolments in 2008 (542,325).

**Chart 2.6: International enrolments by education sector**



Source: Australian Education International

Note: 'Higher education other' includes non-award courses and enabling courses

### 2.3.2 Enrolments by country of citizenship

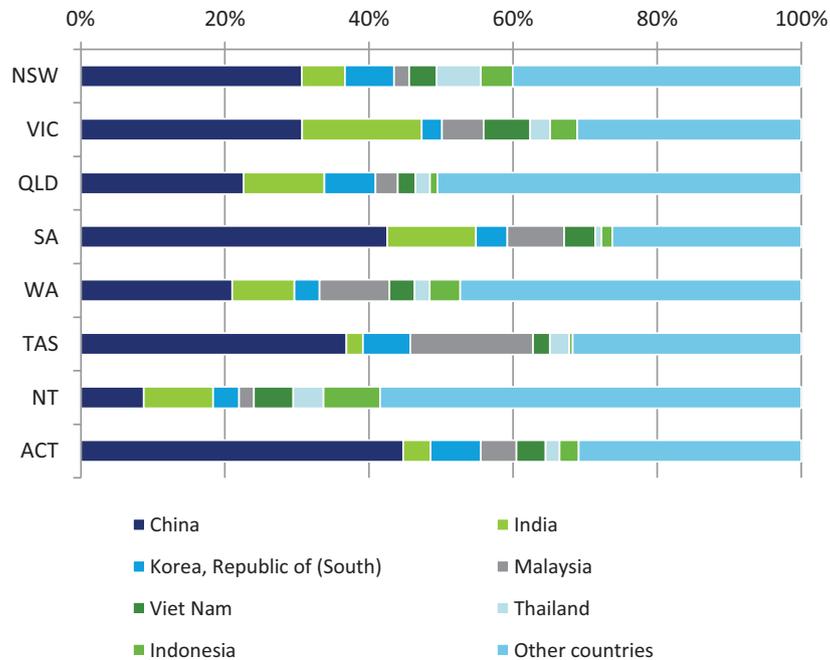
New South Wales had the highest number of international students compared to other states and territories in 2012, with over one third (37%) of international students in Australia choosing to study in New South Wales. Victoria had the second highest proportion (30%) followed by Queensland (16%).

In August 2012, almost half of international students enrolled in the ACT and South Australia were from China; in contrast, less than 10% of international students enrolled in the NT were from China.

Second to China in terms of enrolments, India was a significant source of international students for most states, particularly Victoria (17%), despite the recent declines in enrolments.

Each state's mix of nationalities affected overall trends in international student enrolments. For example, while enrolments from Indian students declined between 2009 and 2012, student enrolments from China increased by 6% between 2009 and 2010 due to increases in the Higher Education sector. States with high dependence on Indian enrolments were more exposed to the downturn in demand for education than states with high enrolments from Chinese students.

**Chart 2.7: Enrolments by nationality by state/territory, August 2012 (top 7 source countries)**



Source: Australian Education International

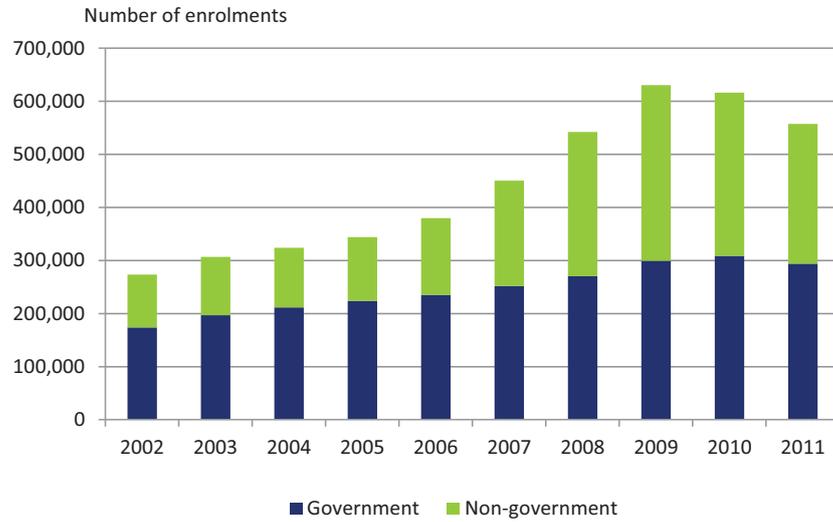
### 2.3.3 Enrolments by provider

The non-government education sector significantly expanded its share of the international education sector between 2006 and 2011, peaking at over 52% in 2009. However, the decline in enrolments from 2009 was more distinct for non-government providers (down 20%) than government providers (down 2%).

The decline in the non-government sector was driven by the same two sectors that caused its rise to prominence in 2006 – the VET sector (down 17%) and the ELICOS sector (down 30%) which together comprised over 83% of total non-government enrolments in 2011.

In contrast, the Higher Education sector comprises the largest share of the government education sector and this sector rose 7.5% over the same period.

**Chart 2.8: Enrolments by provider type, August 2012**



Source: Australian Education International

## 3 International education sector

This chapter provides an overview of recent trends in the global demand for education, providing context for the demand for Australian education.

The latest comparative cross country data on international student numbers is for the year 2009. Since this time, trends in international student numbers in Australia have changed considerably (as explained above). As a result, the exact size of Australia's *current* international education market in comparison to other competitor countries is unclear. However, the 2009 data presented here are included to provide an update on trends in the international education market since the release of our previous report.

### 3.1 Student activity

Demand for international education has grown considerably over the last two decades as prospective students seek to learn at the best higher education institutions, develop global networks and expand their education and cultural horizons more generally. More recently, the sector has not only grown in size, but it has also undergone significant changes in terms of the mix of sending and host nations.

As Table 3.1 shows, over the three years to 2009 the size of the international education sector grew by 22%, with almost 3.4 million students studying abroad in 2009. North America and Western Europe – home to the highest ranked universities – were unsurprisingly the most popular destinations for international tertiary education students. However, the dominance of North America and Western Europe weakened between 2006 and 2009 as other regions increased their share of the global market of places available for international students, notably the Arab States and Central and Eastern Europe.

The rise of the Asian middle class has been a significant factor in the growth of Australia's international education sector. Australia's 7.6% share of the sector belies the small size of the country's economy, particularly in comparison to other popular host countries such as the United Kingdom and the United States. Australia's geographic location and world class universities have proved attractive for Asian students wanting to study abroad.

**Table 3.1: Internationally mobile tertiary\* students by host country**

Host country or territory	2006		2009		Change
	Number	%	Number	%	%
<b>Arab States</b>	<b>80,009</b>	<b>2.9</b>	<b>187,008</b>	<b>5.6</b>	<b>134</b>
<b>Central and Eastern Europe</b>	<b>208,101</b>	<b>7.6</b>	<b>308,877</b>	<b>9.2</b>	<b>48</b>
<b>Central Asia</b>	<b>51,174</b>	<b>1.9</b>	<b>47,168</b>	<b>1.4</b>	<b>-8</b>
<b>East Asia and the Pacific</b>	<b>507,193</b>	<b>18.4</b>	<b>679,055</b>	<b>20.2</b>	<b>34</b>
<i>Australia</i>	207,264	7.5	257,637	7.6	24
<i>Japan</i>	130,124	4.7	131,599	3.9	1
<b>Latin America and the Caribbean</b>	<b>36,803</b>	<b>1.3</b>	<b>80,271</b>	<b>2.4</b>	<b>118</b>
<b>North America and Western Europe</b>	<b>1,798,299</b>	<b>65.3</b>	<b>1,973,680</b>	<b>58.6</b>	<b>10</b>
<i>Canada</i>	75,546	2.7	92,881	2.8	23
<i>France</i>	247,510	9.0	249,143	7.4	1
<i>Germany</i>	259,797	9.4	197,895	5.9	-24
<i>United Kingdom</i>	330,078	12.0	368,968	11.0	12
<i>United States of America</i>	584,814	21.2	680,581	20.2	16
<b>South and West Asia</b>	<b>10,620</b>	<b>0.4</b>	<b>15,358</b>	<b>0.5</b>	<b>45</b>
<b>Sub-Saharan Africa</b>	<b>62,174</b>	<b>2.3</b>	<b>77,825</b>	<b>2.3</b>	<b>25</b>
<i>South Africa</i>	53,738	2.0	60,856	1.8	13
<b>World</b>	<b>2,754,373</b>	<b>100.0</b>	<b>3,369,242</b>	<b>100.0</b>	<b>22</b>

Source: Global Education Digest 2011, Comparing Education Statistics Across the World, UNESCO Institute for Statistics

Note: \* Includes International Standard Classification of Education (ISCED) classifications 5 (first stage of tertiary education) and 6 (second stage of tertiary education) only (Bachelor and postgraduate degrees)

## 3.2 Inbound mobility

The inbound mobility rate – the number of international tertiary students as a proportion of a country's total tertiary student population – highlights the importance of international students to a country's education sector.

Macao's proximity to China, and small domestic population, ensure this country's higher education sector is largely dependent on international students with these students representing almost half of the student population (see Table 3.2).

Consistent with the strong growth in its share of international students in recent years, the United Arab Emirates is another country with a high inbound mobility rate with over 34,000 international students choosing to study at institutions in the UAE.

Australia has both a high number of international students (almost 260,000) and a high number of international students relative to domestic students (approximately 1 international tertiary student for every 5 domestic tertiary students).

While the United Kingdom and United States have higher numbers of international students, they represent only 15.3% and 3.5% (respectively) of the total tertiary education sector. However, these shares have increased in recent years – in 2006 international students represented 14.1% of the United Kingdom’s total student population and 3.3% of the United States’ total student population.

**Table 3.2: Inbound mobility rate for selected countries, 2009**

Host country	Students	Inbound mobility rate (%)
Macao (China)	14,358	49.8
UAE	34,122	39.2
Cyprus	9,846	31.8
Australia	257,637	21.5
Singapore	40,401	20.3
New Zealand	38,351	14.6
United Kingdom	368,968	15.3
United States of America	660,581	3.5

Source: UNESCO Institute for Statistics

### 3.3 Top destinations for education

Many factors affect a student’s choice of study destination including proximity to their own country, quality of the host country’s higher education institutions and ensuing value of the qualification for future career prospects, cost of higher education programs and living expenses, cultural, linguistic and historical ties between host and destination countries, and ease of entry to programs and the country more broadly.

Consistent with Table 3.1, Table 3.3 highlights the dominance of the United Kingdom and the United States in the international education sector. In 2009, over 124,000 Chinese and 100,000 Indian students were studying in the United States, by far the largest contingent of students studying in a foreign country.

Australia’s popularity is highest with countries located in relatively close proximity – Hong Kong, Indonesia, Malaysia and Singapore. China represents the largest number of students studying in Australia with over 70,000 in 2009.

**Table 3.3: Source country and top five destinations, 2009**

Source country	Top five destinations
China	U.S.A. (124,225), Japan (79,394), <b>Australia (70,367)</b> , U.K. (47,033), Rep. of Korea (39,309)
Hong Kong	<b>Australia (12,925)</b> , U.K. (9,600), U.S.A. (8,192), Canada (1,578), China, Macao (387)
Indonesia	<b>Australia (10,205)</b> , U.S.A. (7,386), Malaysia (7,325), Japan (1,788), Germany (1,546)
Japan	U.S.A. (28,783), U.K. (3,871), <b>Australia (2,701)</b> , France (1,847), Germany (1,778)
Malaysia	<b>Australia (19,970)</b> , U.K. (12,697), U.S.A. (5,844), Russian Fed. (2,516), Japan (2,147)
Republic of Korea	U.S.A. (73,832), Japan (24,850), <b>Australia (6,796)</b> , U.K. (4,277), Germany (4,105)
Singapore	<b>Australia (10,394)</b> , U.S.A. (3,923), U.K. (3,188), Malaysia (606), Canada (355)
Thailand	U.S.A. (8,592), U.K. (4,674), <b>Australia (4,377)</b> , Japan (2,193), Malaysia (976)
Viet Nam	U.S.A. (12,612), <b>Australia (7,648)</b> , France (5,803), Russian Fed. (3,518), Japan (2,895)
United Kingdom	U.S.A. (8,558), France (2,580), Ireland (2,184), <b>Australia (1,674)</b> , Germany (1,260)
U.S.A.	U.K. (14,343), Canada (8,310), France (3,544), Germany (3,239), <b>Australia (2,972)</b>
Bangladesh	U.K. (3,488), U.S.A. (2,662), <b>Australia (2,380)</b> , Cyprus (2,085), Japan (1,683)
India	U.S.A. (101,563), U.K. (34,065), <b>Australia (26,573)</b> , New Zealand (5,710), Russian Fed. (4,314)
Pakistan	U.K. (9,609), U.S.A. (5,211), <b>Australia (2,844)</b> , Sweden (2,420), Canada (1,342)
Sri Lanka	<b>Australia (4,296)</b> , U.K. (3,553), U.S.A. (2,927), Japan (1,098), Malaysia (892)
Kenya	U.S.A. (5,780), U.K. (2,394), <b>Australia (1,426)</b> , Malaysia (685), India (508)

Source: UNESCO Institute for Statistics

Note: Brackets contain number of tertiary students studying in destination country

Where Table 3.3 provides the top destination countries, Table 3.4 provides the major source regions for international tertiary education students. In 2009, East Asia and the Pacific region represented 60% of all international students studying in Australia, significantly higher than the region's 28% share of total international students.

Between 2006 and 2009, North America and Western Europe's share of international students studying in Australia declined by 4.5 percentage points to 6.5%. For the United Kingdom this is symptomatic of an overall decline in the number of students studying abroad – in 2006, almost 27,000 students from the United Kingdom were studying abroad but by 2009 this had declined to less than 23,000.

Germany was the most popular destination for international students originating from Central and Eastern Europe (although this was down from 2006) while East Asia and the Pacific accounted for almost 42% of international students studying in the United States.

**Table 3.4: International tertiary students by region of source, selected countries and the world, 2009**

Student source region	Country of study (%)					
	Australia	France	Germany	UK	USA	World
Arab States	2.8	28.1	6.2	5.5	3.9	6.9
Central and Eastern Europe	0.7	8.7	32.3	8.0	5.2	11.1
Central Asia	0.1	0.7	3.0	0.7	0.9	3.6
East Asia and the Pacific	60.0	14.8	16.7	25.5	41.7	28.1
Latin America and the Caribbean	1.3	5.6	4.0	2.3	9.8	5.8
North America and Western Europe	6.5	15.3	19.9	32.9	12.0	15.5
South and West Asia	16.4	1.7	4.1	14.8	18.8	9.5
Sub-Saharan Africa	2.8	18.4	4.3	8.3	4.7	7.0
Unspecified	9.3	6.8	9.4	2.1	0.1	12.5

Source: UNESCO Institute for Statistics and Deloitte Access Economics calculations

### 3.4 Skilled migration

The international education sector also contributes to the Australian economy through supplementing the migration of skilled labour. Many students elect to continue to reside in Australia following the completion of their studies. Table 3.5 outlines the number of visas granted to onshore visa holders while in Australia. Between 2008-09 and 2011-12, an average of 18,300 students each year have been granted residency under various visa classes. This compares to an average of 20,700 students each year between 2005-06 and 2007-08.

Amendments have been made to the General Skilled Migration (GSM) program in 2008-09 in response to the global economic crisis and Australia's changed economic circumstances. Effective from 1 January 2009, the changes sought to ensure that the Skilled Migration program is indeed driven by industry requirements and targets critically needed skills.

**Table 3.5: Onshore student visa holders to skilled migrant pathways, 2005-06 to 2011-12**

	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Un-sponsored	15,504	20,288	17,851	9,989	6,977	19,228	17,363
Sponsored	2,392	2,570	3,570	4,717	2,570	7,263	5,256
Total onshore students	17,896	22,858	21,421	14,706	9,547	26,491	22,619
Total skilled migration	97,340	97,940	108,542	114,780	107,868	113,725	125,755

Source: DIAC annual reports and unpublished visa grant data. Un-sponsored includes visa class 880 and 885 (skilled independent overseas student). Sponsored includes visa sub-classes 881 (Australian sponsored overseas student), 882 (designated area) and 886 (skilled sponsored).

## 4 Economic contribution of international students

This chapter provides an overview of the economic contribution of international students to the Australian economy. It begins with an overview of the size and composition of expenditure by international students and then goes on to estimate the direct and flow-on effects of this expenditure.

See Appendix A for the methodology used to estimate the economic contribution.

### Box 1: Two measures of economic activity

There are two measures of economic activity employed in this study – *value added* and *employment*.

**Value added** measures the value of output (i.e. goods and services) generated by the sector's factors of production – in this case, capital and labour. In other words, value added is the value of the sector's output minus the value of the sector's inputs.

Summing value added across all sectors of the economy will provide an estimate of gross domestic product (GDP).

Specifically, value added is the sum of:

**Gross operating surplus (GOS):** the value of operating profit generated by the sector's *capital* inputs.

**Labour income:** the value of output generated by the sector's *labour* inputs (as measured by the income to labour).

Value added also includes **taxes on production less subsidies** provided for production.

**Employment** measures the number of workers employed by the sector rather than the value of the workers' output.

### 4.1 International student expenditure

In 2011, Australia exported \$50.1 billion in services trade, of which, \$15.1 billion (or 30%) was generated by the activity of international students in Australia. This represents both an increase in the absolute size of education exports (up from \$13.7 billion) and share of exports in services trade (26%) from 2008.

This is consistent with the slight rise in international student numbers from 2008 to 2011.

**Table 4.1: Education related expenditure, 2011**

Category of expenditure	\$ m
<b>Travel services</b>	<b>30,483</b>
Business	3,561
Personal	26,922
<i>Education related</i>	<i>15,127</i>
<i>Other</i>	<i>11,795</i>
<b>Other services trade</b>	<b>19,621</b>
<b>Total services trade</b>	<b>50,104</b>

Source: ABS cat no 5368.0.55.003 International Trade in Services by Country, by State and by Detailed Services Category

## 4.2 International student expenditure profile

Estimating the economic contribution of international students requires further information on *how* students spend their money, not just *how much* money they spend while in Australia (the previous section).

As would be expected, education fees represented the largest proportion of student expenditure (47%) followed by food, drink and accommodation which contributes about 33%.

**Table 4.2: International student expenditure, 2011**

Expenditure category	Expenditure (\$m)	Share of expenditure (%)
Organised tours	111	0.7
International airfares bought in Australia	457	3.0
Domestic airfares	83	0.6
Other transport fares	347	2.3
Self-drive cars, rent-a-cars, campervans	35	0.2
Petrol and oil for self-drive cars or other vehicles	136	0.9
Shopping - items for use in Australia	608	4.0
Shopping - items to take home	288	1.9
Food, drink and accommodation	4,928	32.6
Horse racing and gambling	37	0.2
Entertainment	180	1.2
Motor vehicles	323	2.1
Education fees	7,160	47.3
Phone, internet, fax and/or postage	256	1.7
Other(b)	176	1.2
<b>Total (\$m)</b>	<b>15,127</b>	<b>100.0</b>

Source: International Visitor In Australia, Tourism Research Australia; Deloitte Access Economics calculations

Note: Excludes expenditure on package tours and pre-paid international airfares.

## 4.3 Assessing the economic contribution

### 4.3.1 Value added

The total contribution to GDP from international students was estimated to be \$13.7 billion in 2011. Of this, \$9.3 billion was returned to labour in the form of wages and \$4.3 billion to capital owners at GOS.

Assuming an average annual rate of inflation of 2.5%, the value added of international students in 2011 is comparable to the estimated value added of students in 2008 (from the previous report).

**Table 4.3: Economic contribution of international students, 2011**

	\$million
Expenditure	15,127
Labour	9,318
GOS	4,339
<b>Value added</b>	<b>13,657</b>

Source: Deloitte Access Economics estimates

With GDP of \$1,441.0 billion in 2011, the international education sector was estimated to have contributed just under 1% of GDP (refer to Table 4.4). This is marginally lower than the 1.08% share of GDP estimated in the previous report. The lower share suggests the overall Australian economy (as represented by GDP) grew at a slightly faster rate than the international education sector between 2008 and 2011.

**Table 4.4: Value added contribution and GDP, 2011**

Value added (\$m)	13,657
GDP (\$m)	1,441,034
Share (%)	0.95

Source: ABS cat no 5206.0 and Deloitte Access Economics estimates

### 4.3.1.2 Contribution of education

Table 4.5 presents the economic contribution of international students' expenditure on just education (rather than all expenditure). In 2011 international students spent almost \$7,200 million on education fees, contributing almost \$5,400 million in value added.

**Table 4.5: Economic contribution of the education sector, 2011**

	\$million
Expenditure on education (\$m)	7,160
Labour (\$m)	4,582
GOS (\$m)	781
<b>Value added (\$m)</b>	<b>5,363</b>

Source: Deloitte Access Economics estimates

### 4.3.2 Value added multiplier

Of the \$15.1 billion in expenditure by international students in Australia, \$13.7 billion in value added is generated. This implies a value added multiplier of 0.9 (see Table 4.6).

The value added multiplier measures the income flows to Australian (domestic) capital owners and labour from a dollar of expenditure by international students. The estimates suggest that for each \$1 spent by international students in Australia, \$0.90 accrues in value added as either GOS to Australian capital owners or wages to Australian labour.

**Table 4.6: Value added to total expenditure ratio**

Expenditure on all goods and services (\$b)	15.1
Value added (\$b)	13.7
Value added to total expenditure ratio	0.9

Source: Deloitte Access Economics estimates

The flow-on benefits to the wider economy from expenditure by international students can also provide an indication of the performance of the international education sector. As provided in Table 4.7, \$7.1 billion of international student expenditure is spent on education. Using a similar calculation to the value added multiplier above, for each \$1 spent by international students in Australia on education, there is a flow-on effect of \$1.91 in economy wide value added.

**Table 4.7: Value added to education expenditure ratio**

Expenditure on education (\$b)	7.1
Value added (\$b)	13.7
Value added to education expenditure ratio	1.91

Source: Deloitte Access Economics estimates

### 4.3.3 Employment

As presented in Table 4.8 the international education sector is estimated to contribute almost 127,000 full time equivalent employees (FTE) to the Australian economy in 2011.

Of these, almost 38,500 were employed in the education sector and 88,500 were employed in other related sectors. As outlined above, with a high proportion of the expenditure in the retail trade, accommodation and food and beverage sectors, almost 50,000 FTEs are directly employed in those sectors as a result of international student activity.

**Table 4.8: International student employment contribution, 2011**

	FTE Employment
Education	38,486
Other sectors	88,400
<b>Total employment</b>	<b>126,886</b>

Source: Deloitte Access Economics estimates

For every additional \$1 million of international student expenditure, 8.4 FTE positions are added to the economy (see Table 4.9).

**Table 4.9: Flow-on employment effects**

Total expenditure (\$m)	15,127
Total employment (FTE)	126,886
<i>Employment multiplier (FTE per \$m expenditure)</i>	<i>8.4</i>

Source: Deloitte Access Economics estimates

The employment multiplier for 2011 is lower than the multiplier estimated in the previous report for 2008. This is consistent with students spending a higher proportion of their total expenditure in 2011 on education fees than in 2008.

## 4.4 Value added by student type

As outlined above the higher education sector had the most number of students, just over 226,000 in the calendar year 2011. This is followed by VET with almost 120,000 students and ELICOS with almost 80,000 (see Table 4.10).

Also the modelling suggests university students spend more at about \$43,800 compared to the average of \$35,500.

With value added of just below \$9.0 billion higher education provides two thirds of the economic contribution (see Table iii), despite accounting for just over half the international students in 2011.

**Table 4.10: Economic contribution of international students, by student type, 2011**

	Higher education	VET	Schools	ELICOS	Other	Total
	<b>Total</b>					
Expenditure (\$m)	9,927	3,110	655	675	760	15,127
Value added (\$m)	8,980	2,785	590	612	690	13,657
Employment (FTE)	82,509	27,060	5,535	5,565	6,217	126,886
	<b>Per student</b>					
Number of students	226,420	119,318	20,727	79,997	251,018	426,748
Expenditure	43,843	26,065	31,601	8,438	3,028	35,447
Value added	39,660	23,343	28,484	7,646	2,748	32,002

Source: Deloitte Access Economics estimates

## 4.5 State contribution

At the state level, NSW accrued the largest share of total economic contribution in 2011, with \$4.9 billion in value added and 45,700 FTE. This is consistent with NSW attracting the highest number of international students.

Victoria benefited from the second largest share of total economic contribution, with \$4.1 billion value added and 38,000 FTE.

The state based contributions were based on each jurisdiction's share of total exports in education related travel services (as published by the ABS).

**Table 4.11: State contribution of international students, 2011**

	Value added (\$m)			Employment (FTE)		
	Labour	GOS	Value added	Education	Other	Total
NSW	3,351	1,565	4,916	13,784	31,937	45,720
VIC	2,784	1,303	4,092	11,465	26,597	38,063
QLD	1,491	690	2,175	6,147	14,050	20,197
SA	575	266	840	2,399	5,385	7,784
WA	759	353	1,115	3,167	7,176	10,342
TAS	98	45	143	421	894	1,315
NT	23	11	34	96	215	312
ACT	236	107	343	1,007	2,146	3,154
<b>Australia</b>	<b>9,318</b>	<b>4,339</b>	<b>13,657</b>	<b>38,486</b>	<b>88,400</b>	<b>126,886</b>

Source: Deloitte Access Economics estimates

Note: contributions are weighted by state shares of education related travel services

## 5 Flow-on effects: visiting family and friends

As with the previous report, it has been estimated that for every two ‘formal’ students – where ‘formal’ indicates the student’s main purpose for visiting Australia was education and ‘informal’ indicates the main purpose of visiting was not education, but the student still undertook study while visiting – approximately one friend or relative visited Australia during the student’s stay.

Given total students of 426,748 in 2011, this equates to an estimated 213,374 visiting friends and family. This assumes that all international students recorded in official statistics are classified as ‘formal’ students.

Table 5.1 presents the composition of expenditure by visiting friends and relatives in 2011. Almost half of total expenditure was on food, drink and accommodation, with a further 18% of expenditure on items to take home (souvenirs). In 2011, \$316.6 million was spent by friends and relatives visiting international students in Australia.

**Table 5.1: Expenditure by visiting friends and relatives by expenditure class, 2011**

Expenditure category	Expenditure (\$m)	Share of expenditure
Organised tours	8.6	2.7%
International airfares bought in Australia	6.5	2.0%
Domestic airfares	8.4	2.7%
Other transport fares	11.9	3.8%
Self-drive cars, rent-a-cars, campervans	8.9	2.8%
Petrol and oil for self-drive cars or other vehicles	8.5	2.7%
Shopping - items for use in Australia	24.0	7.6%
Shopping - items to take home	57.9	18.3%
Food, drink and accommodation	145.4	45.9%
Horse racing and gambling	4.0	1.3%
Entertainment	9.1	2.9%
Motor vehicles	10.8	3.4%
Phone, internet, fax and/or postage	4.2	1.3%
Other(b)	8.5	2.7%
<b>Total</b>	<b>316.6</b>	

Source: International Visitor In Australia, Tourism Research Australia; Deloitte Access Economics calculations

Note: Excludes expenditure on package tours and pre-paid international airfares.

In 2011, visiting friends and family contributed \$278 million in value added to the Australian economy. Of this, \$162 million was returned to labour in the form of wages and \$115.4 million in GOS (see Table 5.2).

**Table 5.2: Economic contribution of visiting friends and relatives, 2011**

	<b>\$Million</b>
Expenditure	316.6
Labour	162.6
GOS	115.4
<b>Value added</b>	<b>278.0</b>

Source: Deloitte Access Economics estimates

As outlined in Table 5.3 friends and family visiting international students in Australia contributed an estimated 3,227 FTE positions – 1,309 FTE in the retail sector, 438 in accommodation, cafes and restaurants and 1,479 in other sectors.

**Table 5.3: Visiting friends and relatives employment contribution, 2011**

	<b>FTE</b>
Retail trade	1,309
Accommodation, cafes and restaurants	438
Other sectors	1,479
<b>Total employment (FTE)</b>	<b>3,227</b>

Source: Deloitte Access Economics estimates

By state, NSW accrued the largest share of the contribution from visiting friends and relatives in 2011 with \$102 million in value added and 1,185 FTE positions. Similar to the economic contribution of the students, Victoria accrued the second largest share of the contribution from visiting friends and relatives with \$72 million in value added and 833 FTE positions (see Table 5.4).

**Table 5.4: State contribution of visiting friends and relatives, 2011**

	<b>Value added (\$m)</b>			<b>Employment (FTE)</b>			
	Labour	GOS	Value added	Retail	Accomm.	Other	Total
NSW	60	42	102	481	161	543	1,185
VIC	42	30	72	338	113	382	833
QLD	32	23	55	258	86	291	635
SA	10	7	18	83	28	93	203
WA	13	9	23	107	36	121	264
TAS	2	1	3	13	4	15	33
NT	0	0	1	4	1	4	9
ACT	3	2	5	26	9	29	63
Australia	162.6	115.4	278.0	1,309	438	1,479	3,227

Source: Deloitte Access Economics estimates

Note: contributions are weighted by state shares of education related travel services

## 6 Recent year trends

### 6.1 Students

Since the last report, the economic contribution of students has increased slightly in real terms. This has been driven by a slight increase of 6.1% in the number of students since 2007-08 and a small reduction of 4.7% (in real terms) in the expenditure per student (see Table 6.1).

The relatively large increase in value added compared to expenditure is accounted for by the modelled shift in expenditure to sectors of the economy with higher levels of value added, for example education. This may be a result of the higher proportion of international students in the university sector in 2011. Students in this sector tend to spend more as a proportion on education fees than other students.

**Table 6.1: Student contribution, 2007-08 to 2011 (\$A2011)**

	2011	2007-08	Change (%)
Expenditure (\$m)	15,444	15,359	0.6
Value added (\$m)	13,935	13,535	3.0
Students*	426,748	402,202	6.1
Expenditure per student	35,447	37,196	-4.7

Source: Deloitte Access Economics estimates

\* The number of students for the financial year 2007-08 are modelled to be the average of the number of students for the calendar years 2007 and 2008.

### 6.2 Total education-related expenditure

When the expenditure of visiting friends and relatives is included, the economic contribution has increased slightly in real terms. This has been driven by a slight increase in student contribution and a reduction in the value added associated with visiting friends and relatives, driven mainly by a reduction in the per visitor expenditure bundle (see Table 6.2).

In real terms expenditure has increased to about \$15,440 million in 2011 an increase of 1.9% since 2007-08. The value added has also increased by 3.0% for the reasons outlined above.

**Table 6.2: Student and visiting friend and relatives contribution, 2007-08 to 2011 (\$A2011)**

	2011	2007-08	Change (%)
Expenditure (\$m)	15,443.6	15,152	1.9%
Value added (\$m)	13,934.8	13,535	3.0%

Source: Deloitte Access Economics estimates

While the Australia-wide total contribution, as measured in value added, has grown slightly at 3.0% since 2007-08, this hides some of the movements at the state level. The two

largest states, NSW and Victoria have experienced about a 5% reduction in economic contribution over the modelling period, 2007-08 to 2011. Conversely, off relatively small bases, the two territories have experienced relatively strong growth of over 55% growth in their value added contributions.

**Table 6.3: Total State contribution (value added), 2011, 2007-08 and per cent change**

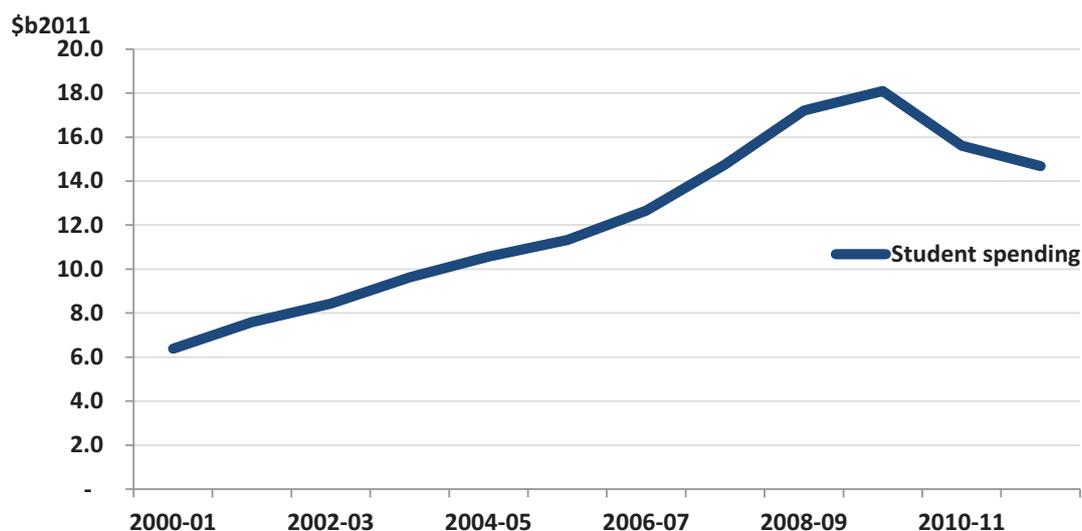
	2011	2007-08	Change (%)
NSW	5,018	5,268	-4.8%
VIC	4,159	4,387	-5.2%
QLD	2,237	1,862	20.1%
SA	858	731	17.4%
WA	1,135	925	22.8%
TAS	145	121	20.2%
NT	34	22	56.4%
ACT	349	219	59.2%
Australia	13,935	13,535	3.0%

Source: Deloitte Access Economics estimates

## 6.3 Trends in student spending (financial years)

Since the last report, student spending increased from \$14.8 billion in 2007-08 to a peak of \$18.1 billion in 2009-10, see Chart 6.1. The 2011-12 financial year reported student expenditure of \$14.7 billion, a reduction of about 19% from the peak.

**Chart 6.1: Student expenditure, 2000-01 – 2011-12, financial year, \$b2011**



Source: ABS cat. no. 5368.0.55.003

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# Appendix A: Methodology

## Contribution – the international education sector approach

The economic contribution study outlined above has quantified measures such as value added, gross output and employment associated with the international educational tourism for the reference year of 2011. The economic contribution is a measure of the value of production by international education to the Australian economy.

### Value added

Value added is the most appropriate measure of an industry's/company's economic contribution to gross domestic product (GDP) at the national level, or gross state product (GSP) at the state level.

The value added of each industry in the value chain can be added without the risk of double counting across industries caused by including the value added by other industries earlier in the production chain.

Other measures, such as total revenue or total exports, may be easier to estimate than value added but they 'double count'. That is, they overstate the contribution of a company to economic activity because they include, for example, the value added by external firms supplying inputs or the value added by other industries.

### Measuring the economic contribution

There are several commonly used measures of economic activity, each of which describes a different aspect of an industry's economic contribution:

- **Value added** measures the value of output (i.e. goods and services) generated by the entity's factors of production (i.e. labour and capital) as measured in the income to those factors of production. The sum of value added across all entities in the economy equals gross domestic product. Given the relationship to GDP, the value added measure can be thought of as the increased contribution to welfare.

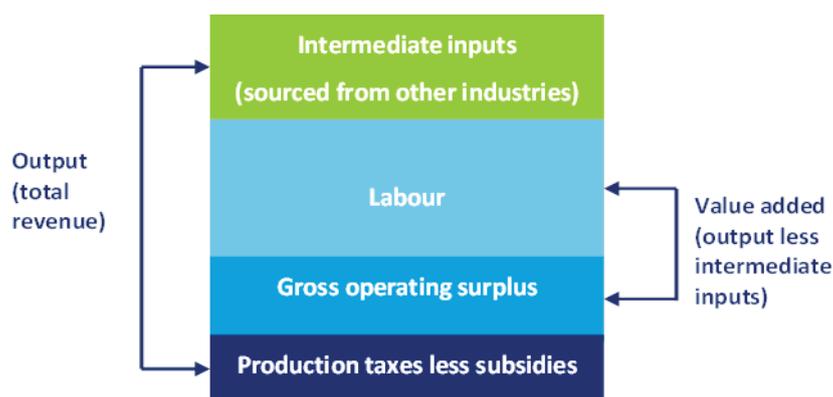
Value added is the sum of:

- Gross operating surplus (GOS). GOS represents the value of income generated by the entity's direct capital inputs, generally measured as the earnings before interest, tax, depreciation and amortisation (EBITDA).
- Tax on production less subsidy provided for production. This generally includes company taxes and taxes on employment. Note: given the returns to capital before tax (EBITDA) are calculated, company tax is not included or this would double count that tax.
- Labour income is a subcomponent of value added. It represents the value of output generated by the entity's direct labour inputs, as measured by the income to labour.

- **Gross output** measures the total value of the goods and services supplied by the entity. This is a broader measure than value added because it is an addition to the value added generated by the entity. It also includes the value of intermediate inputs used by the entity that flow from value added generated by other entities.
- **Employment** is a fundamentally different measure of activity to those above. It measures the number of workers that are employed by the entity, rather than the value of the workers' output.

Figure A.1 shows the accounting framework used to evaluate economic activity, along with the components that make up gross output. Gross output is the sum of value added and the value of intermediate inputs. Value added can be calculated directly by summing the payments to the primary factors of production, labour (i.e. salaries) and capital (i.e. gross operating surplus (GOS), or profit), as well as production taxes less subsidies. The value of intermediate inputs can also be calculated directly by summing up expenses related to non-primary factor inputs.

**Figure A.1: Economic activity accounting framework**



Source: Deloitte Access Economics.

## Direct and indirect contributions

The **direct** economic contribution is a representation of the flow from labour and capital in the company.

The **indirect** contribution is a measure of the demand for goods and services produced in other sectors as a result of demand generated by the international education sector. Estimation of the indirect economic contribution is undertaken in an input-output (IO) framework using Australian Bureau of Statistics input-output tables which report the inputs and outputs of specific sectors of the economy (ABS 2010).

The total economic contribution to the economy is the sum of the direct and indirect economic contributions.

## Limitations of economic contribution studies

While describing the geographic origin of production inputs may be a guide to a firm's linkages with the local economy, it should be recognised that these are the type of normal industry linkages that characterise all economic activities.

Unless there is significant unused capacity in the economy (such as unemployed labour) there is only a weak relationship between a firm's economic contribution as measured by value added (or other static aggregates) and the welfare or living standard of the community. Indeed, the use of labour and capital by demand created from the industry comes at an opportunity cost as it may reduce the amount of resources available to spend on other economic activities.

This is not to say that the economic contribution, including employment, is not important. As stated by the Productivity Commission in the context of Australia's gambling industries:<sup>1</sup>

*Value added, trade and job creation arguments need to be considered in the context of the economy as a whole ... income from trade uses real resources, which could have been employed to generate benefits elsewhere. These arguments do not mean that jobs, trade and activity are unimportant in an economy. To the contrary they are critical to people's well-being. However, any particular industry's contribution to these benefits is much smaller than might at first be thought, because substitute industries could produce similar, though not equal gains.*

In a fundamental sense, economic contribution studies are simply historical accounting exercises. No 'what-if', or counterfactual inferences – such as 'what would happen to living standards if the firm disappeared?' – should be drawn from them.

The analysis – as discussed in the report – relies on a national input-output table modelling framework and there are some limitations to this modelling framework. The analysis assumes that goods and services provided to the sector is produced by factors of production that are located completely within the state or region defined and that income flows do not leak to other states.

The IO framework and the derivation of the multipliers also assume that the relevant economic activity takes place within an unconstrained environment. That is, an increase in economic activity in one area of the economy does not increase prices and subsequently crowd out economic activity in another area of the economy. As a result, the modelled total and indirect contribution can be regarded as an upper-bound estimate of the contribution made by the supply of intermediate inputs.

Similarly the IO framework does not account for further flow-on benefits as captured in a more dynamic modelling environment like the CGE model.

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<sup>1</sup> Productivity Commission (1999), *Australia's Gambling Industries*, Report No. 10, AusInfo, Canberra, (page 4.19).

## **Input-output analysis**

Input-output tables are required to account for the intermediate flows between sectors. These tables measure the direct economic activity of every sector in the economy at the national level. Importantly, these tables allow intermediate inputs to be further broken down by source. These detailed intermediate flows can be used to derive the total change in economic activity associated with a given direct change in activity for a given sector.

The input-output matrix used for Australia is derived from the Australian Bureau of Statistics 2008-09 Input-Output Tables (released in September 2012). The industry classification used for input-output tables is based on ANZSIC, with 111 sectors in the modelling framework.

# Limitation of our work

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