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Foreword

Universities and other higher education institutions can play a key role in human capital development and innovation systems in their cities and regions. Reviews of Higher Education in Regional and City Development are the OECD's vehicle to mobilise higher education for economic, social and cultural development of cities and regions. The reviews analyse how the higher education system impacts local and regional development and help improve this impact. In addition to human capital and skills development, technology transfer and business innovation, the reviews also looks into higher education's contribution to social, cultural and environmental development and regional capacity building. The review process facilitates partnership building in regions by drawing together higher education institutions and public and private agencies to identify strategic goals and work together towards them.

These reviews are part of a wider multi-annum work of higher education in cities and regions coordinated by the OECD Programme on Institutional Management of Higher Education (IMHE). In 2004-07, the OECD/IMHE conducted an extensive study with 14 regional reviews across 12 countries. This resulted in the OECD flagship publication *Higher Education and Regions: Globally Competitive, Locally Engaged* (OECD, 2007) with recommendation to benefit both higher education institutions and national and regional governments. In 2008, the OECD/IMHE launched a second series of OECD Reviews of Higher Education in Regional and City Development to address the demand by national and regional governments for more responsive and active higher education institutions. As a result, 14 regions in 11 countries underwent the OECD review process in 2008-11. The reviews are carried out by the OECD/IMHE in collaboration with international organisations and associations, and other OECD programmes and directorates. This work also supports the OECD Innovation Strategy and OECD Green Growth Strategy.

This OECD review of the Southern Arizona Region in the United States is part of the second round of OECD reviews of *Higher Education in Regional and City Development* and the second review of its kind in the United States. The review was undertaken during the time when tertiary

education in Arizona was at a crossroads due to decreasing state funding and its public good mission was under threat due to the financial cuts.

Acknowledgements

Numerous national and regional stakeholders and representatives of tertiary education institutions provided valuable insights during the review visit and in the form of comments. The review was hosted by the University of Arizona and the OECD would like to thank the leadership of the institutions, especially its former President Robert N. Shelton and the current President Eugene Sander for their contribution. The OECD would also like to thank in particular the lead co-ordinators Francisco Marmolejo and John Paul Jones, with the additional support of Michael Proctor and Jaime P Gutiérrez, and other active local counterparts for this review, as well as Lumina Foundation for Education which generously supported the participation of local higher education institutions in the OECD review.

This publication draws on the second cycle of the OECD reviews in 2008-11, on the interviews carried out during a week-long review visit to Southern Arizona from 4-10 October 2009, on the findings of the Southern Arizona Region's Self-evaluation Report and using additional information provided to the review team. The OECD Review Team had a full and intensive programme and were received openly by a wide range of stakeholders. The team had the benefit of an extensive and reflective Self Evaluation Report which went beyond description to postulating a number of hypotheses about strengths and weaknesses which the team were able to test. The team were also able to rely on a range of other reports; including studies carried out by the National Center for Higher Education Management Systems and the Lumina Foundation and tested their conclusions and recommendations within the higher education sector in the Southern Arizona Region.

This publication was co-ordinated and edited by Jaana Puukka (OECD/IMHE), with support from Ernesto Flores, Oscar Valiente and Austin Delaney. Peer reviewers from Mexico, Spain and the United States participated in the review process and were: Emiliano Duch (The Cluster Competitiveness Group, Spain), Madeleine Green (formerly with the American Council on Education, United States) Salvador Malo (Mexican Competitiveness Institute, Mexico), and Jamil Salmi (World Bank), Further details about the Review Team can be found in Annex 1 of this report.)

Fionnuala Canning and Freya Damrell provided support in the editing phase. Rachel Linden supervised the publication process.

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Acronyms

AA	Associate of Arts
AACC	American Association of Community Colleges
AAEE	Associate of Arts Elementary Education
AAS	Associate of Applied Science
ABOR	Arizona Board of Regents
ABUS	Associate of Business
ACCA	Arizona Community College Association
ACE	American Council on Education
ACT	American Collegiate Test
ACTREC	Arizona Clinical and Translational Research and Education Consortium
AEE	Alliance for Excellent Education
AGEC	Arizona General Education Curriculum
AME	University of Arizona Department of Aerospace and Mechanical Engineering
APLU	Association of Public and Land-Grant Universities
ARRA	American Recovery and Reinvestment Act (Stimulus Bill)
AS	Associate of Science
ASBPPE	Arizona State Board for Private Postsecondary Education
ATF	Articulation Task Force
ATP	Advanced Technology Program
AZ	Arizona
AzCI	Arizona Center for Innovation
AZMET	Arizona Meteorological Network
AzRISE	Arizona Research Institute for Solar Energy
AZUN	Arizona University Networks
BARA	University of Arizona Bureau of Applied Research in Anthropology
Bio-SA	Bio-industry Association of Southern Arizona
BS	Bachelor of Science
CAE-IAE	Center of Academic Excellence in Information Assurance Education

CALS	University of Arizona College of Agriculture and Life Sciences
CC	Cochise College / Community College
CER	Cochise College Center for Economic Research
CHE	The Chronicle of Higher Education
CHEA	Council for Higher Education Accreditation
CLA	Collegiate Learning Assessment
CLAA	Labor Council for Latin American Advancement
CONAHEC	Consortium for North American Higher Education Collaboration
CPSA	Community Partnership of Southern Arizona
EBR	University of Arizona Economic and Business Research Center
ECS	Education Commission of the States
EFRC	Energy Frontier Research Center
FSEOG	Federal Supplemental Educational Opportunity Grants
FT	Full time
FTE	Full-time equivalent
GDP	Gross Domestic Product
GED	General Education Development tests
GIS	Geographic Information Systems
GPA	Grade Point Average
GTEC	Greater Tucson Economic Council
HEA	Higher Education Act
HEFCE	Higher Education Funding Council for England
HEI	Higher Education Institution
HERD	Higher Education Expenditure on Research and Development
HESIN	Higher Education Support for Industry in the North (UK)
HIS	Hispanic-Serving Institutions
IES	University of Arizona Institute for Environment and Society
IMF	International Monetary Fund
IMHE	OECD Programme on Institutional Management in Higher Education
IP	Intellectual property
IPEDS	Integrated Postsecondary Education Data System
IPM	Integrated Pest Management System
IT	Information Technology
KTP	Knowledge Transfer Partnership programme
MA	Metropolitan Area / Master of Arts
MBA	Master of Business Administration
MEP	Manufacturing Extension Partnership Programme
MIS	University of Arizona Department of Management Information Systems
MOHE	Minnesota Office of Higher Education

MS	Master of Science
MSCHE	Middle States Association of Colleges and Schools, Middle States Commission on Higher Education
MSE	University of Arizona Department of Materials Science and Engineering
NASSGAP	National Association of State Student Grant and Aid Programs
NATIVE	Native American Teachers for Indigenous Values in Education
NCA-HLC	North Central Association of College and Schools, Higher Learning Commission
NCEE	National Center on Education and the Economy
NCES	National Center for Education Statistics
NCHEMS	National Center for Higher Education Management Systems
NCPPHE	National Center for Public Policy and Higher Education
NEASC-CIHE	New England Association of Schools and Colleges, Commission on Institutions of Higher Education
NIST	National Institute of Standards and Technology
NSF	National Science Foundation
NWCCU	Northwest Commission on Colleges and Universities
NZ	New Zealand
OALS	Office of Arid Lands Studies
OCBR	University of Arizona Office of Corporate and Business Relations
OCR	Office of Corporate Relations
OECD	Organisation for Economic Co-operation and Development
OED	University of Arizona Office of Economic Development
OEPA	University of Arizona Office of Economic and Policy Analysis
ORCA	University of Arizona Office of Research and Contract Analysis
ORU	Organized Research Unit
OSS	Optical Sciences College
OTT	Office of Technology Transfer
OURP	University of Arizona Office of University Research Parks
PCC	Pima Community College
PT	Part time
PY	Pascua Yaqui
QOL	Quality of Life
RU/VH	Research University with “very high research activity” (Carnegie rank)
SACS	Southern Association of Colleges and Schools
SBIR	Small Business Innovation Research Program
SCNPRC	Southwest Center for Natural Products Research and Commercialization
SHEEO	State Higher Education Executive Officers
SIROW	Southwest Institute for Research on Women

SME	Small and medium-sized enterprise
SSIG	State Student Incentive Grant
STEM	Science, Technology, Engineering and Math
STTR	Small Business Technology Transfer Research Program (US)
SWOT	Strengths, Weaknesses, Opportunities and Threats (analysis)
TLO	Technology Licensing Office
TO	Tohono O'odham
TOCA	Tohono O'odham Community Action
TOCC	Tohono O'odham Community College
TREO	Tucson Regional Economic Opportunities
TRIF	Technology and Research Infrastructure Fund
TTO	Technology Transfer Office
UA	The University of Arizona
UA-S	The University of Arizona-South
UASTP	University of Arizona Science and Technology Park
UILO	University-Industry Liaison Office
UK	United Kingdom
UMC	University Medical Center
UO	University of Oregon
UPX	University of Phoenix
US	United States
USD	US Dollar
USDE	US Department of Education
UW	University of Wisconsin
VPR	University of Arizona Vice-President of Research, Graduate Studies, and Economic Development
WARF	Wisconsin Alumni Research Foundation
WASC-ACCIC	Western Association of Schools and Colleges, Accrediting Commission for Community and Junior Colleges
WASC-ACSCU	Western Association of Schools and Colleges, Accrediting Commission for Senior Colleges and Universities
WRRC	University of Arizona Water Resources Research Center
WWW	World Wide Web

Assessment and recommendations

Southern Arizona region: from a resource-based economy to a knowledge-based economy

Southern Arizona is the southern-most part of the state of Arizona in the United States, bordering the Mexican state of Sonora, with a multi-cultural heritage and a major gateway for trade with Mexico. The vast desert region consists of Pima County, Cochise County and Santa Cruz County, and has a population of approximately 1.2 million, accounting for 18% of the state population. The engine of the region's development is the Tucson metropolitan area, the second largest metropolitan area in the state, just behind the Phoenix metropolitan area. About 23% of the land in Southern Arizona is owned by Native Americans, Tohono O'odham and Pascua Yaqui Nations, who continue to feature low education, labour market and health outcomes.

Population growth is a major strength in the region, an opportunity for many industry sectors, but at the same time it poses cultural, economic and political challenges. Since World War II, Arizona has had one of the fastest growing populations in the United States. Between 1990 and 2000, Arizona experienced a 40.0% population increase which slowed down to 26.7% between 2000 and 2008. In Southern Arizona, the corresponding figures were 26.0% and 18.4%. Arizona has the fastest growing Hispanic population in the US, comprising about 25% of the state population and 27% of that of Southern Arizona. In Tucson, 40% of the residents identify themselves as Hispanic, while in Santa Cruz the majority of population are Hispanic. High birth rates and the fact that Southern Arizona is also a popular retirement destination have resulted in a cultural mix of high-end retirees and young Hispanics who have different social and political needs and expectations. At the same time, there is outmigration to Phoenix and other US cities by a population of young, single and college-graduated demographic.

GDP per capita and average earnings in the state of Arizona consistently lag behind the US averages. The Tucson metropolitan region ranks near the

bottom third of American cities in per capita income, and its ranking has declined in the past few years. While there are growing intraregional disparities in Southern Arizona, poverty rates have increased in all three counties during the past 30 years. Santa Cruz has a particularly low income average and a high poverty rate at 18.6%, compared to the national and state average of 13.3% (2000 figures). Unemployment figures vary by county, Santa Cruz featuring higher levels of unemployment than the US or Southern Arizona as a whole.

The regional economy is largely dependent on the public sector, particularly the education and defence sectors. Strong investments have been made in selected high technology fields, and the Tucson metropolitan region has emerged as a hub of light-based industries. The greatest sources of employment in Arizona are the services, trade and construction sectors, with service jobs accounting for 1 million jobs in 2006. Wholesale and retail trade provided 428 000 jobs, many related to tourism. Despite recent setbacks in total direct spending and employment, tourism continues to play a major role in the regional economy, bringing an estimated USD 12-18 billion annually to the state economy. The tourism and travel industry had the largest share of employment at 11.1%, followed by health care and biotechnology at 7.2%. The greatest job growth – about 30% – is projected in health-related occupations. The region has both large and small companies, the latter generating 80% of all jobs. The defence industry is an important actor, with Raytheon Missile Systems being the largest single employer in Southern Arizona, followed by the University of Arizona and the state government of Arizona.

The major challenge for Southern Arizona is to expand the economic base in order to move to a high-wage, knowledge-based economy. For this to happen a more inclusive and effective human capital development and innovation system needs to be developed against a backdrop of growing demands and constantly decreasing state public expenditure on education. Expenditure per student in Arizona is considerably lower than the national average for the last number of years and Arizona lags behind the US average in the educational attainment of young people: 31.8% of adults aged 25-34 in Southern Arizona have an associate or higher degree whereas the national figure is significantly higher at 40.39%. An important underlying factor is the disparities in educational attainment between racial and ethnic groups: Hispanic and Native Americans lag behind whites in educational attainment at all levels. There is a need to acknowledge that all children and youth, irrespective of their citizenship or legal status, have the right to education.

Southern Arizona's tertiary education includes a Land Grant university with a strong interdisciplinary tradition and world class research and a

responsive community college sector, which both contribute to an ecosystem of collaborative networks in selected fields, particularly within the Tucson metropolitan region. At the same time, there is a lack of vision and steering mechanisms for tertiary education as a state or regional system. Public good missions and academic quality are under threat because of declining funding and the regional innovation system remains underdeveloped and in risk of fragmentation.

In this context, the key challenges for Southern Arizona and its tertiary education institutions are the following:

- How to improve the overall educational attainment levels and the flexibility of the population to face the changes in the labour market? How to improve the relevance, inclusiveness and quality of tertiary education and better align it with regional needs?
- How to develop an effective regional innovation system which promotes long term collaboration between tertiary education institutions and industry?
- How to leverage the current economic base and retain and grow existing businesses in order to expand the economic base? How to improve the absorptive capacity of the SMEs? How to promote new business formation and attract knowledge-based businesses and investment?
- How to address the socio-economic gaps, health and other needs of the diverse population?

In a time of financial stringency, there is a need to preserve the existing areas of strengths in the tertiary education institutions, while addressing the needs of the diverse population. The authorities and the Arizona legislature need to recognise the importance of education for economic development and guarantee sustainability by sufficient funding levels. A co-ordinated approach to human capital development should be developed, including a master plan with vision, goals, milestones, co-ordination measures and a robust evidence base. At the regional level, joint public-private multi-stakeholder efforts are needed to design a balanced vision for Southern Arizona's economic, cultural, social and environmental development. Skills and job creation in the region should be seen as the primary goal of innovation and human capital development. A systematic approach should be adopted to knowledge transfer between tertiary education institutions and industries in Southern Arizona. The existing good practice examples in widening access to and improving success in tertiary education, industry-university collaboration and community outreach should be disseminated, extended and scaled up within and between tertiary education institutions.

Human capital development in Southern Arizona

Cultivating relevant skills for local growth is the best guarantee that a region will thrive in future. If Southern Arizona wants to become globally competitive, it needs to have highly skilled workforce and knowledge-based economy. Investments in education are necessary to widen access and improve the educational attainment levels.

Southern Arizona has a low educational attainment level that limits the region's ability to develop a knowledge economy, and to attract and retain highly-skilled workforce and knowledge-intensive and high value investments. The tertiary education attainment rate in Southern Arizona was 31.8% for adults aged 25-34 falling short of the OECD and national averages (34.15% and 40.39%, respectively). In the context of the United States' aim to restore its status as a world leader of tertiary education graduates by 2020, Southern Arizona needs to significantly increase the number of tertiary education graduates; otherwise it runs a risk of falling further behind the rest of the country in economic development and innovation outcomes.

All children and youth, irrespective of their nationality and legal status, should have access to education. Barriers to education arise from undocumented status of immigrant students; quality and equity problems in K-12 education; and underfunding and costs of education. Significant numbers of high school graduates in Southern Arizona are from undocumented immigrant families, which limit their possibilities to enrol in public tertiary education institutions. The political volatility of the issue of the undocumented status of immigrant students creates considerable barriers to promoting tertiary access to a significant segment of the graduating high school student population in the region.

There is insufficient level of preparation of incoming students, due to serious quality and equity problems in K-12 education. The proportion of high school graduates who are not ready for college is estimated at anywhere between 50% and 80%. With a high school completion rate of 82%, the state is below the national average of 86% and considerably below the 94% performance of the top states in the US. The probability of completing high school for students from low-income families is one-third lower than for students from a high-income background. The proportion of

low-income 8th graders scoring at or above "proficient" on the national assessment math exam is only 12%, compared to 22% in the top states.

In Arizona as in other US states, the cost of tertiary education is a deterrent to participation of students from low-income families. In 2006, the cost of attending community college represented 25% of the average family income while attendance at a public four-year institution was equivalent to 31% of the average income, up from 25% in 1992. For the lowest quintile, the net cost of attending a public university went up from 59% of family income to 73% in 2005, one of the highest proportions in the entire nation. Compared to other states, Arizona provides very little state financial aid. In 2009, the state allocated only USD 26 per student on financial aid, compared to an average figure of USD 549 nation-wide (CHE, 2009). The State of Arizona is therefore spending a mere 4.7% of the national average for student aid.

As a consequence of the diminishing level of funding for tertiary education, accentuated by the financial crisis, the University of Arizona has increased the tuition fees and also increased the proportion of out-of-state undergraduate students in order to make up for the shortfall in budgetary resources. Despite the improved support for students of low socio-economic backgrounds, it is becoming more difficult for in-state students to enrol in the local public university.

To widen access and to increase tertiary education attainment levels, the appropriate financial resources need to be mobilised. The University of Arizona should further improve its accessibility.

Overcoming quality and equity gaps in education is not the direct responsibility of the tertiary education institutions. It is up to the Arizona legislature to mobilise sustainable funding and the school authorities to work towards improving the quality of education. But tertiary education institutions can and should do more to improve access and success in education. There is a need for a region-wide long-term public-private collaboration underpinned with sustainable funding.

Overcoming quality and equity gaps is not the direct responsibility of the local tertiary education institutions. In the first instance, it is up to the Arizona legislature and the school authorities to work towards improving the quality of education in the state of Arizona. They will need to address these

issues in a comprehensive manner and mobilise appropriate levels of financial resources in spite of the economic downturn.

However, tertiary education institutions can and should do more to improve access and success in education. Currently, the most notable is the regional public-private initiative "Tucson Values Teachers" which aims to improve the quality of K-12 teaching in the Tucson area. In addition, each institution has developed its own outreach activities. For example, Cochise Community College offers a technical preparation programme throughout the county high schools to boost up the skills of potential students. Tohono O'odham Community College maintains an open enrolment policy and has partnered with the University of Arizona since 2000 on an initiative to train teachers who are tribal members. Pima Community College runs two federally funded college preparation programmes, Talent Search and Upward Bound that offer academic advice, tutoring, and assistance with admissions and financial aid applications. Given the current insufficient level of preparation of incoming students into tertiary education, long-term region-wide public-private collaboration is needed in order to improve the motivation and academic performance of pre-college students.

Improving retention and progression in tertiary education will require, among other things, a higher rate of transfer between community colleges and four-year institutions. Better functioning pathways and bridges between community colleges and the university should be developed.

One of the major strengths of the tertiary education system in Southern Arizona, and the United States in general, is the high degree of institutional differentiation, which allows catering for the learning and training needs of an increasingly diversified student population. Southern Arizona has a comprehensive network of tertiary education institutions consisting of a major research university; three community colleges embedded in their communities and with branch campuses aligned with the geographical distribution of the local population; and private institutions catering to the training needs of the working population.

To increase the completion rates of tertiary education and to up-skill the local workforce, there needs to be a higher rate of transfer between the community colleges and the university. Currently, the articulation between the community colleges and the University of Arizona is governed by a

state-wide agreement. Students can transfer through two mechanisms: either by using an associate degree which transfers as a block of 64 credits or by completing a general education block of 35 credits called the Arizona General Education Agreement. There is room for clearer transfer rules and conditions in order to ensure that a more significant proportion of community college students transfer to universities.

Ensuring smooth articulation requires close collaboration among all institutions concerned, including joint planning and regular communication between faculty members at the University of Arizona and at the community colleges to ensure comparability of course content, appropriate advising for students, and overall alignment of programmes. Recently, progress has been made in this domain through closer collaboration between the university and the Pima Community College. A common course numbering system would facilitate better functioning pathways. In Florida this type of a system has ensured efficient and effective progression among its 11 state universities and 28 community colleges.

Widening access is also about making sure that students from disadvantaged backgrounds do not face additional barriers to succeed in education. Tertiary education institutions should do more to improve graduation rates and help graduate retention in the region through closer industry collaboration.

Widening access is not only about providing equal opportunities to enrol in a tertiary education institution, but also about making sure that students from disadvantaged backgrounds do not face additional barriers to succeed beyond their own efforts and motivation to achieve good academic results. Retention and graduation rates are important indicators of whether a tertiary system or institution is supportive of students' progression after admission. Currently the tertiary education institutions in Southern Arizona demonstrate a relatively low level of efficiency in graduate production. The graduation rates in the US community colleges are generally at a low level and the community colleges in Southern Arizona do not make an exception to this. The graduation rate of the University of Arizona is 56%, much lower than that of public research universities with high research intensity (70%) (ACT, 2008).

Tertiary education institutions should develop more relevant academic, social and financial support to ensure success in education.

The tertiary education institutions in Southern Arizona effectively contribute to the formation of a quality labour force for the region. They offer academic programmes in all of the cluster priority areas identified by the Tucson Regional Economic Opportunities Agency (TREO), the regional economic development agency; with the exception of tourism, which is a growth area in the regional economy. To improve graduate retention and the quality and attractiveness of local jobs, the tertiary education institutions should continue their efforts to align the educational programmes with the regional needs, including fields currently neglected. Sustained efforts should be made to establish programmes to link all students, graduates and post-graduates with the local industry. Creating ties between students and regional employers through internships, and co-operative programmes should be made a priority in all institutions. A broader range of students should be able to benefit from innovative, experiential learning models and entrepreneurship training. It will also be important to adjust the performance evaluation system to ensure that there are appropriate incentives to ensure that faculty members are equally devoted to undergraduate teaching as to their research and technology transfer activities.

Internal and external administrative barriers and a lack of incentives may impede students, researchers, professors and administrators to engage in entrepreneurship, industry collaboration and regional development activities. Tertiary education institutions need to create synergies between education, research, industry collaboration and entrepreneurship, and create an incentive structure to encourage such activities, including in the criteria for staff promotion and tenure.

The following measures would promote human capital development in the Southern Arizona region:

- To improve the quality of high school graduates, the local school authorities should address existing academic and equity gaps in a comprehensive manner and mobilise appropriate levels of financial resources in spite of the economic downturn.
- In order to widen access to tertiary education, especially among underserved population groups, all concerned tertiary education institutions should step up their outreach efforts and share good practices among themselves in a more systematic manner. The joint admission programme between the University of Arizona and Pima Community College appears to operate smoothly in that respect. A similar mechanism to link the University with Cochise Community College and Tohono O'odham College could be

envisaged. It would also be useful to implement a common course numbering system for the entire State along the lines of the Florida system. Furthermore, in implementing its strategy to cope with the financial crisis, the University of Arizona should carefully monitor the rise in the proportion of out-of-state students to avoid any adverse equity impact in the medium term. Access to the University must be improved.

- Tohono O'odham College needs to be included more systematically into the tertiary education community of the Southern Arizona Region. All parties concerned should identify ways of supporting the efforts of the younger public institution to draw more extensively on existing resources in the community.

- Tertiary education institutions should continue to align their educational provision with the needs of the region, and also address needs of skills development in industries relevant to the region, including tourism which is one of the key drivers of the regional economy.

- To further improve its pedagogical practices the University of Arizona should ensure a more systematic and widespread sharing of experiences across colleges and programmes. All students should be able to benefit from innovative and experiential learning models including entrepreneurship education. The expertise of the McGuire Center for Entrepreneurship should be mobilised to transform education provision throughout the university and other tertiary education institutions in the region and to scale up the entrepreneurial activities of the university faculty. The challenge will be to facilitate increased cross-fertilisation and institutional learning without stifling the existing culture of faculty-driven innovation. Appropriate incentives need to be in place to ensure that faculty members are equally devoted to undergraduate teaching as to their research and technology transfer activities. The University of Arizona should also consider applying evaluation instruments, such as the Collegiate Learning Assessment (CLA), to measure the generic competencies and higher order skills that students are acquiring in the course of their programmes.

Innovation in Southern Arizona

The US leadership role in pro-innovation policies has recently been challenged by other OECD countries. To face these challenges, the federal government has taken steps to reassume its leading role. The state of Arizona and Tucson Regional Economic Opportunities, TREO, also invest in innovation with focus on high technology fields.

The United States has traditionally led the way in developing pro-innovation policies. It was the first country in the world to offer companies a R&D tax credit and, through the 1980 Bayh-Dole Act, the first to allow universities to patent products originating from federal R&D funds. The Massachusetts Institute of Technology (MIT) and Stanford University are global leaders in commercialising university research, and the Silicon Valley and Route 128 continue to inspire many regions.

At the same time, there is growing evidence that other OECD countries are catching up to the US in terms of capacity for innovation. This catching-up process takes place in four domains: human capital development, taxation policies, commercialisation of research and innovation policy. As most US university technology licensing/transfer offices generate less licensing revenue for the university than the cost of their operations, the traditional technology transfer model is also becoming under increasing pressure. Many universities have also focused on technology transfer or developing revenue streams from products that have limited or no relation to the regional economy.

The US federal government's role in innovation has until recently been limited to funding basic research, subsidising the education of scientists and engineers, and maintaining a system of intellectual property law. In 2009, the government assumed a more active role with the aim to transform the United States into an "Innovation Economy" that would support innovation for sustainable growth and quality jobs. The goal is to restore the US leadership in fundamental research, to build a world-class workforce, to develop a physical infrastructure, and to develop an advanced IT ecosystem. This will in turn form the basis for innovation that will promote competitive markets that are able to spur productive entrepreneurship and catalyse breakthrough discoveries for national priorities; for example, in clean energy, health care and advanced vehicle technologies.

While many US state and local governments have established technology-based economic development programmes to promote innovation, these programmes often focus on the same high technology field, regardless of whether they are suited to the regional and local economies. In Arizona, considerable investments have been made in biotechnology through the Technology Research Infrastructure Fund (TRIF) and Governor's Council on Innovation and Technology. Local and regional economic development agencies, such as the Tucson Regional Economic Opportunities Agency (TREO), see their main role in attracting inward investment and serving industry that is relocating.

The United States provides favourable framework conditions for small business development. Programmes have been developed to create "demand-pull" for R&D and innovation within small businesses. These programmes balance the universities' traditional tendency to focus on knowledge generation rather than knowledge transfer and diffusion.

The United States has developed many programmes to support SME development. The US Small Business Development Centers have a 30-year track record as an SME service network, annually serving 750 000 SMEs through 1 100 centres located in universities and community colleges. In Southern Arizona, both Pima Community College and Cochise College administer small business development centres that offer free consulting, training and referrals to small business owners and entrepreneurs. In view of the weak labour market outcomes and limited SME development among Native Americans, consideration should be given to whether the Tohono O'odham Nation would benefit from a Small Business Development Center hosted by its community college.

The Small Business Technology Transfer Research (STTR) and the Small Business Innovation Research (SBIR) programmes award USD 2 billion to small high-tech businesses every year. Established in 1982, SBIR is the largest US innovation partnership programme, benefitting from a stable budget: 2.5% of federal agencies' R&D budgets have been set aside for small business awards. SBIR has helped firms cross the "valley of death" by providing funding for proof of concept and prototypes and have created a "demand pull" for RDI within the SMEs, thereby encouraging them to evaluate commercial potential of research results.

Southern Arizona has developed a strong research base and multidisciplinary tradition within the University of Arizona. Nicknamed the optics valley, the Tucson metropolitan region has developed into a hub of light-based industries. Despite considerable investments in the science components of innovation, Southern Arizona remains a low wage economy with wide disparities.

The University of Arizona is the key research institution in Southern Arizona and a national leader in inter-disciplinary research. It is strong in R&D expenditures, with nearly USD 407 million in total sponsored research expenditures, ranking 21st among all US research universities in R&D expenditures and 13th among public universities in 2006. The university produces research that is nationally and internationally recognised, and, with the exception of tourism, undertakes research in all fields identified by TREO as important for the regional economy. Close industry links have been forged in high tech fields.

The University of Arizona has a tendency to measure success in innovation by the amount of research expenditure, not the amount of commercial return generated or jobs created. This approach is likely to strengthen with the decreasing state funding for tertiary education. Much of the university's research infrastructure is subsidised by TRIF/Prop 301 sales tax revenue, which threatens the sustainability of many research programmes.

As a response to the cuts in the state funding, the University of Arizona has shifted its focus on high technology areas with the hope of drawing federal government funding. The collaboration with industry is spurred by public investments from federal government in fields such as defence, biotech & health, and environmental technology. Challenges here are also linked to publicly-driven innovation strategies that may have negative impact on entrepreneurship attitudes. It will also be important to balance the strong high-tech focus with the development of a private sector base in the related industries, and, at the same time, increase collaboration in other fields that are important to the regional economy.

Southern Arizona has chosen the path to develop high technology fields in order to diversify the regional economy and to create high wage employment. The University of Arizona's College of Optical Science and the local optics industry have made the Tucson metropolitan region a hub of light-based technologies. The optics industry consists of 150 companies,

consisting mostly of small companies dedicated to a small niche area generating 4 573 jobs and over USD 650 million in revenue. The region is also home to a number of defence-oriented organisations that play an important role in the regional innovation system by generating or using R&D. In biosciences, the University of Arizona has established the Bio5 Institute, an interdisciplinary centre that brings together more than 300 researchers. Environmental technology and the agri-food industry feature opportunities for new growth through sustainable energy and resources development. The region is also well positioned to develop solar industry.

Despite efforts made to diversify the economic base of the Southern Arizona, in general, high value added activities continue to have a limited weight in the regional economy, while the average per capita income in Southern Arizona remains consistently below the US average. For example, in Tucson, average wages were, 17.2% below the national average in 2007. Evidence suggests that income inequality will continue to increase with growth in high wage jobs related to the federal government investments and with continued inflow of poor people over the border. Southern Arizona will need to continue its efforts to expand high skill/higher wage jobs in the environmental, health & biotech fields, defence-related fields; and in global service operations that take advantage of the bi-lingual and bi-cultural environment and the ability to reach markets across NAFTA countries and Latin America. Diversification of the economic base, creation of quality jobs and raising the educational attainment levels among the diverse population groups remain key challenges for the region.

The University of Arizona has developed a wide range of mechanisms to facilitate industry-university interface. Despite efforts to rationalise the system, the university continues to feature a fragmented approach to the industry interface. Stronger impacts could be achieved through concerted efforts by all tertiary education institutions.

The university has created a broad range of mechanisms for engaging with business and industry. The plethora of offices, parks, institutes, centres and initiatives have lead to overlap, duplication and confusion among the regional stakeholders and companies. The effectiveness of the innovation infrastructure could be improved by a co-ordinated approach between the sub-units to university-industry collaboration, research and innovation. This could lead to improved communication within the university, cost savings and more approachable structure from the perspective of external

stakeholders. Currently, the support for innovation remains fragmented within the university, each department and office developing its own initiatives, often in isolation from each other. There seems to be also limited attempts to connect technologically-oriented centres with business faculties and with other disciplines to provide support for service sectors.

Industrial engagement is seen by the university faculty as a science and engineering pursuit, rather than a role that could embrace business schools, social sciences and the humanities. A sector such as tourism, which has potential in the region, is not seen as a focus for university activity. Broadening the sectoral orientation and the disciplines that underpin engagement could be beneficial for large and growing clusters in the service sector.

In general, there is limited evidence of the development of a region-wide innovation system. The regional innovation system remains Tucson-centred and underdeveloped, with limited connections between the University of Arizona and community colleges, whose role is vital in developing the skills of the local population. There is currently no mechanism of pooling the knowledge and expertise of all tertiary education institutions to deliver support to industry. The tertiary education institutions, and also the University of Arizona's different units and offices, did not present themselves as a coherent system, and there was no attempt to set out the collective needs of the region in terms of innovation infrastructure, or for the university and community colleges to co-ordinate their actions in meeting such needs. There appears to be a generally weak focus on meeting the needs to generate high wage jobs in non-high tech fields where Southern Arizona has a comparative advantage. The development of a better functioning, region-wide innovation system would require co-ordination and collaboration among the university and community colleges in their engagement with business and industry.

The economic growth and development in Southern Arizona is strongly related to that of the Mexican state of Sonora, which is a key manufacturing centre for cross-border trade between the US and Mexico. Sustainable development on the Mexican side of the border is of vital importance to Southern Arizona and further efforts should be made to build cross-border regional innovation and skills development system.

There has been considerable encouragement for the university to promote the commercial exploitation of its technologies, but the outcomes remain modest in terms of regional

development. There is a need to place less emphasis on financial returns to the university and focus on how the university R&D can support jobs, industry, productivity and innovation in the region.

There has been considerable encouragement for the US universities to promote the commercial exploitation of their technologies. Much of this activity is based on a technology-push model as inventions developed in the university are marketed to potential licensees in industry. The US legal framework for intellectual property rights is helpful in protecting ideas and research of the members of the academia. However, legal costs, lengthy time for patent issuance, limited budgets and the limited long term return on investment have been identified as barriers to commercialisation. As an additional disincentive, the University of Arizona is not allowed to own equity in firms.

In view of its size and research strength, the University of Arizona's license agreements and patents remain at a low level. The revenue has ranged from USD 1.6 million to USD 583 000 in 2008, revealing a negative trend. It can be expected that the university's Office of Technology Transfer (OTT) actually loses money, as is the case with many other technology licensing offices in the United States. Considering the fact that the national pharmaceutical industry is concentrated in Southern California and New England, much of the university's activities are also likely to involve commercialisation outside of the region. With the decreasing state funding for the university, the OTT is faced with pressures to maximise university revenue, rather than spur regional economic growth.

Given the limited scope of the revenues generated by the university and the decreasing trend, broadening the understanding of knowledge exchange, knowledge utilisation and exploitation would be useful. By placing less emphasis on financial returns to the university, and focusing on how the university research can support jobs, industry productivity and innovation in the region, the University of Arizona could move away from the current transaction-based system to a system that is based on developing continuous partnerships with industry, government and other partners. Key aspects of knowledge mobilisation include working to develop open access/open source systems and invention that have low revenue potential but high societal return. This type of broader knowledge transfer would also have the potential to build support among broader segments within the university (beyond high technology) and within non-profit sectors located in the region.

International experience shows that while university technology transfer models may lead to saleable intellectual property and start-ups, they seldom produce enterprises that grow in the region and contribute to regional economic development. The creation of localised supply networks is critical to the process through which innovation is transferred to enterprises enabling the creation of new innovation that transforms and upgrades existing industries. A well functioning regional knowledge transfer model is based on ongoing relationship between the tertiary education institutions and industry to determine what innovations have the best opportunities for adoption and commercialisation, creating an industry-university learning environment. It supports the human capital development required to adopt and apply process and product innovations and works with SMEs as well as large corporations. It measures success in terms of the sustainability and transformation of regional industry and employment growth. University entrepreneurship programmes should therefore also support the existing industries and SMEs. The University of Arizona's College of Optical Sciences is a good practice example, which combines leading edge research with industry collaboration, through multiple mechanisms including joint appointments, industry affiliates programme and student internships.

While population growth is a major strength for Southern Arizona and provides opportunities for economic growth and innovation, the region loses talent with a continuing outmigration of college-educated graduates. Knowledge transfer programmes based on people mobility could help retain talent in the region.

While population growth is a major strength for Southern Arizona and provides opportunities for many industry sectors, the region also suffers from outmigration to Phoenix and other US cities by a population of young, single and college-educated demographic. For example, many graduates of the University of Arizona in science, technology and engineering are recruited by national companies outside the region. Between 2005 and 2007, 547 000 people left Arizona for other states, particularly California. The region also loses talent to the Phoenix metropolitan area.

To improve graduate retention, and quality and attractiveness of local jobs, the University of Arizona, community colleges and key regional and local stakeholders could consider establishing programmes that systematically link tertiary education and industry, faculty, and all students and post-graduates with the local industry. This type of programmes would improve the competitiveness of the local firms through the recruitment of

talent and/or the introduction of some form of innovation or new technology garnered from the mobility programme.

Finding ways to increase entrepreneurship would be an effective strategy for regional development in Southern Arizona, but requires an institution- and region-wide strategies and collaboration.

Entrepreneurship plays an important role in generating innovation and stimulating growth in the United States. Americans are twice as likely as adults in Europe and Japan to start a business and grow it rapidly. Small businesses employ 30% of high tech workers such as scientists, engineers and information technology workers. Spin-off companies are also often likely to be locally based and offer the potential of indigenous industrial development.

In recent years, the University of Arizona has made efforts to develop a stronger entrepreneurial spirit among the faculty. The McGuire Entrepreneurship Program and the involvement of the non-profit Desert Angels in technology transfer opens up possibilities for small business creation. There is also growing evidence of enterprise support within the student and graduate community being mainstreamed within some degree programmes and through supporting infrastructures. However, in general, this support is fragmented within the university and with limited collaboration across tertiary education institutions in the region.

The University of Arizona has underutilised potential for entrepreneurship. It has an improving record of generating spin-offs. In 2009, the University of Arizona spun off seven new companies, surpassing the record of six in the previous year and further six companies were "in the pipeline" or in negotiations over IP licensing. About 80% of the university start-ups have remained in Arizona following incorporation, with an improving trend. At the same time, there is a wide diversity among the different centres and schools in terms of entrepreneurship outcomes. Furthermore, there appears to be a lack of focus on the job generation aspects. This is reflected by the fact that the employment figures of spin-offs are not available and no data is collected about the university start-ups that often generate more jobs than academically driven high tech spin-offs.

Concerted efforts are needed to support entrepreneurship activities within the university and among the university and community colleges for the benefit of Southern Arizona. The good practice examples provided by the McGuire Center and some of the most entrepreneurial units should be

shared and mobilised. There is also a need to extend the current entrepreneurship programmes and tie them more closely to regional efforts and community engagement activities.

The following measures would promote innovation in Southern Arizona:

- A systemic perspective should be applied in developing a regional development strategy by improving the connectivity in the regional innovation system through stronger collaboration and networking as well as through consensus building for economic development and partnering between the educational institutions and industries in order to create close research collaboration across tertiary education and research and industry, particularly small and medium-sized enterprises. Consistent innovation indicators should be developed and monitored over time.

- The state government and regional/local agencies should ensure that research on clusters and the demands of industry extend into the service sector. Clusters should also be conceptualised as cutting across the manufacturing-service divide. For example, manufacturing innovations should increasingly incorporate service components. Tertiary education institutions should be encouraged to draw upon business schools, humanities and social sciences in providing assistance to business.

- Southern Arizona, its tertiary education institutions, and the public and private sectors should make systematic concerted efforts to support new business formation and build an environment and mechanisms that support start-up and entrepreneurial companies through aligning incentives for a sustained period of time. Building on the experience of the University of Arizona's McGuire Entrepreneurship Program, the tertiary education institutions should support entrepreneurship throughout the curriculum and build comprehensive support programmes encompassing entrepreneurship training;, practical experience of creating new businesses for groups of students; and incubation and hatchery facilities together with seed funds for new graduate ventures. Private funding sources willing to invest in "ideas" rather than real estate should be strengthened.

- The tertiary education institutions should play a more active role in helping the region to build a more diversified and robust economy based on knowledge and innovation. The University of Arizona should broaden its understanding of knowledge transfer, knowledge utilisation and exploitation and place less emphasis on financial return to the university. By focusing on how the university research can support jobs, industry productivity and

innovation in the region, the university Technology Transfer Offices (TTOs) could move towards a system that is based on continuous collaboration with industry, government and other partners. There should be stronger emphasis on the development of open access/open source systems and interventions with low revenue potential but high potential to yield societal returns in order to build support among broader segments within tertiary education institutions (beyond business and engineering faculties) and within non-profit sectors in the cross border region.

- State government and regional agencies should balance the current focus on high tech R&D with considerable efforts to develop general competencies among the population to help adjustments to rapid changes in the labour market and to facilitate lifelong learning. Systematic concerted efforts should be made by the State of Arizona, educational institutions and key stakeholders to raise the levels of education attainment.

- The tertiary education institutions should focus their concerted efforts on challenge-driven innovation on the key issues in the cross border region, such as water, Hispanic/border health and border security in its broader sense, and use the region as a "laboratory" for research, knowledge transfer and outreach to reach global levels of excellence. Job creation should be seen as the focus of innovation activities.

- Incentives for tertiary education institutions should be strengthened to increase their capacity to act as technology transfer "agents" to bring non-local knowledge to the region and to create community partnerships. Incentives for tertiary education institutions and their staff to engage in local and regional development should be developed. The state government should seek to encourage greater collaboration between tertiary education institutions through joint investments in research facilities and incentive programmes.

Social, cultural and environmental development in Southern Arizona

Population growth, ethnic diversity and the vicinity of Mexico are key assets for Southern Arizona, but also pose challenges. Tertiary education institutions have generated a wide variety of social and cultural programmes, initiatives and facilities that capitalise on the assets and address these challenges.

The ethnically and economically diverse population is both an asset and a challenge for the economic, social and cultural development of Southern Arizona. The region's large Hispanic population is in the prime working age and has many children. In the near future, there will be a large influx of new, non-traditional students, who will constitute a growing portion of the population available to fill skilled jobs. Migration and ethnic diversity also pose social and cultural challenges with respect to integration and social inclusion.

The University of Arizona and community colleges have generated a wide variety of programmes, initiatives and facilities to address the key social and cultural challenges in the region. Examples range from help and assistance to migrants or the provision of health care, legal aid, women advocacy and other services to individuals and communities in need, to personal enrichment programmes, neighbourhood planning, policy advice and cultural performances and facilities. Institutions also contribute to the maintenance and preservation of the region's indigenous languages, folklore and traditions.

The University of Arizona and community colleges actively contribute to social and cultural development using the region as a "laboratory" for their research, outreach and student learning. In collaboration with stakeholders, they act as conduits for information and funding between state and federal agencies, Native nations, local school districts, businesses, military personnel, young people and at-risk populations, such as homeless communities. They serve as brokers in regional policy-making between communities; non-profit organisations and government agencies; advocating for at-risk populations in public health policy; preparing new citizens for civic duties; and eliminating public fears and xenophobia, etc. In key areas, such as youth programmes, they partner with each other to build local capacity.

The diverse programmes and projects are fragmented, built on separate and non-coordinated initiatives stemming more from specific circumstances rather than an overarching vision of needs and joint efforts. Maintaining the active visibility in social and cultural development is important for tertiary education during the period of economic crisis, but will require prioritisation and co-ordination of efforts.

The opportunities for sustainable and extended third mission activities of education institutions lie in building the region's reputation as a positive model in addressing the demographic transition in the region and the needs of its diverse population. These areas should be recognised by the public and private stakeholders as important to the region's future. Tertiary education institutions' collaborative engagement in these arenas can enhance support for tertiary education, influence public opinion and emphasise their critical role in social and economic leadership.

There is scope for stronger collaboration to build joint capacity and to foster joint efforts in order to ensure that limited resources are not spread thinly and that the projects will generate multiplier effects. Sustainable engagement will require prioritisation; building critical mass; pooling resources; new research incentives; re-conceiving incentives for faculty and staff responsibilities; and developing new approaches and metrics to measure progress and participation.

There is a risk that the university's strong focus on high technology fields will divert the attention from the key challenges in the region. Despite world class examples, such as SIROW and health interventions, social and cultural engagement has developed inconsistently without system-wide support. In economic downturn, the challenge for the institutions is to identify and prioritise critical social, cultural and environmental issues and gaps in knowledge and action where they can make – individually and collectively – contributions to build regional sustainability through critical mass, collaborative effort and long term action.

Southern Arizona needs to do more to retain and attract talent. The Tucson Metropolitan Region is the engine of regional development and a "mini-mecca" of arts. Building on the expertise of the university, public-private efforts are needed to develop a culturally vibrant and socially inclusive Downtown Tucson, renowned for the quality of its sustainable urban design.

The Tucson metropolitan region plays an important role in the development of Southern Arizona. It is home to the majority of jobs, firms and tertiary education institutions and the focal point of innovation, entrepreneurship and economic growth, increasing region's global competiveness. It is also a place of natural beauty with diverse people, rich cultural heritage and a wide variety of outdoor and diverse cultural opportunities. The University of Arizona supports the city's cultural strength

through its education programmes, performances and other outreach activities, art venues and museums.

Cultural and creative industries can contribute to the growth and development of Southern Arizona in an indirect way, through attraction and retention of talent and knowledge-intensive industries that tend to move to regions with a high concentration of talents and creative workers. In spite of many positive attributes, the Tucson city region has not sufficiently developed its cultural potential, which is evidenced in brain drain and out-migration of population of a young, single and college-educated demographic.

Building on the expertise within its university, Tucson could also strive to become known for the quality and ambition of its physical planning, innovative approaches to socially and environmentally sustainable city development, as well as environmental and urban planners' ability to integrate the new with the old Pueblo and Mission style architecture. In the first instance, there should be a more serious attempt to extend the "Downtown Tucson" to span from the historical core of downtown to the University of Arizona. This would help draw the community onto the campus and campus into the community. The new approach would call for improved public transportation; creation of a more vibrant downtown, with around-the-clock activity; and linking it with surrounding neighbourhoods through developing a pedestrian-friendly region with safe public spaces, bike paths and public cycle hire network. International examples in this domain come from Barcelona, Spain, where the city government has developed a model of urban development that transforms old industrial and/or distressed areas into multi-functional urban areas and places universities in the core of these developments.

Economic development can only be sustainable when it is accompanied by measures designed to reduce poverty, social exclusion and environmental problems. Tucson and Southern Arizona would benefit from an integrated public-private multi-stakeholder approach that not only encourages growth and jobs, but also pursues social, cultural and environmental objectives. Economically disadvantaged and undocumented immigrants represent a significant portion of the regional population. Strong efforts are needed to foster economic growth and educational opportunities for all.

Southern Arizona covers a large geographical area with a sparsely distributed population. Water management, solar energy applications and climate change are important to the region. The green sector can be one of the key sectors

of economic development. While the University of Arizona is making significant contributions to the green sector, there is scope for further expansion through stronger collaboration and skills development…

The University of Arizona has taken a lead in addressing local to global climate change issues and policies, including economic impacts and the development of urban planning, architecture, transportation and water management. Its Water Resources Research Center has a focus is on assisting Arizona communities with water management, while the Arizona Research Institute for Solar Energy aims to drive innovation between university and private industry to achieve solar energy solutions.

First movers in green research can benefit from substantial returns on investment. Deloitte's 2009 survey on Global Trends in Venture Capital reports that, despite the economic crisis, 63% of venture capitalists anticipate an increase in their investment in clean-tech, the highest percentage among all sectors considered. Green jobs are projected to increase to several millions worldwide by 2030, most of them in a small number of innovative regions. Green technologies rely on local know-how and generate new applications and higher demand for technologies developed by traditional industries.

Given the critical role that the development of sustainable energy and energy efficiency will play in the future of the US economy and to benefit from economic gains, green innovation capacities need to be unlocked in Southern Arizona through cluster policies. Many OECD countries are building partnerships between government, industry and academia as eco-innovation clusters. These clusters merge skill development and education, cutting-edge research in environmental technologies and job creation through spin-offs, venture capital and integration of enterprises. Joint green action and research would also contribute to developing a more co-ordinated regional innovation system in Southern Arizona.

While agriculture employment is on a decline, it remains a key sector in the Arizona economy. At the same time, it is under increasing pressure as regards to land use and water management. The University of Arizona's College of Agriculture and Life Sciences' Cooperative Extension Service's brings research-based information into Arizona agri-business communities with focus on water management, climate change, sustainable agriculture, range management and youth development. More structured R&D, dissemination and commercialisation efforts targeted at the local agricultural and agri-industry structure are needed to reduce emissions related to agriculture, and to ensure food security and sustainable rural development.

The university and community colleges could play a more important role in supporting technical, organisational and process improvements for eco-efficiency of the existing industry, *i.e.* exploring ways to create more goods and services while using fewer resources and creating less waste and pollution. Southern Arizona does not seem to have a strong portfolio of programmes targeting emission reduction in businesses that have been initiated by universities and community colleges. Experience from OECD countries shows that tertiary education institutions can become successful partners of local businesses who want to upgrade their environmental standards.

Many national and regional governments in the OECD area are developing green skills strategies, including new industry-recognised credentials and training packages for workers in traditional occupations, by facilitating re-training and efficient mobility of learners between vocational institutes, universities and industries. In Southern Arizona, the creation of highly skilled human capital is critical for improving the opportunities for wider market penetration of renewable energy and low carbon technologies. Skill creation for green jobs could be effectively organised at the regional level by pooling the resources of industry and the educational institutions. Southern Arizona could also take steps to anticipate the employment effects and labour reallocation needs across industries. Partnerships between the university, community colleges and industrial associations could stimulate innovation in the modes of delivery of education and training.

The following measures would promote social, cultural and environmental in Southern Arizona:

- To boost green growth and eco-innovation, there should be collaboration between tertiary education institutions and industry, and among the institutions themselves; for example, through collaborative platforms for eco-innovation and other cluster-based initiatives. Skill creation for green jobs should be organised by pooling learning resources of educational institutions and industries in the region and providing flexible pathways between institutions.
- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should develop a strategy that sees arts and culture as an agent of development through: *i)* a direct benefit in enhancing the quality of life of the diverse population; *ii)* indirect economic benefits in attracting and retaining talent that can drive the knowledge society; and ii) a direct contribution to the creative industries through enterprise formation,

growth, productivity and employment. This strategy should address the needs of the region's diverse communities and also enhance the internationalisation of the region.

- Southern Arizona's tertiary education institutions should support cultural development by increasing multi-stakeholder, public-private efforts to support arts and culture, and entrepreneurial skills among students of arts, humanities and social sciences. Given the high proportion of self-employment and small business in the creative sector, the universities and community colleges should contribute to the development of regional creative economy by developing and expanding programmes in entrepreneurship and non-profit management both in formal degree programmes and through extension efforts.

- Building on the expertise within Southern Arizona's tertiary education institutions, regional and local agencies should develop Downtown Tucson into an attractive urban centre known for the quality and ambition of its physical planning. It would span from the historical core of the downtown area to the University of Arizona, The new approach would call for improved public transportation, creation of a more vibrant downtown and linking it with surrounding neighbourhoods, developing a pedestrian-friendly region with safe public spaces, bike paths and public cycle hire network.

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should adopt an integrated public-private multi-stakeholder approach to regional and city development that not only encourages growth and jobs, but also pursues social, cultural and environmental objectives.

- Southern Arizona's tertiary education institutions should engage in long-term community development seeking ways to empower communities to find their own solutions to economic, social, cultural and environmental challenges which are global, national and local in nature. They should continue to collaborate with authorities, schools, NGOs and the private sector, to reach out to under-served communities, such as migrants, to ensure social and economic cohesion. They should scale up current activities in a systematic way, including long term multi-stakeholder collaboration with schools to raise aspiration among youth in under-served communities. They should provide training and capacity building so that community can do the work themselves; and continue to see the region as a laboratory for developing research, students' work-based

and experiential learning and developmental projects in different fields. Tertiary education institutions should reward and recognise faculty who are involved in these activities. Provide centralised support services for student and staff for community engagement (for example, internship oversight).

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should develop a forum for social, cultural and environmental development. A systematic exchange of information should be put in place to track and monitor different initiatives and their outcomes and identify best practices for publication and policy fine-tuning. Such a forum could organise thematic events with regular information retrieval and exchange facilitated by a dedicated website, and the installation and/or development of new communication technologies, such as long distance learning capabilities that can bridge the physical distances between tertiary education institutions and community stakeholders not only in Southern Arizona, but also in Northern Mexico. As a first step, the tertiary education institutions' current connections, initiatives and projects involving stakeholder collaboration, community development and/or outreach should be mapped.

- Southern Arizona's tertiary education institutions should improve the monitoring and follow-up of the success and results of the initiatives, projects and programmes to show return on public investment. The lack of robust and comparable data constrains the visibility and impact of the tertiary education institutions' activities. It also makes it difficult to measure the success or failure of programmes. Building on existing models, capacity should be developed in regional data gathering and sharing regional data repositories and technical skills associated with using regional data.

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should capitalise on Arizona's multicultural heritage. The University of Arizona should take a leadership role in regional initiatives to develop strategies to integrate immigrants, including those from families with low educational attainment. The university would benefit from an active role in international study of immigration and integration, and from participation and implementation of relevant integration plans and seeking multidisciplinary approach in its community action. The university should continue to raise public officials' and other stakeholders' awareness of labour market and educational strategies and encourage positive action.

Steering, funding and capacity building

One of the main issues impeding tertiary education development in the State of Arizona is the fragmented governance architecture and the absence of a state-wide co-ordinating structure that brings together universities and community colleges. There is a need to create appropriate mechanisms to articulate a long-term vision and implement an integrated development strategy for all tertiary education institutions.

One of the main issues impeding tertiary education development in the State of Arizona is the fragmented governance architecture and the absence of a state-wide co-ordinating structure and appropriate mechanisms to articulate a long-term vision and implement an integrated development strategy for all tertiary education institutions. The authorities and interested parties in the Southern Arizona region should work together with the other regions in the State to propose the establishment of a tertiary education co-ordinating body that would help define state-wide goals, policies and priorities, in line with the recommendations of the 2006 Governor's initiative.

The advantages of a system-wide governance model is the ability to plan more effectively for the tertiary education needs of the region; to co-ordinate missions and programmes; to encourage an appropriate division of labour among institutions; to co-ordinate missions and programmes; and to maintain appropriate data bases for institutional and system policy research. A comprehensive approach also provides the ability to reallocate resources among institutions as needed; to shift programmes and staff among institutions and facilities; to merge programmes or even institutions; and to close programmes, facilities, and even institutions, that are redundant, too expensive, of low quality, or simply too small in scale to be cost-effective. Finally, it allows presenting a strong and unified political front to the state authorities and the legislature in order to maximise the case for sufficient and stable public resources.

To steer the future of tertiary education in the State of Arizona, the proposed co-ordinating body will need to define a comprehensive vision which outlines clear qualitative and quantitative goals and confirms the respective contribution of each type of tertiary education institution. Despite the present financial woes, the California master plan remains a relevant

model of careful articulation and division of responsibilities among the various institutions in a state system (research universities, teaching universities and community colleges).

An important dimension of good governance consists of putting in place an adequate information system to monitor the performance of tertiary education in the State of Arizona and benchmark its progress with appropriate comparators in the US and among other OECD countries.

There is an urgent need for a sustainable financial expansion plan reflecting a long-term commitment on the part of the Arizona legislature to support tertiary education and to increase educational attainment.

Any attempt to better co-ordinate tertiary education development in Arizona and increase educational attainment is a substantial challenge, unless it is backed by a sustainable financial expansion plan reflecting a long-term commitment on the part of the legislature. A two-pronged strategy could be articulated and implemented to achieve this goal: *i*) mobilise a greater share of public expenditures for tertiary education in the State of Arizona budget; and *ii*) increase resource diversification in the public universities. Public funding for tertiary education has declined steadily in the past two decades, endangering the ability of the University of Arizona and the community colleges to continue fulfilling their public good function and threatening their academic quality.

The drastic cuts in response to the economic and financial crisis have amplified a long term negative evolution which threatens the sustainability of Arizona State's public institutions. A comparison of the state allocation for tertiary education between the fiscal year 1999/2000 and fiscal year 2009/10 indicates that, while the state government general fund increased by 57.7% over the period, public resources for tertiary education institutions rose only by 20.2% for universities and a mere 3.9% for community colleges. The state of Arizona cannot realistically expect to achieve further progress on the tertiary education front, or even protect the achievements thus far, unless its authorities and legislature reach a consensus to increase public funding for the sector in a significant way, and make a long-term commitment to finance tertiary education on the basis of clear criteria aligning needs, performance and resources in an objective and transparent manner.

Any increases in tuition fees should go hand in hand with more student aid from the state. The University of Arizona could also amplify its efforts to increase its endowment.

The University of Arizona will undoubtedly continue to compete successfully for local and federal research grants. It has also the potential to generate additional resources in two complementary ways: by augmenting tuition fees and through fund-raising efforts.

Tuition fee increases should go hand in hand with more student aid funding from the State, to avoid creating two categories of students: those who can afford to enrol in the university, and those who would be only able to afford a community college.

The University of Arizona could amplify its efforts to beef up its endowment, currently estimated at USD 335 million. The fund raising efforts of the University of Arizona and other public tertiary education institutions in Arizona could be supported through a matching grant scheme similar to ones implemented in other US States, or in other OECD countries. The earlier local experience with a matching programme through the Science Foundation of Arizona shows that private donors are willing to contribute, provided there is a real commitment on the state side.

Partnerships within Southern Arizona between tertiary education institutions and the regional and local partners, acting in concert with each other, are key to attracting talent and investments and partnering with other regions and tertiary education institutions globally. For this interaction to take place, capacity – skills and resources – needs to be built in regional agencies and stakeholders as well as tertiary education institutions.

Tertiary education institutions in Southern Arizona are engaged in diverse collaboration with regional and local industry and community partners. Much of this collaboration is on an *ad hoc* basis without long-term planning, adequate resources and monitoring of the results. Furthermore, the fragmented nature of the innovation system means both the innovation actors and tertiary education institutions are not fully realising their potential capacity.

Permanent, long-term collaboration is needed to address the key challenges and opportunities in Southern Arizona. Better co-ordination, building critical mass and developing evaluation measures would benefit the region and bring costs savings. Collaborative work should be supported by a detailed knowledge of the needs and opportunities in the region and the knowledge of tertiary education institutions' teaching and research portfolio.

There is a lack of national, state and institutional policies to improve the incentive structures to support the regional and local engagement of universities and their faculty and staff. The lack of incentives is a common feature in many tertiary education institutions and countries where regional engagement is perceived not only as a secondary role for universities when compared with research, but also as a detracting activity. In Southern Arizona, the recruitment, and promotion of the university staff are nearly exclusively determined by research performance, measured primarily by publications. The "third mission" activities have been traditionally absent from the list of factors that have an impact on faculty career development. Tertiary education institutions need to incorporate local and regional development activities in the criteria for staff promotion and tenure.

The following measures would promote steering, sustainability and capacity building in Southern Arizona tertiary education:

- To improve the overall governance of the regional tertiary education system, the authorities and interested parties in Southern Arizona should work together with the other regions in the State to propose the establishment of a tertiary education co-ordinating body that would help define state-wide goals, policies and priorities.
- The Arizona legislature should make a long-term commitment to increase educational attainment in Arizona backed by a sustainable financial expansion plan. A two-pronged strategy could be articulated and implemented to achieve this goal: *i)* mobilise a greater share of public expenditures for tertiary education in the State of Arizona budget; and *ii)* increase resource diversification in the public universities. Furthermore, an adequate information system needs to be established to monitor the performance of tertiary education in Arizona and benchmark its progress with appropriate comparators in the US and among other OECD countries.
- At the regional/local level, a permanent partnership structure of key stakeholders from local and regional authorities, business and industry, the community colleges and the University of Arizona

should be established to provide a focus for dialogue with tertiary education in relation to its contribution to regional and local development, and identify and develop leaders within the public and private sectors to populate this partnership structure. A clearly articulated long-term integrated strategy should be developed to drive the economic, social, cultural and environmental development of the Tucson metropolitan region and Southern Arizona and the state and to complement the current project-based approached. Resources of tertiary education institutions should be mobilised in the preparation and implementation of regional and urban strategies.

- Tertiary education institutions should build on existing links and initiatives that align them with the regional needs in order to develop a common vision of local and regional development, and support this vision with a strategy, milestones and funding in order to ensure that local engagement is part of tertiary education institutions' activities and reflected in their development plans.
- Tertiary education institutions should review staff recruitment, hiring and reward systems so as to include the regional development agenda. They should create mechanisms to systematically monitor and evaluate the activities in this area, to share good practice within their institution and benchmark this experience with other organisations and localities.
- Tertiary education institutions should develop senior management teams to deliver the corporate response expected by regional and local stakeholders without discouraging entrepreneurial academics.

Chapter 1

National and regional context

This chapter gives a brief outline of Southern Arizona. It examines the tertiary education institutions in the region and their role in regional development. It highlights the key features and development trends in the tertiary education system in the United States and Southern Arizona.

Finally, it identifies the major challenges in the context of tertiary education institutions. These are: i) *the relative low level of tertiary education attainment and the substantial gap between population groups;* ii) *articulation between community colleges and the University of Arizona;* iii) *continuing decline of state funding for education; and* iv) *the absence of a steering mechanism for tertiary education in Arizona.*

1.1 Geography and population

Southern Arizona is the southern-most part of the Arizona State with a land area of 42 975 km^2 bordering the Mexican state of Sonora borders to the south. It includes three counties: Pima, Santa Cruz and Cochise. The combined population of the three counties is approximately 1.2 million people, *i.e.* 18% of Arizona's population. Pima County is the largest county, comprising 55% of the region's land area and 85% Southern Arizona's population. Cochise and Santa Cruz account for 11% and 4% respectively of the population. Approximately 23% of the region's land is owned by the Tohono O'odham and Pascua Indian Nations, both of which are in Pima County.

Since World War II, Arizona has one of the fastest growing populations in the United States. Between 1990 and 2000, Arizona experienced a 40.0% population increase which slowed down to 26.7% between 2000 and 2008. In Southern Arizona, the corresponding figures were 26.0% and 18.4%. The fastest growing county in Southern Arizona was Pima, at 20%. Population growth can be attributed to three factors: the popularity of Southern Arizona as a retirement destination for people older than 75; high birth rates; and migration, mainly from Mexico. Arizona has the third highest birth rate in the United States – 16.6 births per thousand people – compared to a national average of 14.2.

During 2007, 834 000 people immigrated to Arizona, while 287 000 left. In 2007-08, Southern Arizona experienced a net increase of 6 604 people, due primarily to migration into Pima County, which gained 7 021 people while Cochise and Santa Cruz Counties lost 115 and 302 people respectively. Immigrants from Central and Latin America, mainly Mexico, contributed to the increase in population.

Figure 1.1. The Southern Arizona Region

Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Arizona has the fastest growing Hispanic population in the US; Hispanics comprise 25% of the residents in the state Arizona, numbering at least 1.8 million. In Southern Arizona, 27% of the population are Hispanics. Santa Cruz County has a majority Hispanic population, while 40% of Tucson residents identify themselves as Hispanic.

The Arizona legislature has passed a number of controversial laws to address migration issues. In 2000, Arizona repealed the bilingual education laws in order to require that all classes are taught in English.[1] In 2008, access to formal learning in Arizona was deprived from undocumented

immigrants, contributing to a considerable decrease in the number of community college learners. In April 2010, an act was passed by the Arizona senate to authorise local police to require anyone whom they reasonably suspect of being in the United States illegally to provide evidence of their lawful presence. This act (The Support Our Law Enforcement and Safe Neighbourhoods Act) is currently subjected to federal injunction and not implemented. This legislation has raised concerns about racial profiling and the negative impact on international students in the state's tertiary education institutions. The migrant population may also choose to move to other US states instead of Arizona, which in the coming years will be in need of workforce for example in health care due to the ageing population.

1.2 Regional economy

The greatest sources of employment in Arizona are the services, trade and construction sectors, with service jobs accounting for 1 million jobs in 2006. In 2005, the tourism and travel industry had the largest share of employment: 11.1% or 371 737 people. Health care and biotechnology were second, at 7.2%, employing 241 874 people, up from 134 990 a decade earlier (NCHEMS, 2007). In recent years, tourism brought in an estimated USD 12 to USD 18 billion; however, the recession has had a negative impact on tourism. Construction has also declined, as 242 800 people in Arizona were employed in construction in 2006 and that number has gone down rapidly since the recent bust in the housing market. In addition, the manufacturing sector accounted for 183 100 jobs in 2006 (Arizona Department of Commerce, 2009). The greatest job growth is predicted in health care related occupations. Moreover, employment in health care support occupations is expected to grow by 33% and healthcare practitioner and technical occupations by 30%. The field of nursing is growing very rapidly, with 4 476 expected annual openings between 2005 and 2025 (NCHEMS, 2007).

Public sector employment plays a dominant role in the Southern Arizona economy. The top three employers in Southern Arizona are Raytheon Missile Systems (11 539 employees), the University of Arizona (10 575 employees) and the State Government of Arizona (9 329). Of the top ten employers, seven are government agencies (Table 1.1). The top three employers in Cochise County are the United States Army Intelligence Center at Fort Huachuca, the government of Cochise County, and the Sierra Vista Unified School District. The top employers in Santa Cruz County are located in the border city of Nogales and are: Canchola Foods Company, which operates McDonald's and other restaurants in Nogales;

Carondolet Holy Cross Hospital; and the federal government's Immigration and Naturalization Services. In many of the most innovative regions of the world, economic dynamism is based on the agility of private sector actors operating in highly competitive environments. Innovation is necessary for firm survival, success is rewarded in monetary terms and firms that cannot compete do not survive. The dominance of the public sector in the economy may distort the idea of innovation away from its core as "commercially useful knowledge" toward a broader definition of "new knowledge." Tertiary education institutions should therefore be encouraged to go beyond their traditional role of knowledge producers and embrace a more robust conception of innovation.

Table 1.1 Top employers in Southern Arizona 2009

Name	Employees
Raytheon Missile Systems	11 539
University of Arizona	10 575
State of Arizona	9 329
Davis-Monthan Air Force Base	7 509
Tucson Unified School District	7 227
Wal-Mart Stores	6 715
Fort Huachuca Army Base	6 463
Pima County	6 235
Freeport-McMoRan Copper & Gold	5 987
City of Tucson	5 635

Source: Tucson Regional Economic Opportunities (TREO) (2009), *Industry Strengths*, *www.treoaz.org/Industry-Strengths.aspx.*

In 2010, the State of Arizona's unemployment rate at 9.3% is higher than the national average of 8.7%. In Southern Arizona, unemployment rates vary by county. Pima and Cochise counties are roughly the same at 8.5 % and 8.6%, respectively. Santa Cruz County's unemployment rate is 15%, much higher than that of the other two counties and the national average.

Arizona's state and local taxes are below the national average, collecting USD 478 per capita, compared to an average USD 813 in the United States in 2005. Arizona ranked 39th out of 50 in per capita state and local income tax collection. Sales tax is an important source of tax revenue. The city of

Tucson, for example, has a total sales tax of 8.1%, which includes a 5.6% state sales tax. For the city of South Tucson, the total sales tax rate is 9.6%.[2]

In terms of GDP and average earning per job, the State of Arizona is below that of the national average. In 2005, the average per capita personal income in Arizona was USD 30 019, compared to USD 34 471 for the United States (NCHEMS, 2007). Per capita income relative to the US average has held steady for the past 15 years at about 87%.

Local economic development is addressed by county and municipal governments as well as state and federal programmes. Tucson has a federally funded Empowerment Zone where businesses receive tax credits for locating in that area. It also has an Enterprise Zone, a state programme that provides tax incentives to businesses location in certain low-income areas. Founded in 2005, Tucson Regional Economic Opportunities, Inc. (TREO) is a quasi-public agency representing strategic economic development interests in Southern Arizona. It recruits business to the area and provides services to facilitate the process. Tucson Regional Economic Opportunities (TREO) identified in 2007 seven industry strengths in Southern Arizona: Bioindustry, environmental technology, aerospace, information technology, optical sciences, advances composites, and tourism.

1.3 Tertiary education in the United States

Within US tertiary education, the most common classification system is the one defined by the Carnegie Commission on Tertiary education, also known as the Carnegie Classification (McCormick, 2000), which includes the following categories:

- Associate's colleges. Includes institutions where all degrees are at the associate's level, or where bachelor's degrees account for less than 10% of all undergraduate degrees. Excludes institutions eligible for classification as tribal colleges or special focus institutions.
- Doctorate-granting universities. Includes institutions that award at least 20 doctoral degrees per year (excluding doctoral-level degrees that qualify recipients for entry into professional practice; and also excludes special focus institutions and tribal colleges).
- Master's colleges and universities. Generally includes institutions that award at least 50 master's degrees and fewer than 20 doctoral degrees per year. Excludes special focus institutions and tribal colleges.

- Baccalaureate colleges. Includes institutions where baccalaureate degrees represent at least 10% of all undergraduate degrees and that award fewer than 50 master's degrees or 20 doctoral degrees per year. Excludes special focus institutions and tribal colleges.
- Special focus institutions. Institutions awarding baccalaureate or higher-level degrees where a high concentration of degrees is in a single field or set of related fields. Excludes tribal colleges. It includes religious seminaries and colleges, medical schools and medical centres, schools of engineering and schools of law.
- Tribal colleges. Colleges and universities that are members of the American Indian Tertiary education Consortium

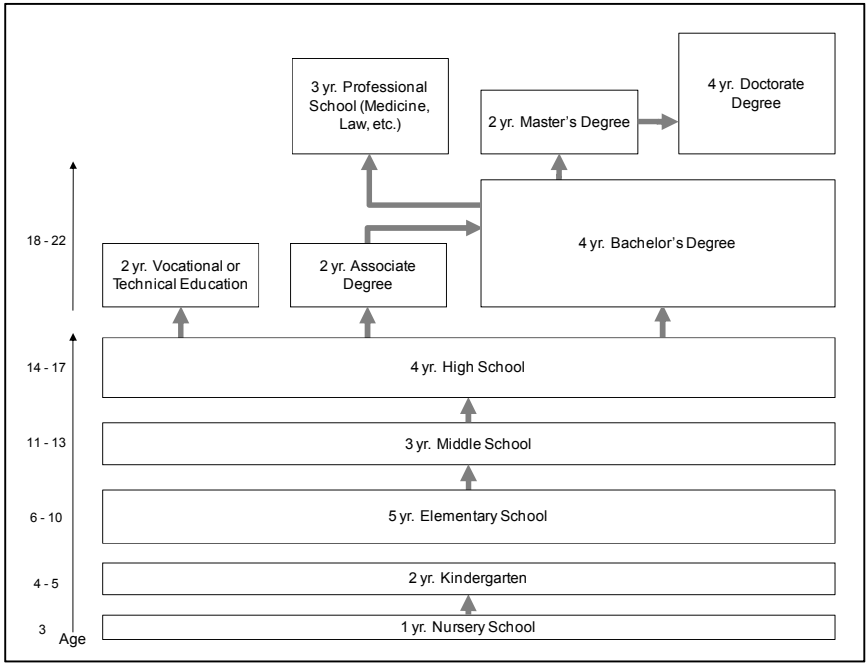
US tertiary education includes a highly diverse array of institutions with differentiated missions. Institutions are divided into categories in different ways: by the primary source of funding (public, private not-for-profit, and private for-profit); by the source of control (public if established by the state, private if an independent entity receiving a charter from the state); and by the highest degree granted. In 2007, there were 4 352 accredited degree-granting institutions, including 2 675 four-year institutions and 1 677 two-year institutions (Snyder, *et al.* 2009). Although public institutions comprise less than 40% of all accredited degree granting institutions, approximately four in five US students attends a public institution.

Of the total 1 667 two-year colleges, 1 032 are public institutions, usually called community colleges. They grant certificates and associate's degrees and enrol the largest share of undergraduate students. They play an important role in US tertiary education in providing affordable credit-bearing and non-credit educational opportunities. Community colleges offer degree programmes that provide a transfer gateway to four-year colleges and universities, certificate and degree programmes that prepare students to directly enter the workforce, and non-credit continuing education. Community colleges make an important contribution to widening participation in US tertiary education, especially for minority students. In 2005, 45% of all minority students were enrolled in community colleges (Ryu, 2008).

US tertiary education values its independence from government and its role in promoting inclusiveness and social mobility. The US Constitution does not include education as a federal responsibility; the states provide direct funding to public institutions and policy co-ordination. However, the US government provides major support for tertiary education through approximately USD 20 billion in need-based financial aid to students in the form of grants and loans. It is also the primary funder of scientific research.

Market forces play an important role in tertiary education; institutions compete for resources, faculty, students and prestige.

Figure 1.2. Educational system in the United States



Source: Elaborated with information from US Department of Education

Tertiary education attainment in the United States

There is a strong correlation between educated workforce and economic development.

In 2009, 41% of the US population aged 25-64 had a tertiary education degree compared to the OECD average of 28%. The United States ranked fourth among the OECD countries in the rate of postsecondary attainment among adults aged 25-64, with Canada, Israel and Japan in first, second and third place, respectively (OECD, 2011).

However, OECD data have drawn attention to the fact that the United States no longer leads the progress in tertiary education attainment. When educational attainment is disaggregated by age group, it becomes clear that in educating young people the United States is falling behind the

best performing OECD countries, which have made rapid progress during the last few years. In 2009, the United States was ranked 15th among the OECD countries in the postsecondary attainment rate of young adults: 41.05% of US population aged 25-34 had tertiary education (OECD average was 36.98%). (see also Figure 1.3).

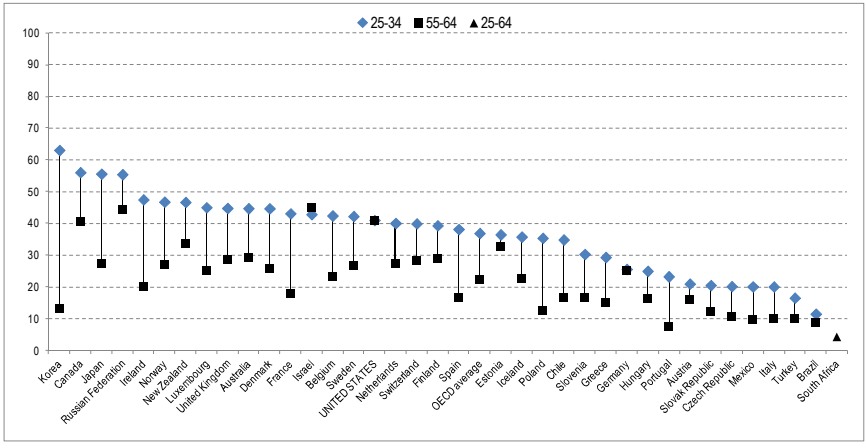
As a result, American young adults aged 25-34 are only slightly more likely to have a degree than older Americans aged 55-64, whereas in most other top-ranked nations, postsecondary attainment rates have considerably improved among the younger generation. For example, in Korea, only 13% of those in the older age bracket have a postsecondary credential, but 63% of young adults have completed postsecondary education.[3]

Furthermore, certain key groups in the United States are falling behind their older peers. In particular, young Hispanics, African Americans, and American Indians have slightly lower rates of postsecondary attainment than their older peers (Ryu, 2008). These data suggest that without significant intervention, future generations of Americans will have less education than those who came before them (Figure 1.3).

The Programme for International Student Assessment (PISA) evaluates 15-year-old school pupils' performances in reading, mathematics and science and this indicator allows for comparison of countries educational outcomes. For the United States of America, their performance in all three subjects is close to the OECD average, but lagging behind the best performing countries, such as Korea and Finland. In mathematics, a key subject in the knowledge economy, the United States is significantly falling behind. There is a large socio-economic disparity in the PISA results for the United States which limits the opportunities to develop a multi-skilled labour force and mitigates the potential for economic recovery and development (OECD, 2010, see Annex 1.A.1).

Figure 1.3. Population that has attained at least tertiary education in selected countries (2009)

Percentage, by age group



Source: OECD (2011) *Education at a Glance 2011*, OECD, Publishing.

Note 1: Countries are ranked in descending order of the percentage of 25-34 year-olds who have attained at least tertiary education. The year of reference for the Russian Federation is 2002.

Note 2: For technical reasons, these figures use Israel's official statistics, which include data relating to the Golan Heights, East Jerusalem and Israeli settlements in the West Bank.

In 2009, the US government declared the "bold goal" of restoring the United States to its position as the world leader of tertiary education graduates by 2020 (American Graduation Initiative). A range of policy changes have been pursued including: USD 10 billion competitive grant funding through the "Race to the Top Fund" and other programmes to accelerate the reformation of elementary/secondary education; redesigning the tertiary education financial aid application process and student loan programmes, devoting additional funds to the federal need-based Pell Grant programme; and leveraging an increased focus on degree completion at community colleges via new competitive grants under the proposed American Graduation Initiative.

In addition to Federal Government initiatives, major education foundations have targeted their resources toward increasing postsecondary education attainment, most notably the Bill & Melinda Gates Foundation and the Lumina Foundation for Education. After devoting most of its education grant-making toward scholarships and reform of elementary and

secondary education, including the movement toward college-ready standards, the Gates Foundation has announced a new initiative focusing on college success, and has reframed its elementary and secondary work toward the ultimate goal of boosting college attendance and success. In its strategic plan released in 2009, Lumina describes how it will focus virtually all of its grant-making and advocacy on the foundation's goal of 60% postsecondary attainment by 2025.

However, under the economic and financial crisis achieving the "bold goals" have proved challenging. For example, by March 2010, altogether 34 US states had made cuts to spending on their colleges and universities, imposing measures such as furloughs, layoffs and tuition increases. The projected cumulative budget deficit for all 50 US states and Washington DC in 2011 is USD 142 billion (Douglass, 2010).

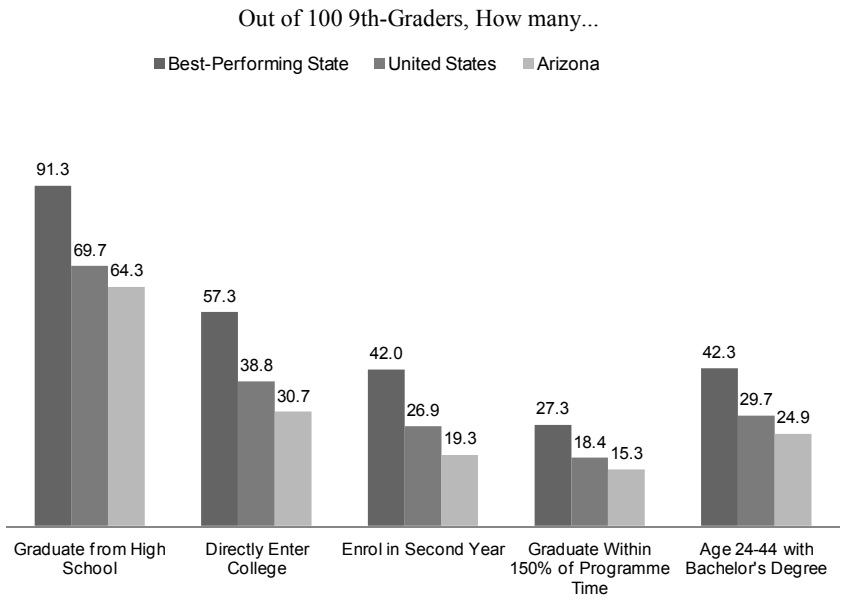
1.4 Tertiary educational attainment in Arizona

There is considerable scope for improvement in educational attainment levels in Arizona. For instance in 2006, 29% of Arizonans aged 25 to 65 held a bachelor's degree or higher, compared to 37% in the top performing US states (NCPPHE, 2006). Comparisons with attainment in other states vary by age group. In 2004, Arizona was slightly ahead of the average in the United States in educational attainment in the 55-64 age group (38% had an associate degree or higher, compared to 36.2% in the United States) (NCHEMS, 2007). However, there has been a declining trend in educational attainment among younger people in Arizona as well as elsewhere in the United States. Arizona lags behind the US average in the educational attainment of young people. In 2005, 39% of adults aged 25-34 in the United States held an associate degree or higher degree, compared to 31.8% in Arizona. In 2005, Arizona ranked 38th among the 50 states in the proportion of young adults with some postsecondary education degree (NCHEMS, 2007).

Arizona also lags behind other states in getting its students through the educational pipeline (Figure 1.4.). An important underlying factor is the disparities in educational attainment between racial and ethnic groups. Hispanic and Native Americans lag behind whites in education attainment at all levels. In 2005, 34.1% of 18 year olds were Hispanic, while 26.9% of the high school graduates were Hispanic. High school graduation rates for Arizonan Native Americans and Hispanics in 2006 were 46% and 61% respectively, compared to 74% for white students (AEE, 2009). The representation of Hispanics decreases at each successive point in the educational pipeline: Hispanics comprised 19.2% of first-time college freshman, 20.9% of recipients of associate degrees, and 11.5% of recipients

of bachelor's degrees. Whites are twice as likely as non-whites to have a bachelor's degree (NCPPHE, 2006). Projected population increase is concentrated in these two groups in the three counties in the Southern Arizona region.

Figure 1.4. Student pipeline 2004 - Arizona



Source: NCHEMS (National Center for Tertiary Education Management Systems) (2007), *A Feasibility and Demand Study for the State of Arizona*, NCHEMS, Boulder, p. 12.

The cost of tertiary education is a deterrent to participation. In 2006, the cost of attending community college represented 25% of the average family income; attendance at a public four-year institution represented 31%, up from 25% in 1992 (NCPPHE, 2006). Arizona provides limited state financial aid, and the average annual loan for undergraduates was USD 3 762.

1.5 Tertiary education institutions in Southern Arizona

The Southern Arizona region includes the following postsecondary institutions: the University of Arizona, a public, land-grant research university; three community colleges – Pima Community College, Cochise

College and Tohono O'odham College; and the University of Phoenix, a for-profit university.

The University of Arizona

The University of Arizona (UA) was founded in 1885 as a land-grant institution, that is, an institution authorised by the Morrill Act of 1862. The Morrill Act, also known as the Land-Grant College Act, was introduced to help finance tertiary education institutions in each of the states and meet the need for scientifically trained technicians and professionals. Land-grant universities are characterised by their commitment to community outreach and extension services. Outreach in agriculture was part of the founding philosophy, but it now extends to other areas.

In the second half of 2009, the University of Arizona (UA) enrolled 38 767 students, including 30 346 undergraduates, 6 989 graduate students and 1 432 professional students. The University of Arizona employs 14 396 individuals, including 2 165 full time faculty. In 2008, it offered 123 bachelor's degree programmes, 120 master's degree programmes, 95 doctorate degree programmes, 5 education specialist programmes, 3 professional degree programmes and 27 graduate certificates through 17 colleges and 21 schools. The campus is located in Tucson, and the Sierra Vista Campus of the University of Arizona South (UA South) was established as part of UA in 1995. The Sierra Campus enrols 815 students in 2011, it offers degree programmes to students in Southern Arizona and Northern Mexico, and carries the designation of "Hispanic Serving Institution", *i.e.* a tertiary education institution with more than 25% enrolment of Hispanic students. Classes are held in various locations around Southern Arizona, including the campuses of Pima and Cochise Community Colleges. UA South offers 16 bachelor's degree programmes and two master's degree programmes not offered at the main UA campus. UA South also offers certification programmes, endorsement programmes, certificates and non-credit programmes.

In 2008, the University of Arizona received 29% of its total revenue from the state (USD 589 553 400), 16% from tuition and fees and 39% (USD 496 974 385) in research gifts and grants; and 15% from auxiliary enterprise revenues, net investment income, and education department sales and services. The University's endowment was USD 335 million. In 2011, the absolute value for total revenue from the state was USD 600 934 400, a slight increase on 2008 figures and revenue from tuition and fees was USD 532 454 477.

Pima Community College

Founded in 1966, Pima Community College (PCC) is one of the ten largest multi-campus community colleges in the United States, enrolling 68 461 students in 2010 at more than 100 teaching locations. This is a decrease of around 5 000 students from 2008 when there were 73 740 students. It offers 195 transfer and occupational programmes, courses designated as transferable to qualifying universities. In 2008, about 84% of the students were enrolled in credit programmes; 66% attend part-time. Around half (45%) were enrolled in transfer programmes, 31% in occupational and workforce programmes, 20% in developmental programmes and 4% in special interest courses. 32% of students taking courses in the second half of 2009 indicated that they were attending the college with the intention of transferring to a four-year institution; 5.6% of students were enrolled at the University of Arizona and taking courses at PCC. PCC employs 951 staff, including 377 full-time instructional and educational support staff.

In 2009/10, Pima Community College (PCC) had a total revenue of USD 206 964 145, of which 47% came from county property taxes, 15% from tuition and fees, 7% from state appropriations, 23% from federal grants, and 8% from state sales tax, state and local grants and other sources.

Cochise College

Cochise College was founded in 1961 to serve the rural community of Douglas. In the second half of 2009, Cochise College enrolled 4 832 students at several sites and in on-line courses. Located near the Fort Huachuca military base, the college serves service men and women stationed there. In 2008, it offers 65 certificate programmes and 67 associate degrees, of which 40 are transfer programmes; by 2006, it had 343 full-time and 358 part time employees. It receives 32% of its funding from a local property tax, 30% from state appropriation, 11% from state appropriations, 11% from tuition and fees, 17% from government grants and contracts, and 9% from other sources.

Tohono O'odham Community College (TOCC)

Tohono O'odham Community College (TOCC) was founded in 1998 and fully accredited in 2004. It is a tribal college under the Tribally-Controlled Colleges and Universities Act and is designated by the Department of Education as a Minority-Serving Institution. There are 35 federally recognised tribal colleges in the United States serving a population of approximately 30 000; 29 tribal colleges received land-grant

status in 1994. Tohono O'odham Community College has land-grant status as a member of the 1994 group of Land-Grant institutions. In spring of 2009, TOCC enrolled 209 students, out of which 101 were full-time students. About 97% of students are members of the Tohono O'odham nation with an average age of 36 years. In 2009, TOCC has 58 full-time employees, including 16 faculty, 38 staff and 4 administrators. In 2008, 37% of TOCC's revenue came from the nation, appropriated by the Tohono O'odham Legislative Council; 17% from gifts and dividends; and 2% from tuition and fees, which are USD 47 per credit hour.

Around 56% of the Tohono O'odham Community College employees belong to the Tohono O'odham Tribe, 9% to other Native American tribes, and 36% are non-Native American. The college's mission includes revitalisation of the Tohono O'odham language and culture; offering associate degrees for transfer; certificates and apprenticeships for direct employment; and developmental education. Tohono O'odham Community College has teacher training programmes, childcare and social service programmes dedicated to addressing the shortage of American Indian teachers in Arizona and strengthening families and communities. It also offers courses to help students prepare for the General Education Development (GED) examination, a national high-school equivalency test.

The University of Phoenix

The University of Phoenix (UPX), a for-profit institution owned by the Apollo group, was founded in 1976 to serve working adults, operates 80 campuses and 114 learning centres in 39 states, the District of Columbia, Puerto Rico, Canada, Mexico, and the Netherlands. It falls under the purview of the Arizona State Board for Private Postsecondary Education, which licenses and regulates private universities, colleges, career colleges and vocational colleges. Like other institutions in Southern Arizona, it is accredited by the North Central Association of Colleges and Schools under the Higher Learning Commission. As a private, for-profit institution, its main source of revenue is tuition and fees (92%). In 2006/07, total institutional revenue from tuition was USD 20 913 000. As an accredited institution, UPX students are eligible to receive federal grants and loans. UPX offers 1 700 courses in bachelor's and master's degrees through face-to-face instruction, on-line courses, and programmes combining the two delivery systems. It has a campus in Tucson and learning centres in four locations. Enrolment in the Southern Arizona campus in the second half of 2007 was 2 287. Worldwide, UPX enrols 420 700 students. It has a core faculty of 1 410 professors and a part-time faculty of 20 507.

Articulation between community colleges and the University of Arizona

A key feature of the United States' tertiary education system is the articulation from community colleges to public universities. Transfer between Arizona community colleges and four-year universities is governed by a state-wide articulation agreement. Students can transfer using an associate degree, which transfers as a block of 64 credits; or a general education block of 35 credits called the Arizona General Education Agreement (AGEC). Completion of the AGEC courses at a community college fulfils the lower-division general education requirement to transfer to any public university in the state as an upper-division student.

These state-wide agreements are important instruments to facilitate transfer from two to four-year institutions. An increase in the education attainment rate will require, among other things, a higher rate of transfer between community colleges and four-year institutions. It is difficult to obtain accurate data on transfer rates, since institutions cannot always track their outgoing students. According to the Arizona Daily Star, 1 500 students transfer from community colleges to universities within six years (Mackey, 2009). Pima Community College cites an 8% transfer rate for men and 7% for women within three years of matriculating in the academic year 2005/06) (the sample size is 1 196 men and 1 160 women). Ensuring smooth articulation also requires ongoing communication between faculty members at four-year institutions and community colleges to ensure comparability of course content, appropriate advising for students and overall alignment of programmes.

1.6. Governance and funding of tertiary education in Arizona

The three public universities in Arizona – the University of Arizona, Arizona State University, and Northern Arizona University – are governed by the Arizona Board of Regents (ABOR). The board reviews and approves institutional rules and procedures, and has the authority to expend income of land funds, expend money for the use of benefit of the institution, to accept grants of money, and to issue bonds and manage money and property, including research parks.

Governance of community colleges changed in 2003, when the legislature eliminated the State Board of Directors for Community Colleges, a body that had oversight over all community colleges. The Arizona Community College Association (ACCA), a voluntary dues supported organisation, took over several co-ordinating functions, including the submission of statutory reports to the legislature, and data collection for

reporting to the legislature. In 2008, the governor announced the creation of the Arizona Community College Council, a new body that would give community colleges a seat during state budget negotiations and co-ordinate with other agencies. That entity was not launched until June 2009, when the new governor reinstituted the council, "to establish new state-wide goals and performance measures for the system and to propose a plan to deal effectively with the longer-term ramifications of the constricted economy" (State of Arizona, 2009). Each community college has its own board of trustees, elected by the public, and serving terms of four to six years.

State funding per student, considerably lower than the national average, has declined in the past twenty years. The decline has been steeper in elementary and secondary than in tertiary education. The reduction in education expenditures reflects the fact that Arizona faces a structural budget deficit, even before the economic crisis.

The economic crisis has had a severe impact on many US states, and many are cutting their education budgets to close the budget gap. The American Recovery and Reinvestment Act (known as the Stimulus Bill) ARRA has helped states to close the gap in the short-term, and much of the funding has been used to restore funding to education.

The funding of tertiary education in Arizona has deteriorated over the years and the global financial and economic crisis has accentuated the crisis. In 2008/09, the state government of Arizona was facing important budget gaps which were mostly addressed by imposing a USD 145 million cut to state universities and the Arizona Board of Regents. Since 2008, state support for the University of Arizona has declined by USD 100 million, from about USD 440 million to about USD 340 million a year. This has forced the institution to increase tuition, implemented a hiring freeze for state-funded positions; closed, merged or consolidated 58 programmes, 33 departments and four colleges; and cut about 600 state-funded campus jobs through reductions, position eliminations and not filing vacant positions (Lo Que Pasa, 2011). Similarly, community colleges in the state have been greatly affected considering that just in 2011 they received nearly USD 73 million budget cuts (Sunshine Review).

Under the American Recovery and Reinvestment Act (ARRA), Arizona received USD 2.3 billion for education funding out of which USD 831.5 million were allocated towards Arizona's Education Stabilization Fund. The money was used to cover elementary, secondary and tertiary education budgetary shortfalls for 2008/09, 2009/10 and/or 2010/11. USD 726.3 million was allocated specifically for tertiary education.

1.7. Contribution of tertiary education to the regional development

In Southern Arizona, each tertiary education institution charts its own course for regional engagement. Higher education institutions contribute to regional development in several ways: as employers, by preparing students for the workforce, and engaging in research and technology transfer. The University of Arizona is the second largest employer in Southern Arizona, with 14 663 employees in the second half of 2008. The employees include 40% classified staff, 2% administrative staff, 19% faculty, 19% graduate assistants, and 20% professional staff. There are 1 629 fulltime faculty. The University of Arizona Science and Technology Park generates 13 247 jobs, of which 6 175 are direct jobs. It pays USD 688 million in wages in Pima County, and generates USD 63.9 million in tax revenue. Pima Community College (PCC) is also a large employer, with 995 staff members, of which 371 are full time instructional and education support faculty. Cochise College is the tenth largest employer in Cochise County with 343 full-time and 358 part-time employees in 2006. Although Tohono O'odham Community College is small, with 49 full time employees, it contributes to the economy of the reservation. 61% of the employees belong to the Tohono O'odham tribe and 12% to other tribes.

The following growth sectors in Southern Arizona have been identified by Tucson Regional Economic Opportunity (TREO): bio-industry, environmental technology, aerospace, information technology, optical sciences, advanced composites and tourism. Table 1.2 outlines how the five institutions in the region are addressing these areas of growth in terms of human capital and skill development. The biggest gap appears to be in the field of tourism and green jobs.

Table 1.2. Tertiary education institutions and growth sectors addressed

University or College	Area addressed	Degree programmes offered
University of Arizona	Aerospace & mechanical engineering, biotechnology, medicine information technology, optical sciences	BS,MS, PhD
Pima Community College	Aerospace & mechanical engineering; biotechnology; information technology	Certificate, AS, AAS
Cochise Community College	Aerospace, information technology	Certificate, AS, AAS
Tohono O'odham Community College	Information technology	AAS
University of Phoenix	Information technology	AA, BS, MA, PhD.

Note: AA (Associate of/in Arts), AAS (Associate of Applied Science), AS (Associate of/in Science), BS (Bachelor of Science), MA (Master of Arts), MS (Master of Science)

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

The University of Arizona offers academic programmes and conducts research in all the identified growth clusters, excluding tourism. It also conducts considerable research in agriculture because of its land grant mission. The College of Optical Sciences, considered the best in the world, offers BS, MS, MS with MBA and PhD degrees, as well as graduate certificates. Research in the optical sciences is world-renowned. The University of Arizona also offers some 40 programmes in life sciences, which also provide foundational and graduate education relevant to careers in biotechnology. The university is addressing the need for health professionals by increasing recruitment of nursing and medical students. Over a four-year period, the number of nursing degrees awarded rose from 95 to 164 and the number of pharmacy PhD grew from 44 to 76.

The community colleges' mission includes responsiveness to local workforce needs. Pima Community College offers training for careers in public safety, elementary and secondary education, health and related professions, biotechnology and engineering, and several trades. It sponsors the Center for Development and Training to provide training directly aimed at locally defined economic needs in areas such as quality training for emergency services personnel, and safety training mandated by federal law. A 2008 survey conducted by Pima Community College showed that,

according to 82% of the community leaders, it had been successful in collaborating with business in Pima County.

Cochise College's offerings are tailored to meet the needs of local employers and staff and soldiers of Fort Huachuca US Army Base. It also serves inmates at the Arizona Department of Corrections. Cochise offers certificates in aerospace thermal fusion, aerospace welding technology, airframe mechanics and avionics technology, as well as health care occupations, education, information technology and IT security. Cochise also offers military service members an AAS degree in intelligence operations studies, aerospace and IT skills.

Tohono O'odham Community College has an extensive programme to prepare students for the General Education Development (GED) exam (a national high-school equivalency test) and offers programmes focusing on direct employment, apprenticeships, and transfer degrees. Its apprenticeship programmes prepare students for a variety of building trades, have open enrolment, and are free of cost.

The University of Phoenix offers courses in a range of disciplines, including the liberal arts, communications, psychology, counselling, criminal justice and nursing. It offers degree and certificate programmes as well as continuing education for professional licensure or certification, and training. In Southern Arizona, business and nursing programmes have been particularly attractive among students.

Challenges

There are three key policy issues that are important to the ability of Southern Arizona's tertiary education institutions to further regional development: the need to raise the level of tertiary education attainment; to facilitate stronger articulation between community colleges; and to increase the funding for education.

Raising the level of educational attainment is a key factor for economic growth in Southern Arizona. The region has a rapidly growing Hispanic population and there is a gap between their educational attainment and that of the white population. Furthermore, the achievement gap and the poverty of the Native American population are pressing issues in Southern Arizona. Despite the many good initiatives in place to improve the situation, more efforts need to be made to address these inequities.

Improved articulation between the community colleges and the University of Arizona is necessary in order to raise the attainment level in Southern Arizona. Currently, barriers remain that limit articulation and

transfer despite the state-wide policies for the transfer of general education courses and the associate degrees as well as the ambitious plans by the University of Arizona to expand enrolments by 10 000 by 2020, in part by increased collaboration with community colleges. Greater efforts should be targeted at outreach, student advising and policies concerning application of transfer credit.

Continuing decline of state funding is affecting the quality and access of tertiary education. Experiences in the US states, such as California where the funding cuts have been very steep, have brought along employee furloughs, cuts in the numbers of courses available any given semester and a reduced capacity in the four-year colleges to admit transfers from two-year institutions. Further cuts in elementary and secondary schools will make it even more difficult to attract and retain qualified teachers, and are likely to result in larger class size. Continued cuts are likely to have the same effect in Arizona. Additionally, special support services for students are usually the first victims of cuts, affecting the students with the greatest need for academic and other support.

Finally, the absence of a regional vision or steering mechanism for tertiary education in Southern Arizona makes it difficult to create a plan for the future and integrate the efforts of the region's tertiary education institutions. The Pima Community College and the University of Arizona have long-standing and close working relationships, but informal co-ordination among the five institutions in the region remains limited. While US states vary in their state-wide and regional co-ordinating mechanisms and there is no one-size-fits-all model, the absence of state–wide co-ordinating mechanisms or mechanism to articulate a vision and create a strategy for tertiary education and regional development results in the fragmentation of institutional efforts.

Notes

1. During a temporary transition period, pupils classified as "English Learners" are educated through sheltered English immersion programmes which provide nearly all classroom instruction and materials in English, but may use a minimal amount of the child's native language when necessary.

2. Tucson Regional Economic Opportunities, Inc. Tucson Regional Economic Profile, n.d.

3. Because of differences in the structure of postsecondary education and national data collection systems, international statistics such as these often contain inconsistencies. Correcting for these inconsistencies results in estimates that the rates of postsecondary attainment among young adults are closer to 41% in the United States and 49% in Canada, a smaller gap, but still substantial.

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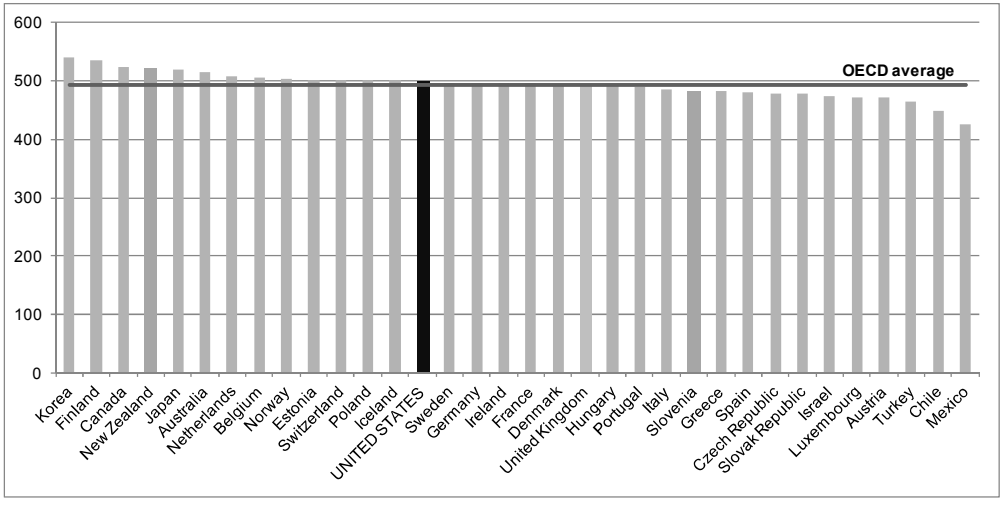
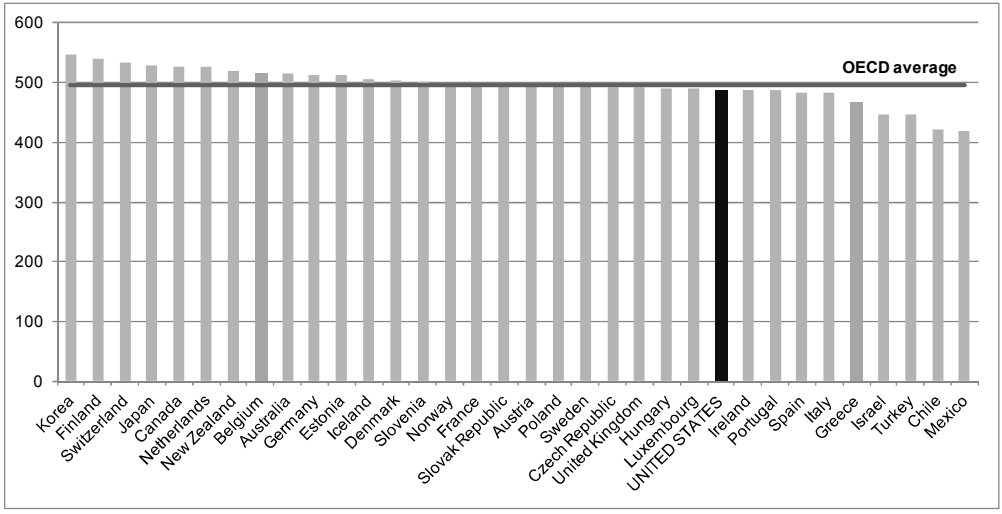
Annex 1.A1 PISA 2009 results

Figure 1.A1.1 Student performance: average PISA score in OECD countries

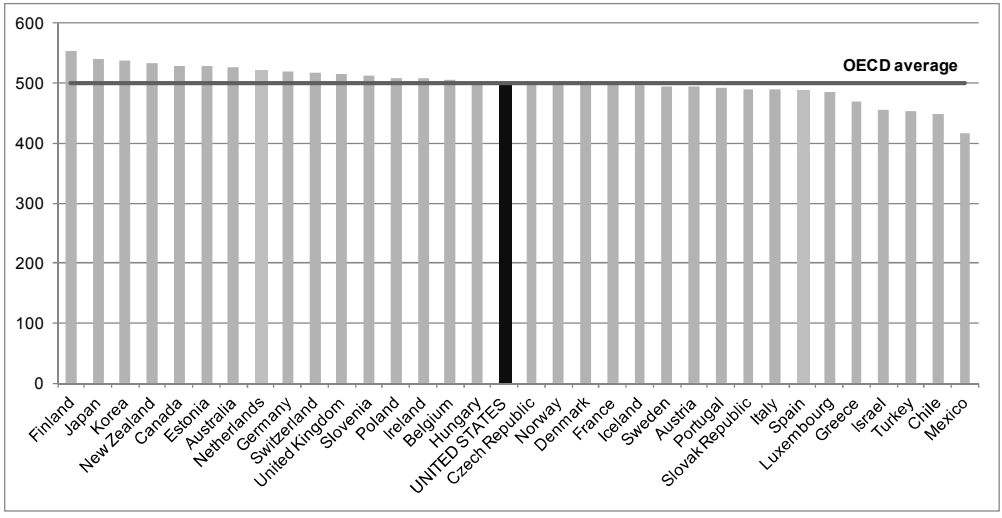
Reading scale



Mathematics scale

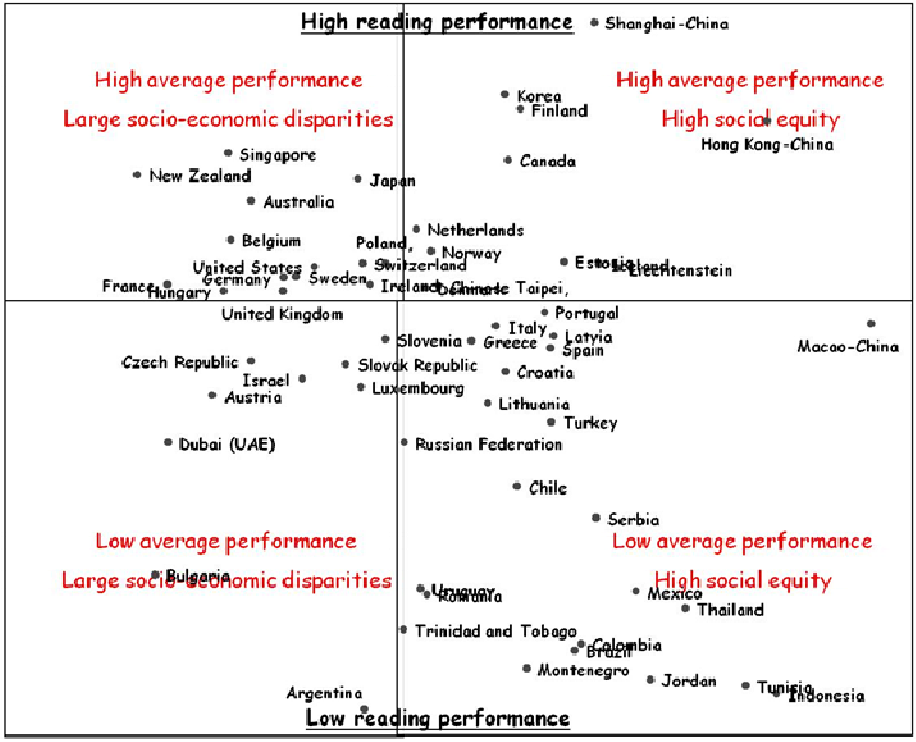


Science scale



Source: OECD (2010), PISA 2009, OECD, Paris.

Figure 1.A1.2 Strength of the socio-economic gradient and PISA reading performance



Source: OECD (2010), PISA 2009, OECD, Paris

Table 1.A1.1. Strength of the socio-economic gradient and PISA reading performance

	Score point difference associated with one unit increase in the PISA index of economic, social and cultural status	Average student performance
Shanghai-China	26.95364424	555.8281134
Korea	31.89585081	539.2674893
Finland	31.06929289	535.8779753
Hong Kong-China	17.40073792	533.1512703
Singapore	47.23906629	525.8965239
Canada	31.72187458	524.241845
New Zealand	52.27926412	520.8799983
Japan	40.08110682	519.8577294
Australia	45.95813541	514.9006564
Netherlands	36.82921585	508.4037133
Belgium	47.08949138	505.9457662
Norway	36.02484815	503.2300286
Estonia	28.61279698	500.9618257
Switzerland	39.77774331	500.5002359
Poland	38.52212359	500.4784684
Iceland	26.67353183	500.2833922
UNITED STATES	**42.43739989**	**499.8268135**
Liechtenstein	25.63645125	499.3222332
Sweden	43.48186661	497.4494431
Germany	44.17087301	497.3050538
Ireland	39.41136341	495.6390937
France	50.61613083	495.6165806
Chinese Taipei	35.58686009	495.240479
Denmark	36.28947767	494.9161793
United Kingdom	44.19687468	494.1820287
Hungary	47.51902278	494.1787355
Portugal	29.70308292	489.3349035
Macao-China	11.63733474	486.6352887
Italy	32.39656119	486.0510915
Latvia	29.2162251	483.9601629
Slovenia	38.52980601	483.0819914
Greece	33.75674742	482.7762296
Spain	29.41288051	481.0423397
Czech Republic	45.94721614	478.1867339
Slovak Republic	40.75205154	477.4433396
Croatia	31.88835843	475.7489051
Israel	43.13268127	473.9899308
Luxembourg	39.8814893	472.1730861
Austria	48.13679398	470.2836389
Lithuania	32.8724727	468.4427394
Turkey	29.32357028	464.1943785

Table A.1.1. Strength of the socio-economic gradient and PISA reading performance (continued)

Dubai (UAE)	50.57711898	459.4368246
Russian Federation	37.49810848	459.3959588
Chile	31.21814273	449.369602
Serbia	26.87426859	442.0166956
Bulgaria	51.27529425	429.0810425
Uruguay	36.59935951	425.8133528
Mexico	24.65921224	425.2653095
Romania	36.25293106	424.4583075
Thailand	21.91007338	421.3744066
Trinidad and Tobago	37.53437089	416.452405
Colombia	27.69578931	413.1815005
Brazil	28.03956196	411.7549158
Montenegro	30.71392927	407.5478461
Jordan	23.8378968	405.0093094
Tunisia	18.56574631	403.6326641
Indonesia	16.84979526	401.7051906
Argentina	39.70253545	398.2608751

Source: OECD (2010), PISA 2009, OECD, Paris

Chapter 2

Contribution of tertiary education to human capital development

This chapter examines how effectively tertiary education institutions in Southern Arizona contribute to meeting the social and economic needs of the population in terms of opportunities to study and relevance of the qualifications offered. It identifies the main strengths and areas for improvement of the tertiary education system in Southern Arizona.

The chapter closes with a series of recommendations that include the need to design a long-term vision outlining the role of tertiary education in support of regional development and the responsibilities of the state for tertiary education governance and funding.

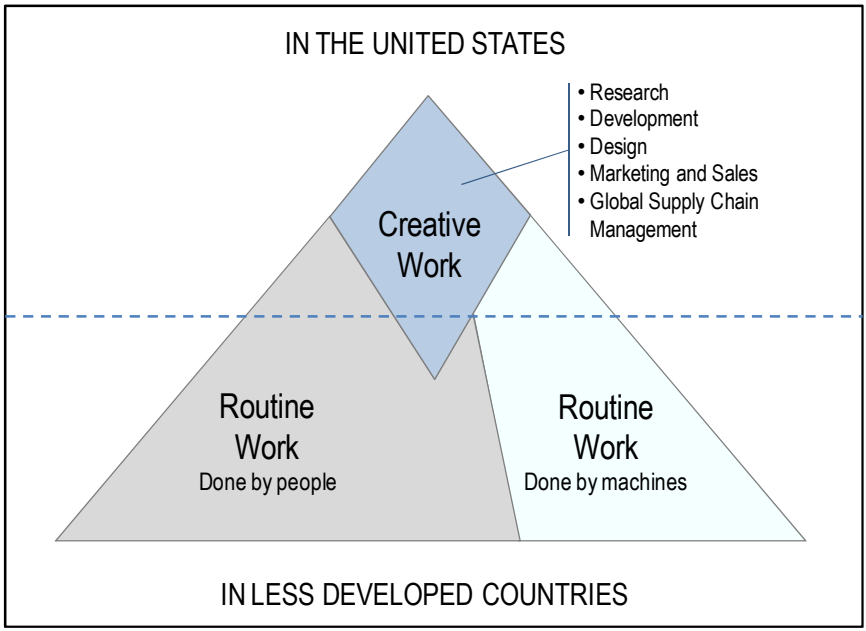
Introduction

In times of financial and economic crisis, governments find it difficult to resist the temptation to cut down expenditures in social sectors, including education, which are often perceived as non-priority areas. As shown in Chapter 1, the recent budgetary decisions of the Arizona legislature are a textbook example of this kind of behaviour. Yet, there is ample evidence that investment in human capital can contribute to economic recovery. The OECD (2009) emphasises that there are large and often growing earnings differentials between individuals with tertiary education qualifications and those who have only completed high school. When the economy is in trouble, job prospects for less qualified youths tend to deteriorate more than for youths with tertiary education qualifications. In addition, educational attainment seems to be positively associated with important social outcomes, such as better health, participation in political life and interpersonal trust.

Beyond short term considerations about the most appropriate investment to accelerate recovery from the crisis, there are clear indications that investment in human capital is vital for the future of the US economy. The New Commission on the Skills of the American Workforce concluded its work in 2006 by recommending that, in order to avoid losing the education race to other nations in the global economy, a total overhaul of the US education system was imperative. This would allow supporting the strengthening of economic sectors with high-value products and services, as illustrated by Figure 2.1.

In late 2006, four former state governors, including Mr. Richard Riley, former US Secretary of Education, wrote to every governor in the United States, warning that "we can no longer afford to be complacent about the performance of higher education in America" and urging them to make higher education a priority. In July 2009, the Obama administration launched an ambitious plan that will offer significant additional resources, through the "Race to the Top Fund" mentioned in Chapter 1, to expand and strengthen the community college sector throughout the nation.

Figure 2.1. Proposed international distribution of labour in the knowledge economy



Source: NCEE (National Center on Education and the Economy) (2007), Tough Choices or Tough Times: The Report of the New Commission on the Skills of the American Workforce, NCEE, Washington, D.C., *www.skillscommission.org/pdf/exec_sum/ToughChoices_EXECSUM.pdf.*

In this context, this chapter examines the following three dimensions to assess the effectiveness and coherence of human capital formation policies in Southern Arizona:

- Widening access: do the existing tertiary education providers offer adequate learning and training opportunities to the local population?
- Demand for skills: are existing tertiary education institutions and programmes adequately aligned with the skill needs of the local economy?
- Governance and financing framework: does the State of Arizona co-ordinate and govern tertiary education in an effective manner and provide sufficient financial support?

2.1 Widening access

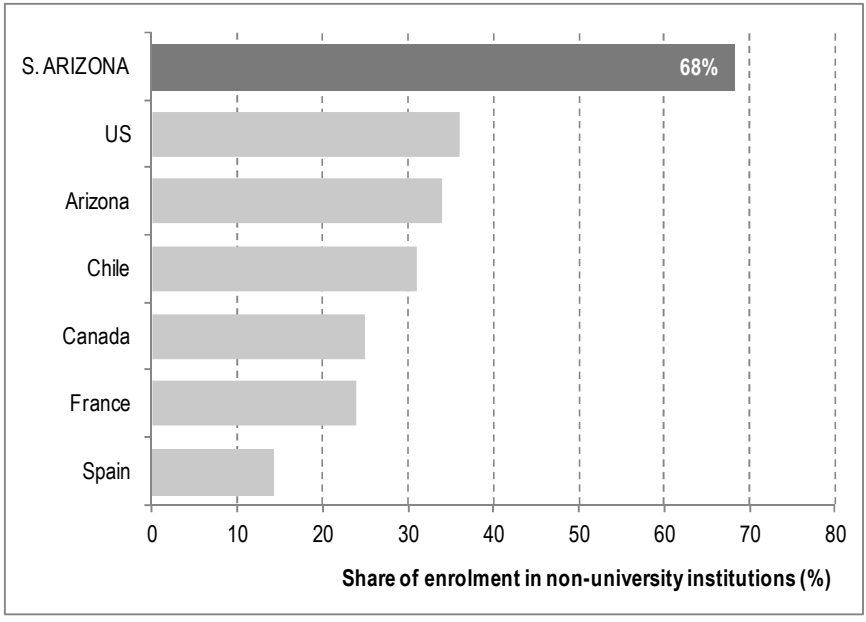
Given the extensive social and private benefits that result from tertiary education, inclusive access and success are essential for achieving social justice and ensuring the realisation of the full potential of all people. For Southern Arizona, as for any other region in the world, widening access and eliminating education inequalities is an imperative for two complementary reasons: fairness and efficiency.

In the interest of social justice, every individual must be given an equal chance to partake in tertiary education and its benefits, irrespective of income and other individual characteristics, including gender and ethnicity. In addition, there is a strong economic efficiency argument in favour of widening access. A talented, low-income student who is denied entry into tertiary education represents a loss of human capital for the individual person and for the region as a whole. The lack of opportunities for access and success in tertiary education leads to under-developed human resources and a resulting shortfall in the capacity to capture economic and social benefits (Ramcharan, 2004). At the macroeconomic level, the development of human capital is a key driver of competitiveness and growth.

Positive achievements

One of the major strengths of the US tertiary education system is its high degree of institutional differentiation, which allows catering for the learning and training needs of an increasingly diversified student population. The situation in Arizona illustrates this strength in three ways. First, as documented in Chapter 1, Southern Arizona has a comprehensive network of tertiary education made of a major research university; three community colleges whose branch campuses are aligned with the geographical distribution of the local population; and private institutions catering to the training needs of the working population. This means that potential students have a large range of options to choose from to match their level of academic preparation and their personal needs with the supply of education programmes. In 2009, about 32% of the students attending a public institution in Southern Arizona were enrolled at the University of Arizona, and 68% study in a community college. As illustrated by Figure 2.2., the proportion of students enrolled in two-year colleges is much more favourable than the state average (66% / 34%), the national average (64% / 36%) and the proportion that can be observed in selected OECD countries.

Figure 2.2. Proportion of students enrolled in non-university institutions



Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

Second, most of these institutions, especially the community colleges and the private institutions, are embedded in their communities to better serve the needs of the local population. Pima Community College, the largest tertiary education institution in Southern Arizona, operates six campuses, four educational centres and more than 100 different teaching locations throughout Tucson. Cochise Community College is the largest rural community college in the State of Arizona, offering courses on five campuses, five educational centres and numerous high schools throughout Cochise County. Of more recent creation, Tohono O'odham Community College is the only tribal college in Southern Arizona, seeking to serve the educational and cultural needs of the Tohono O'odham nation in the southern part of the region.

Even the University of Arizona has attempted, as part of its outreach programme, to get closer to the local community. In 1995, it established a small campus in Sierra Vista, under the label of University of Arizona South. UA South operates as a branch campus with its own administrative

body and faculty. It enrolled about 1 200 students in 2009 in classes distributed in various locations around Southern Arizona, including the campuses of Pima and Cochise Community Colleges. The courses offered are only division courses (300 and 400), delivered through hybrid online and traditional face-to-face modalities to older students, including active military duty students. UA South offers 11 bachelor's degree programmes and two master's degree programmes not offered at the main University of Arizona campus.

Third, unlike what happens in countries where non-university institutions often represent dead-end academic careers, in the US in general and in the State of Arizona in particular, there are pathways and bridges across the various types of institutions, thus making it easier for students to move from one type of institution to the other. The articulation between the community colleges and the University of Arizona, governed by a state-wide agreement, is a key element of this setup. Students can transfer through two mechanisms, either by using an associate degree, which transfers as a block of 64 credits; or by completing a general education block of 35 credits called the Arizona General Education Agreement (AGEC), which fulfils the lower-division general education requirement to transfer to any public university in the state as an upper-division student.

Academic challenges

Despite the achievements, Southern Arizona needs to do more to widen access and increase education attainment. As documented in Chapter 1, the region still falls short when compared to the national average. Two issues will have to be addressed in that context: the preparation of high school graduates, and retention/progression at the tertiary education level.

One of the recurrent concerns mentioned by the leaders of the tertiary education institutions visited during the South Arizona Review is the insufficient level of preparation of incoming students, due to serious quality and equity problems in K-12 education.[1] The proportion of high school graduates who are not ready for college is estimated at anywhere between 50% and 80%. In the 2006 State Report Card on Higher Education prepared by the National Center for Public Policy and Higher Education, Arizona got a D for its poor performance in preparing students for college (NCPPHE, 2006). With a high school completion rate of 82%, the state is below the national average of 86% and considerably below the 94% performance of the top states in the US (Connecticut, Maryland, Massachusetts, New Jersey, New York, Utah, Virginia). The probability of completing high school for students from low-income families is one-third lower than for students from a high-income background. The proportion of low-income 8th graders

scoring at or above "proficient" on the national assessment math exam is only 12% compared to 22% in the top states.

Overcoming these quality and equity gaps is not the direct responsibility of the local tertiary education institutions. In the first instance, it is up to the school authorities to work towards improving the quality of education in the State of Arizona. They will need to address these problems in a comprehensive manner and mobilise appropriate levels of financial resources in spite of the economic downturn.

At the same time, however, the community colleges and the University of Arizona can reach out to the local high schools to help improve the motivation and academic performance of pre-college students. Several programmes are already in operation. For example, there is a regional initiative, "Tucson Values Teachers", which aims to improve the quality of K-12 teaching in the Tucson area (Box 2.1.). Cochise Community College offers a technical preparation programme throughout the county high schools to boost up the skills of potential students. These students can also benefit from a 50% reduction in tuition once they enrol in Cochise College courses. Tohono O'odham Community College maintains an open enrolment policy and offers free tuition for apprenticeship programmes. It has also partnered with the University of Arizona since 2000 on an initiative to train teachers who are tribal members (Project NATIVE). Scholarships are available to students of American Indian descent who are willing to work in the territories of the Tohono O'odham Nation or in Tucson schools with a high proportion of American Indian students after completing their studies at the College of Education. Pima Community College runs two federally funded college preparation programmes, Talent Search and Upward Bound, which offer academic advice, tutoring, and assistance with admissions and financial aid applications. The OECD review team encourages all concerned tertiary education institutions to step up their outreach efforts and share good practices among themselves in a more systematic manner.

Box 2.1. Tucson Values Teachers

Tucson Values Teachers is a regional initiative involving the University of Arizona, local businesses and non-profit organisations in concrete actions to retain, recruit and reward K-12 teachers in the Tucson area, in recognition of the critical role of teachers and their vital influence on the future generations.

More than 10 000 teachers at local public, private and charter schools are targeted to receive donations throughout the project. The campaign is "part of fulfilling the organisation's goal of increasing teacher salaries to nationally competitive levels within five years."

Tucson Values Teachers has identified four focus areas necessary to the foundation of teachers' success. These areas are: *i*) incentives, *ii*) internships, *iii*) professional development and *iv*) educational resources. Businesses can donate incentives to help increase teacher salaries by offering discounts on professional and personal services and products. Teachers can earn industry wages during the summer months while learning how the businesses work and then apply that knowledge in the classroom. Furthermore, the University of Arizona is partnering with Tucson Values Teachers to create internships for science, technology, engineering and math teachers to better prepare them to instruct in these subjects. Tucson Values Teachers is also finding effective ways to provide professional development relative to 20th century learning goals. In seeking new revenue to support teachers, students and schools, Tucson Values Teachers is also partnering with Voices for Education, a parent-based education advocacy organisation that works to improve the educational outcomes of Arizona's students. This organisation is conducting research to identify new revenue sources to make K-12 teacher salaries more competitive nationally.

Many Southern Arizona teachers are in a position where they have to spend from USD 500 to USD 1 000 of their salary annually to purchase school supplies. With the fact that teachers are being underpaid already, this "forced" expense is an additional burden for them and their families. Tucson Values Teachers has worked with Walgreens drugstores in Pima County and Sierra Vista to host the first campaign "Tucson Supplies Teachers" to address this issue. Each store hosted collection boxes for a month at the beginning of the 2009 academic year for the community to drop off items such as notebooks, pencils and crayons.

Source: Tucson Values Teachers (2010), Tucson Values Teachers website, *www.tucsonvaluesteachers.org*, accessed 16 April 2010.

Improving retention and progression in tertiary education will require, among other things, a higher rate of transfer between community colleges and four-year institutions. It is difficult to obtain accurate data on transfer

rates, since institutions cannot always track their outgoing students. According to available estimates, however, 1 500 students transfer from community colleges to universities within six years (Mackey, 2009a). Pima Community College cites an 8% transfer rate for men and 7% for women within three years of matriculating in the academic year 2005-06. Feedback received during the field visits reveals that, while University of Arizona students are easily taking advantage of learning opportunities at the local community colleges, the transfer rules and conditions may still appear confusing to a significant proportion of community college students.

The fact that there is room for further progress in overcoming the achievement and motivation gap between minority students and white students is further demonstrated by comparing the ethnic distribution of students entering local community colleges and those enrolling at the University of Arizona as transfer students. The proportion of white transfer students is higher than the proportion of white students originally enrolled at the community college, from which the transfer population can be expected to come (Table 2.1.).

Table 2.1. Ethnic distribution of transfer students, %

Academic Results	Pima Community College (students enrolled in fall of 2005)	University of Arizona (new resident transfers in fall of 2007)
African American	4.4	3.4
American Indian	4.4	4.5
Asian American	2.2	4.1
Hispanic	38.8	23.1
White	47.4	64.7
Non-resident alien	2.9	0.1

Source: Pima Community College and University of Arizona statistics, 2009.

Ensuring smooth articulation requires close collaboration among all institutions concerned, including joint planning and regular communication between faculty members at the University of Arizona and at the community colleges to ensure comparability of course content, appropriate advising for students, and overall alignment of programmes. The joint admission programme between the University of Arizona and Pima Community College appears to operate smoothly in that respect. The OECD team recommends envisaging a similar mechanism to link the university with Cochise Community College and Tohono O'odham College. Between departments at the university and in the community colleges there are also many individual linkages which are worth bringing under a co-ordinating

umbrella, not to impose a controlling framework but to allow for fluid cross-fertilisation of experiences across schools and departments within the respective institutions.

Furthermore, the OECD review team also suggests implementing a common course numbering system for the entire state. Such a system exists in the State of Florida and is one of the tools that Florida uses to facilitate efficient and effective progression among its 11 state universities and 28 community colleges, in the context of a state-wide articulation agreement (Box 2.2). In fact, half of the students receiving a bachelor's degree in the State of Florida originate in the community college sub-system. This is both impressive and cost-effective for Florida and is an idea worth considering for Arizona.

Box 2.2. The Florida Common Course Numbering System

Created in the 1960s, Florida's Statewide Course Numbering System is a key component of Florida's K-20 seamless system of articulation. The system provides a database of post-secondary courses at public vocational-technical centres, community colleges, universities and participating non-public institutions. The assigned numbers describe course content to improve research, assist programme planning, and facilitate the transfer of students.

Source: State of Florida (2010), The Statewide Course Numbering System website, *http://scns.fldoe.org/scns/public/pb_index.jsp*, accessed 16 April 2010.

Generally speaking, the OECD review team suggests including Tohono O'odham College more systematically into the tertiary education community of the Southern Arizona Region and identifying ways to support the efforts of the younger public institution to draw more extensively on existing resources in the community.

All tertiary education institutions in the Southern Arizona Region must be wary of the danger of "mission creep". For example, in the case of the University of Arizona, while the outreach model developed for its South Campus reaches students in their community with a more appropriate schedule (late afternoon and weekend classes) and a flexible model based on smaller classes, in its 14 years of existence, UA South has not reached sufficient economies of scale to justify its continuation. This finding is consistent with the results of research on college costs nation-wide, which show that upper-division programmes tend to be expensive to operate as free-standing institutions (NCHEMS, 2007). Overall, UA South illustrates an interesting *ad hoc* initiative to match the strengths of the university with

local needs. But it was not initially planned with a long term vision and it does not have sufficient resources to staff and support the programme adequately. UA South is caught between wanting to design programmes more adapted to the needs of the local community and having to abide by the requisites of the main campus, which retains academic oversight. If the University of Arizona wants to maintain this window of local outreach, then it should dedicate appropriate planning and sufficient resources to UA South.

Similarly, the proposal by Pima Community College to start offering its own bachelor's degrees should be carefully studied to avoid any risk of dilution of mandate as a well as mission creep across the Arizona's public tertiary education institutions. If embedding some of the upper division courses in the local community is important for improving retention and progression, then Pima Community College and the University of Arizona could envisage joint programmes. Table 2.2 presents examples of successful partnerships between universities and community colleges in the United States and Canada that could be taken into consideration in Southern Arizona.

Table 2.2. Models of partnerships between community colleges and universities

Partnership	Areas of partnership
Guelf University with Humber College Institute of Technology and Advanced Learning (Ontario, Canada)	Four years of full time study leading to two credentials: a university degree and a college diploma. Innovative learning facility.
University of Alberta and Grant McEwan College (Alberta, Canada)	Offers both college and university programmes (regular and applied bachelor degrees, university transfer programmes, diploma and certificate programmes. Preparation for both University and College University transfers programme give undergraduates the option of taking their first two years in a small-class setting before moving to the University of Alberta.
York University and Seneca College (Ontario, Canada)	Joint degrees offered in media and advertising majors.
University of Oregon, Lane Community College and Southwestern Oregon Community College (Oregon)	Students admitted into dual-enrolment programmes may satisfy the general education requirements for the UO either by completing the Associate of Arts Oregon Transfer degree or by using the "direct transfer" path. Students have access to student services at both the university and community college campuses.
North Carolina State University and Craven College	Students can enrol towards both associate's and bachelor's degree in one of 17 programme areas. Six of the 17 programmes can be finished online after completing an associate's degree programme (except nursing which requires on-campus instruction or on-site clinical or practical experience. Institute of Aeronautical Technology in Havelock hosts both associate and bachelor's degree programmes in related fields.

Source: *www.guelphhumber.ca/; http://www.macewan.ca; www.senecac.on.ca/degrees/senecayorkdegrees.html; http://admissions.uoregon.edu/freshmen/dualenrollment; www.cravencc.edu/educational/univconn.cfm.*

Widening access is not only about providing equal opportunities to enrol in a tertiary education institution, but also about making sure that students from disadvantaged backgrounds do not face additional barriers to succeed beyond their own efforts and motivation to achieve good academic results. Retention and graduation rates are important indicators of whether a tertiary system or institution is supportive of students' progression after admission. The University of Arizona has a one-year persistence rate of 78%, a four-year graduation rate of 34% and a six-year graduation rate of 57%. These numbers compare favourably to the national averages of 65.7% persistence from first to second year, 36.2% four-year graduation rate, and 56.1% graduate rate after six years (ACT, 2008; NCES, 2010). It should be noted, however, that the graduation rate of public research universities with high

research intensity is 70%, much higher than that of the University of Arizona (ACT, 2008).

Table 2.3. presents the graduation and success rates at the main two community colleges and compares them to the national average. The graduation rates in the community colleges are generally at a low level and the community colleges in Southern Arizona do not make an exception to this.

Table 2.3. Progression at the community colleges

Academic results	Pima College	Cochise College	Nation-wide Public
Graduation rate	16% (M) – 28% (F)	14% (PT) – 26% (FT)	21.9%
Success rate	24% (M) – 25% (F)	n.a.	n.a.

Note: the graduation rate measures the proportion of incoming students who complete their associate degree or certificate, while the success rate also includes transfer students.

F = female; M = male; PT = part time; FT = full time; n.a. = not applicable

Source: Pima Community College; and National Center for Education Statistics (2010), Integrated Postsecondary Education Data System, *http://nces.ed.gov/IPEDS*, accessed 3 April 2010.

The potential for improving the remedial side of academic and financial support at Pima Community College is illustrated by the results of the Student Survey conducted in late 2008. While 84% of the students were satisfied with their overall experience, emphasising in particular the quality of facilities, the variety of courses and the knowledge of their teachers, many of the factors highlighted as areas of weakness had to do with support for students with academic difficulty and the availability of student aid. Pima College authorities use the results of the survey to try to remedy to these deficiencies. Similarly, Cochise Community College has put in place several special programmes to support at-risk and under-prepared students, including the creation of a Retention Specialist.

The OECD review team would like to signal that, by not participating in the Access to Success Initiative[2], the State of Arizona seems to have missed an important opportunity to work towards reducing the achievement gap between mainstream students and minority students in concert with other States facing the same problem. The 24 States that partnered in 2007, including Maryland, California and New York, share the goal of halving the gap in college completion rates that low-income and minority students face by 2015 (Vise, 2009).

Southern Arizona could consider a stronger public-private multi-stakeholder action to widen access to and improve success in education. Examples in the United States include The El Paso Collaborative for Academic Excellence that has brought measurable improvements particularly in the performance of Hispanic students. Underlying individual institutional efforts is a College Readiness Consortium, which connects efforts in primary and secondary education institutions in all school districts in the region to tertiary education programmes to increase access and attainment (Box 2.3).

Box 2.3. El Paso: widening access through broad-based long-term collaboration

The ability of the tertiary education institutions to widen access and increase educational attainment depends significantly on preparation in primary and secondary education. The El Paso Collaborative for Academic Excellence is a long-term multi-stakeholder public-private effort, initiated by and based at the University of Texas at El Paso, to improve educational attainment and retention from the first year in school through college or university degree programmes. The goal of the collaboration, which started in 1991, was to make systematic changes in educational policy and curriculum in all of the twelve El Paso County School Districts that would produce measurable results in performance in key areas of the curriculum. A specific goal was to decrease the achievement gap across ethnic and socio-economic groups. The collaborative includes membership from the business community, all levels of educational institutions (from primary through university), the public sector and a non-profit organisation concerned with improving educational achievement.

The approach of the collaborative has been measurably successful, particularly in improving the performance of Hispanic students, a group with the largest proportion of low-income students and for whom English is usually a second language. Test results for Hispanic students in the critical 11th grade (a year before college entry) show improvement in performance from the 33rd percentile in 1993 to the 72nd percentile in 2008. Hispanic students show increases in enrolment in science, technology, engineering and mathematics related curriculum over the period of collaborative activities and a graduation rate of 76.7%, which is the highest among the large urban school districts in the State of Texas. Given that Hispanic students make up 89% of the student population in the El Paso school district, improvement in their educational achievement has had a significant effect on the overall performance of the school districts.

Box 2.3. El Paso: widening access through broad-based long-term collaboration (continued)

Tertiary education institutions benefit from the efforts to improve college readiness in the primary and secondary institutes. El Paso Community College, with five campuses in the region, is critical to the effort of widening access to higher education. The community college system is the primary entry point to tertiary education for low-income students who are unable to pay for a four-year degree programme. As a result of direct efforts to widen access and increase educational attainment, for example by obtaining grant funding to improve remedial education, enrolment rates increased 35% between 2002 and 2008 and graduation rates increased 92% during the same period. Programmes to increase college readiness and thus potential success in a four year degree programme have resulted in significant improvements in mathematics, reading and writing measures, with, for example, the percentage of students assessed as college ready with respect to writing skills, improving from 35% in 2003 to 74% in 2008.

One of the most innovative programmes undertaken at El Paso Community College to improve educational attainment and to increase the knowledge base of the region is the Early College High School Program. This programme enables high school students to obtain credit for college level courses and thus to shorten the time and money needed to complete a college degree.

The University of Texas at El Paso (UTEP) benefits from the efforts to improve college readiness in the primary and secondary institutions and the community college and has undertaken its own programmes to widen access and improve student performance and completion rates. The relationship between the community programmes to improve college readiness and the ability of the University of Texas at El Paso to respond are integrally related because over 70% of the UTEP students come from within the region. UTEP has increased its enrolment by approximately 40% since the late 1990s and the vast majority of the growth has been in Hispanic students, who have increased from below 40% of the student body to over 75%. Degree awards have risen from approximately 2 000 in the late 1990s to 3 500 in 2008. Approximately 10% of UTEP's students are Mexican citizens who cross the border to attend the university.

The University of Texas at El Paso (UTEP) has also taken specific steps to make education affordable and accessible to students who almost universally have to work. UTEP has undertaken programmes to provide financial support and to change course scheduling. The programmes at UTEP are important given the low-income levels of the college age population and their households, their lack of familial experience with higher education, their need to combine work and study and propensity to avoid borrowing to invest in higher education.

Source: OECD (2010), Higher Education in Regional and City Development – The Paso del Norte Region, Mexico and the United States, OECD, Publishing. *www.oecd.org/dataoecd/17/61/45820961.pdf.*

Affordability issues: Cost of education for students

In Southern Arizona, as in other US states, the cost of tertiary education is a deterrent to participation of students from low-income families. In its Measuring Up 2006 Report Card on Higher Education, the latest one available, the National Center for Public Policy and Higher Education gave a failing grade to Arizona, emphasising that the State had lost a lot of ground in making tertiary education affordable (NCPPHE, 2006). In 2006, the cost of attending community college represented 25% of the average family income while attendance at a public four-year institution was equivalent to 31% of the average income, up from 25% in 1992. For the lowest quintile, the net cost of attending a public university went up from 59% of family income to 73% in 2005, one of the highest proportions in the entire nation.

Compared to other states, Arizona provides very little state financial aid. In 2009, the state allocated only USD 26 per student on financial aid, compared to an average figure of USD 549 nation-wide (CHE, 2009). The State of Arizona is therefore spending a mere 4.7% of the national average for student aid.

To illustrate the acute need for financial aid, it is worth mentioning that, at Pima Community College for example, the proportion of low-income students who apply for financial aid and are eligible for Pell Grants grew from 64 to 70% between 2006 and 2009, while the proportion of first generation students who applied went from 38 to 40% in the same period.

Compounding these affordability issues is the undocumented status of potential minority students. While there are no statistics to document the scope of the problem, it is widely acknowledged that significant numbers of high school graduates in Tucson are from undocumented immigrant families, which limits their possibilities to enrol in public tertiary education institutions. The political volatility of the issue of the status immigrant students creates considerable barriers to promoting tertiary access to a significant segment of the graduating high school student population.

Finally, the diminishing level of funding for tertiary education in Arizona in recent years, accentuated by the financial crisis, is a threat to widening learning opportunities at two levels. First, the level of resources available for student aid is unlikely to rise significantly. Second, the University of Arizona has increased the tuition fees and is also gradually increasing the proportion of out-of-state undergraduate students to make up for the shortfall in budgetary resources. For many years, the proportion of in-state students was stable, oscillating between 67% in 1996 and 71% in 2009. But this is already significantly below the national average of 81%. While having a diverse student population undoubtedly contributes to the

quality of the learning experience, the possibility of collecting higher fees should not become an important driver of student recruitment policies, at the risk of excluding local students. In this regard, the university's strategy to cope with the crisis is consistent with a national trend that makes it more difficult for in-state students to enrol in the local public universities. The OECD review team suggests that the University of Arizona leadership carefully monitors this dimension to avoid any adverse equity impact in the medium term (Box 2.4.).

Box 2.4. How the financial crisis affects in-state students

The financial crisis is shining a spotlight on the relatively less-examined area of public universities' admission of out-of-state students. As state and federal contributions to public universities continues to diminish, institutions are forced to seek income from private sources, including tuition and other fees. And, when the reality is that out-of-state students pay fees that are often two to three times more than in-state students, the utility of having greater numbers of out-of-state students cannot be ignored. According to the Washington Post (Vise, 2009), "Since pre-recession 2007, the share of non-resident students in the freshman class has grown considerably at several flagship universities: from 34 to 37% at William and Mary; from 19 to 25% at the University of Washington; from 43 to 49% at the University of Iowa; and from 35 to 44% at Penn State." At the University of Maryland, for instance, in-state tuition has been frozen for four consecutive years, but out-of-state tuition continues to rise: for Maryland residents' tuition and fees total USD 8 053; for non-residents, it is USD 23 990, though Maryland caps non-resident enrolment levels at 30% of the student population.

While administrators and campus leaders might legitimately argue that out-of-state students drive improvements in campus diversity and, in many cases, the overall quality of the student body, their presence does change the tenor of what it means to be a university in service to its particular state. In addition, in-state students not able to access their local universities might also be pushed into enrolling as out-of-state students at another state's public university, taking a place there that may have gone to an in-state student and creating an enrolment domino effect and taking local resources (such as the fees being paid by a local student) and distributing them to another state's institution. The implications of this domino effect deserve further examination by both legislative policy-makers and campus leaders, to ensure the fairest treatment of students possible.

Source: Vise, D. de (2009), "In-state Students' Admission Obstacle: Their Home Address" article in 14 November edition of *The Washington Post*, *www.washingtonpost.com/wp-dyn/content/article/2009/11/13/AR2009111301940.html*

2.2 Improving the balance between labour market supply and demand

Through its diverse offering of degrees and programmes, the network of tertiary education institutions that operate in Southern Arizona provides an extensive range of education and training qualifications to satisfy the needs of the labour market and the local economy. Table 2.4. illustrates the range of degrees offered by the main institutions in the area.

Table 2.4. Range of degree programmes offered by tertiary education institutions

Institution	Associate	Bachelor	Master's	PhD
University of Arizona	n.a.	123	120	95
Pima Community College	61 (17)	n.a	n.a.	n.a.
Cochise Community College	67 (40)	n.a	n.a.	n.a.
Tohono O'odham Community College	12	n.a	n.a.	n.a.
University of Phoenix	19	36	38	9

Note: the number in parenthesis shows the number of transfer programmes in community colleges.

n.a. means not applicable.

Source: Southern Arizona's Regional Steering Committee (2009). "The Southern Arizona Region, United States: Self-evaluation report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*; and University of Phoenix (2008), Academic Annual Report, UPX, Phoenix.

In terms of specialised training, the University of Arizona offers academic programmes in all of the cluster priority areas identified by the Tucson Regional Economic Opportunities Agency (TREO), the regional economic development agency, with the exception of tourism which is a growth area in the regional economy. Similarly, the courses available at the community colleges are directly relevant to the types of firms operating in Tucson and the region. They range from traditional occupational programmes to customised workforce training courses. Consistently with its vocation as a research university, the University of Arizona has a higher proportion of graduate students than the national average (17.1% compared to 14.7%).

During the OECD review visit in October 2009, there was unanimous recognition on the part of employers and economic actors interviewed that both the University and the community colleges effectively contribute to the formation of a quality labour force for the region. To maintain the relevance of their programmes, all tertiary education institutions in the Southern Arizona region have developed close linkages with employers to

guide the choice of programmes and courses and obtain regular feedback on the qualifications of their graduates (Table 2.5).

Table 2.5. Examples of partnerships between tertiary education institutions and the region

Institution	Type of partnership
University of Arizona	Advisory Boards, Industrial Affiliates
Pima Community College	Consultation with Workforce Investment Board, Occupational Programme, External Advisory Board, Small Business Development Center
Cochise Community College	Center for Economic Research, Small Business Development Center, Economic Outlo-ok Lunch, Fort Wachuca
Tohono O'odham Community College	NATIVE Project, Apprenticeship Programme
University of Phoenix	Consultation with employers, students sponsored by companies, Southern Arizona Task Force

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

Despite the importance of tourism to the economic development of Southern Arizona, programmes to support education, training and RDI in tourism do not feature highly in the portfolio of the University of Arizona or the community colleges. This is in contrast to many OECD countries and regions which are building skills to move to higher value-added segments in tourism. Many OECD countries, for example Canada and the United Kingdom, have launched skills development programmes to train and up-skill personnel for tourism. Some of the programmes have a regional focus such as the Welcome Ireland programme ("Fáilte Ireland"). They may also use migration policies to address skills shortages as is the case in Scotland (Box 2.5.).

Box 2.5. Programmes to support workforce education, training and development in tourism

Major initiatives which are helping to enhance the status and position of the tourism sector as a career option include the United Kingdom's People 1st Programme and Canada's Tourism Human Resources Council which emphasise stakeholder engagement as well as industry needs. These programmes highlight the need for long-term continuity in state policies and investment in tourism training and development to build the capacity of the workforce.

Ireland has made a sustained intervention through the funding of its national training body CERT which was merged to create Fáilte Ireland. It is one of the most comprehensive approaches to education and training, co-ordinating all education and training needs for the industry as well as labour-market planning. Fáilte Ireland trained 10 000 staff in the sector in 2007 to improve skills and industry capability to complement the higher level skills at the Institutes of Technology and Universities. Fáilte Ireland has also funded a Human Resource Development Strategy, Management Development Programme and a regionally focused capability building programme for SMEs.

Many OECD countries are using migration policies to address skills shortages in tourism since the financial rewards in the hotel and catering sectors are often uncompetitive. For example, the Scottish government's Fresh Talent Policy – a managed migration policy to attract returning Scots and overseas skilled labour – has addressed skills shortages in tourism and hospitality, notably in larger cities with high labour turnover rates. Here, eastern European labour has been used to fill significant skill gaps. In Canada, the Temporary Foreign Worker Programme helped streamline the time required to employ a foreign worker while also extending the length of time lower-skilled workers could stay in the country. A new scheme introducing faster processing of job applications helps employers facing labour shortages in high demand occupations such as tourism.

Source: OECD (2010a), Tourism Trends and Policies 2010, OECD, Publishing. 2010.

Changing forms of educational provision

One of the strengths of the University of Arizona is the marked emphasis on inter-disciplinary learning which characterises many of its colleges and programmes. To this day, the university has 14 inter-disciplinary graduate programmes producing 10% of all PhD graduates. The inter-disciplinary nature of these programmes is evidenced by the large number of joint programmes across colleges; the relatively large proportion

of faculty appointed in more than one college; the numerous networking mechanisms; and the flexibility given to students for taking classes in other schools or colleges. At the College of Optics, for example, 38 out of 55 full-time faculty have a joint appointment; the college employs 59 adjunct faculty from industry. All undergraduate students undertake a senior project in partnership with a company. To attract motivated young people, the college participates in an outreach programme to local high schools.

Besides the colleges organised along multi-disciplinary lines, the University of Arizona also operates several inter-disciplinary research centres, such as the Arizona Research Laboratories, the BIO5 Institute, the Biosphere, which are closely integrated with local industrial clusters.

In addition to facilitating technological discoveries by allowing researchers from various disciplines to find together "new solutions to old problems", the interdisciplinary pedagogical approach makes for a highly relevant education experience for both undergraduate and graduate students who participate, as part of their regular curriculum, in inter-disciplinary research projects and internships with industry. These internships complement the work-based learning opportunities provided through the University's Career Services. However, only a small proportion of students have an opportunity to participate in interdisciplinary research projects and internships with industry.

Moving forward, the University of Arizona should continue to build upon its existing successes in developing strong inter-disciplinary programmes. The OECD team was impressed by the quality and innovative nature of such programmes. At the same time, there is room for more systematic and widespread sharing of experiences across colleges and programmes within the university. To achieve this, the challenge will be to facilitate increased cross-fertilisation and institutional learning without stifling the existing culture of faculty-driven innovation. Furthermore, a broader range of students should be able to benefit from innovative and experiential learning models. The University of Arizona may also want to consider applying evaluation instruments, such as the Collegiate Learning Assessment (CLA),[3] to measure the generic competencies and higher order skills that students are acquiring in the course of their programmes. It will also be important to adjust the performance evaluation system to ensure that there are appropriate incentives to ensure that faculty members are equally devoted to undergraduate teaching as to their research and technology transfer activities.

The community colleges have similarly demonstrated their ability to implement dynamic teaching methods to impart professional skills. At Pima Community College, for example, nursing and other health professionals are

trained with an effective combination of theoretical courses and patient care simulation exercises resulting in a very high success rate at the state board examination.

A core element of university support for innovation and enterprise in most countries is new business incubation and graduate entrepreneurship (Potter, 2008). Experience in other OECD countries shows that the best support for graduate entrepreneurship often comes from teaching programmes where students work in teams to form real companies mentored by entrepreneurs. Such programmes can run at undergraduate and graduate levels and be targeted at students from across the sciences, engineering, business and arts disciplines.

The University of Arizona has an award winning entrepreneurship education centre – The McGuire Center for Entrepreneurship – with a more than two decades track record in the field (Box 2.6.). It provides a wide range of activities and is also collaborating with the university's office of technology transfer to identify commercially viable faculty inventions and building entrepreneurial skills among the academic staff of the faculty. The knowledge and expertise of the McGuire Center for Entrepreneurship should be used to help transform education provision throughout the university and in other institutions in Southern Arizona and to scale up the entrepreneurial activities among the University faculty. It would also be useful to collect more robust data about the McGuire start-ups, including their success rate and economic impact.

Box 2.6. The McGuire Center for Entrepreneurship

The McGuire Center for Entrepreneurship is located within the Eller College of Management at the University of Arizona and is ranked as the fourth best entrepreneurship programme among public universities in the United States, and tenth among all schools, according to US News and World Report. Founded in 1984 with the support of university alumnus and entrepreneur Karl Eller, McGuire was one of the first university-based entrepreneurship centres established in the United States and today one of the few to consistently maintain top-tier ranking status. In 25 years, more than 1 200 graduates have gone on to launch hundreds of ventures, often based on the plan they conceived in the programme.

McGuire teaches entrepreneurship to early-career business people; helps transfer research into practice by identifying and transferring technology and innovations to the market place; and serves on-and-off-campus organisations through technical assistance on entrepreneurship activities.

Box 2.6. The McGuire Center for Entrepreneurship (continued)

McGuire offers a limited-enrolment undergraduate degree stream, an entrepreneurship-focused MBA and a one-year Graduate Associates in Entrepreneurship. The year-long academic programme is available to undergraduate and graduate students from all university disciplines and is completed during the regular course of study. The experience integrates the process of launching a venture into the Idea PathTM curriculum, delivering a hands-on exercise in entrepreneurship.

According to Impact of Entrepreneurship Education, part of a Kauffman Research Series report and the first study to measure the value of entrepreneurship education, McGuire Center alumni are three times more likely to start new business, be involved in a new venture or be self-employed; as well as earn 27% more annually, have 62% more assets than non-entrepreneurial peers, and express greater work satisfaction, regardless of professional choice. McGuire produces about seven to ten start-up businesses annually from student collaborations. These start-ups have a significant economic impact, particularly in terms of employment. While a spin-off technology firm may employ two to three full time equivalent employees, a successful start-up (like Frost Gelato Shoppe, a McGuire start-up with two outlets) may employ dozens of employees. Despite the obvious success, the McGuire start-ups are not included in the spin-off figures released by the university's office of technology transfer.

McGuire collaborates with the university's office of technology transfer (OTT) in many different ways: it identifies commercially viable research in university and funnels technological innovators to entrepreneurship programmes; it offers workshops for university faculty to provide tools for assessing potential market and social value for their innovations; it hosts workshops for students and faculty to explore the implications of technologies available for commercialisations; it consults with McGuire venture teams on topics such as development, pro-of of concept and prototype creation via its on-staff technology mentors; and it helps to identify opportunities for collaboration in the university setting and beyond via shared McGuire/OTT knowledge transfer liaison.

McGuire Center is also well networked outside of the university. As part of Innovation Frontier Arizona's Idea Fair for K-12 schools it is spreading entrepreneurship among school children across the region. McGuire also works with Southern Arizona entrepreneurs on projects including IdeaXchange – a referral network for emerging entrepreneurs – and the IdeaFunding Conference – a day-long workshop for business people, investors and university faculty. In addition to providing resources for new ventures in the region, these activities offer an opportunity for students to network with working entrepreneurs and learn about the issues affecting the entrepreneurial community in an informal setting.

Box 2.6. The McGuire Center for Entrepreneurship (continued)

The McGuire Center has championed a number of innovations in embedding entrepreneurship into curriculum. For example it has developed a pioneering Business/Law Exchange™, a mock law firm staffed by law students, with entrepreneurship teams serving as clients, to address issues including intellectual property, patent law and contracting. It provides experiential learning opportunities for both students in law and entrepreneurship.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

2.3 Lifelong learning and distance education

If universities can't find the will to innovate and adapt to changes in the world around them, universities will be irrelevant by 2020.

Professor David Wiley (Brigham Young University)

A growing proportion of people seeking to further their education are not high school graduates interested or able to pursue full-time studies. One of the strengths of the US community colleges system is its receptivity to the learning needs of working youth and adults, as illustrated by the situation in Southern Arizona. At Pima Community College, for instance, 72% of the students enrolled on part-time courses. Only 44% are day students; the others study at night, during the weekend or through distance education modalities. At Cochise Community College, 75% of the students are enrolled part time.

Complementing the work of the public tertiary education institutions, the private, for-profit University of Phoenix fulfils an important role in support of training and retraining for the adult population in Southern Arizona, constituting about 3 000 students from the region. In the words of its President, Bill Pepicello, the University owes its success to the recognition that "... education needs to be something that fits people's lives and becomes part of it ... It needs to be that kind of accessibility and many people are willing to pay a premium price for that" (Mackey, 2009b).

Over the past 30 years, the University of Phoenix has developed a unique pedagogical model to fit the characteristics and needs of its adult student body (the average age of students is 34 years old) who are looking to

earn a degree corresponding to their actual work activity or for starting a new career. The students go through a sequence of six-week modules that usually combine actual class time and online learning, although the University of Phoenix offers four different modalities to match the variety of learning preferences of the students (classroom, blended, online, and directed study mode with a one-on-one instructor). Faculty members do not lecture generally, but facilitate self-learning among the students. The University of Phoenix has a comprehensive quality assurance and standards system to train the practitioner faculty and ensure that students achieve the prescribed learning objectives. Learning is enhanced through a wide array of online resources, including a digital library, e-texts and pedagogical software (*e.g.* tutorials, grammar support, plagiarism checker).

Table 2.6. summarises the variety of academic models that can be found in Southern Arizona from the point of view of their ability to serve the needs of working adults.

Table 2.6. Academic models to serve "working learners"

Institution	Academic organisation	Admissions requirements
University of Arizona	Campus-based, day classes	Selective
Pima Community College	Campus-based, day and night classes	Open admission
University of Phoenix	Blended learning, night and weekend classes	Open admission

2.4 Strategic co-ordination of the regional human capital system

… We need to wake up and realize that one of the keys to our nation's historic success is now a wasting asset. Education made America great; neglect of education can reverse the process.

Paul Krugman

One of the main issues impeding tertiary education development in the State of Arizona is the fragmented governance architecture and the absence of a state-wide co-ordinating structure and appropriate mechanisms to articulate a long-term vision and implement an integrated development strategy for all tertiary education institutions. The OECD team recommends that the authorities and interested parties in the Southern Arizona region work together with the other regions in the State to propose the establishment of a tertiary education co-ordinating body that would help

define state-wide goals, policies and priorities, in line with the recommendations of the 2006 Governors initiative.

This approach has been effectively followed by the OECD countries as diverse as the UK, Ireland, Denmark, South Korea or Australia, which have achieved impressive tertiary education outcomes in support of their economic growth and social development objectives. Some US States also rely on comprehensive governance and co-ordination mechanisms to guide the development of their tertiary education system. Box 2.7. illustrates, for example, the Ohio model of governance and co-ordination.

Box 2.7. Ohio model of governance / co-ordination

Ohio is one of 12 states in which the senior institutions are governed by individual governing boards. All institution heads are presidents. A state-wide board, the Ohio Board of regents, is the co-ordinating body for higher education. The State Higher Education Executive Officers (SHEEO) in Ohio is called a Chancellor.

Ohio's higher education structure presents a paradigm of autonomous public and private universities and colleges co-ordinated by a strong state board. According to the 1988 master plan prepared by the Board of Regents, "*over 150 institutions offer higher education and are licensed or authorised to award associate of higher-level degrees in Ohio*."

The decentralised structure in Ohio provides significant institutional autonomy. Ohio's public colleges and universities have been able to retain significant independence over the years in a state whose government has been active in higher education policy.

The stability of the Ohio system stems from the state's geographic distribution of political power. In the establishment and operation of the structure, legislators and higher education administrators acknowledge the importance of population distribution. There are significant population centres in every geographic region of the state (except one), which has been a key factor in the development and continuation of the public colleges and universities.

Source: Schick, E.B., *et al.* (1992), *Shared Visions of Public Higher Education Governance: Structures and Leadership Styles that Work*, American Association of State Colleges and Universities, Washington, DC.

The advantages of a system-wide governance model, as opposed to the present segmented organisational setup, is the ability to plan more effectively for the tertiary education needs of the region, to co-ordinate

missions and programmes, to encourage an appropriate division of labour among institutions, to co-ordinate missions and programmes, and to maintain appropriate data bases for institutional and system policy research. A comprehensive approach also provides the ability to reallocate resources among institutions as needed; to shift programmes and staff among institutions and facilities; to merge programmes or even institutions; and to close programmes, facilities, and even institutions that are redundant, too expensive, of low quality, or simply too small in scale to be cost-effective. Finally, it allows presenting a strong and unified political front to the state authorities and the legislature in order to maximise the case for sufficient and stable public resources (Johnstone, 2000; Bowen, 1997).

To steer the future of tertiary education in the State of Arizona, the proposed co-ordinating body will need to define a comprehensive vision which outlines clear qualitative and quantitative goals and confirms the respective contribution of each type of tertiary education institution. In this respect, the California master plan remains a relevant model of careful articulation and division of responsibilities among the various institutions in a state system (research universities, teaching universities and community colleges), despite the present financial woes of the State of California.

An important dimension of good governance consists of putting in place an adequate information system to monitor the performance of tertiary education in the State of Arizona and benchmark its progress with appropriate comparators in the US and among other OECD countries. The Minnesota tertiary education accountability system is an interesting example that the State of Arizona could learn from (Box 2.8.).

Box 2.8. State-wide monitoring and accountability system of Minnesota

Since 2005, the Minnesota state legislature has mandated the preparation of an annual report that measures the progress of the higher education system in supporting the state's economic development strategy. Minnesota's leaders recognise that in order to lead consistently in these areas, the state must first embrace a system of accountability that can measure progress toward the achievement of its ambitious agenda. As outlined by Governor Tim Pawlenty, "*building Minnesota's world-leading status in the knowledge economy requires us to set goals for higher education and measure results. This report gauges outcomes so we can focus on strategies for improvement in productivity and student success*."

Box 2.8. State-wide monitoring and accountability system of Minnesota (continued)

The report reflects the results of a consensus-building exercise that brought together educators, policy makers, employers, and community leaders in 2005 and 2006. Together they identified five broad goals that define the public agenda for higher education and 23 indicators that measure success towards these goals. The five goals are to:

- Improve the success of all students, particularly students from groups that are traditionally underrepresented in higher education.
- Create a responsive system that produces graduates at all levels who meet the demands of the economy.
- Increase student learning and improve the skill levels of students so they can compete effectively in the global marketplace.
- Contribute to the development of a state economy that is competitive in the global market through research, workforce training, and other appropriate means.
- Provide access, affordability and choice to all students.

For each indicator, the report benchmarks the results of Minnesota against the top three US states, the national average, and a group of peer states selected on the basis of common characteristics such as geography, tertiary education structure, economic situation and demographic features.

Source: MOHE (Minnesota Office of Higher Education) (2009), Minnesota Measures: 2009 Report on Higher Education Performance, Minnesota Office of Higher Education, St. Paul, *www.ohe.state.mn.us/pdf/MinnesotaMeasures2009.pdf*.

2.5 Elaborating a financially sustainable expansion model

*"*How did you go bankrupt*?" Bill asked.*

*"*Two ways*," Mike said, "*Gradually and then suddenly.*"*

Ernest Hemingway (The Sun Also Rises)

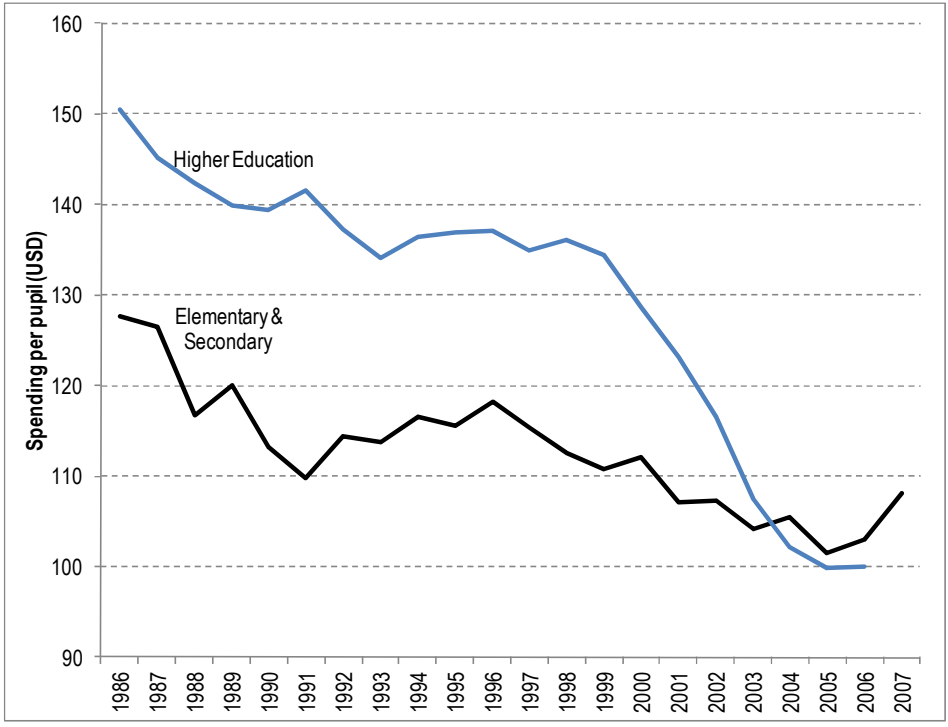
Any attempt to better co-ordinate tertiary education development in Arizona and increase educational attainment is a substantial challenge unless it is backed by a sustainable financial expansion plan reflecting a long-term

commitment on the part of the legislature. A two-pronged strategy could be articulated and implemented to achieve this goal: *i*) mobilise a greater share of public expenditures for tertiary education in the State of Arizona budget; and *ii*) increase resource diversification in the public universities.

As documented in the Regional Self-Evaluation Report (Southern Arizona's Regional Steering Committee, 2009), public funding for tertiary education has declined steadily in the past two decades, endangering the ability of the University of Arizona and the community colleges to continue fulfilling their public good function and threatening their academic quality. Figure 2.3. illustrates this downward trend, showing an acceleration of the phenomenon since 2000.

Figure 2.3. Evolution of public expenditure per student per USD 1 000 per capita personal income

Arizona, 1996-2007



Source: Arizona Indicators (2009), "Government Expenditures for Education in Arizona", Public Finance indicators, *www.arizonaindicators.org/pages/finance/education-spending.html*.

The drastic cuts in response to the economic and financial crisis have only amplified a long term negative evolution which threatens the sustainability of the State's public institutions. A comparison of the state allocation for tertiary education between the fiscal year 1999/2000 and fiscal year 2009/10 indicates that, while the state government general fund increased by 57.7% over the period, public resources for tertiary education institutions rose only by 20.2% for universities and a mere 3.9% for community colleges. The State of Arizona cannot realistically expect to achieve further progress on the tertiary education front, or even protect the achievements thus far, unless its authorities and legislature reach a consensus to increase public funding for the sector in a significant way and make a long-term commitment to finance tertiary education on the basis of clear criteria aligning needs, performance and resources in an objective and transparent manner.

While the University of Arizona will undoubtedly continue to compete successfully for local and federal research grants, it has the potential to generate additional resources in two complementary ways: by augmenting tuition fees and through fund-raising efforts. In the first case, tuition fee increases should go hand in hand with more student aid funding from the State, to avoid creating two categories of students: those who can afford to enrol in the University, and those who would be only able to afford a community college. At 16% of total income, tuition fees at the University of Arizona represent a significantly smaller proportion than the national average of about 35% because of the high proportion of research income. At the same time, the State of Arizona is among the US states that receive a failing grade for affordability and availability of student aid in the annual State Report Card on Higher Education prepared by the National Center for Public Policy and Higher Education.

In the second instance, the University of Arizona could amplify its efforts to beef up its endowment, currently estimated at USD 335 million. The example of the University of Virginia, which is well on its way to successfully completing USD 3 billion endowment drive, illustrates that well-targeted and conducted fund raising strategies can be effective, even in the midst of a financial crisis.

The fund raising efforts of the University of Arizona and other public tertiary education institutions in Arizona could be supported through a matching grant scheme similar to ones implemented in other US States, such as the Major Gifts Trust Fund programme in Florida; or in other countries, for example the Canadian province of Alberta, Hong Kong, New Zealand and the United Kingdom. The earlier local experience with a matching programme through the Science Foundation of Arizona shows that private

donors are willing to contribute, provided there is a real commitment on the state side.

Box 2.9. The power of matching funds

The experience of countries that have set up matching grants shows that they can be very powerful fund-raising mechanisms. In New Zealand, for instance, the Partnerships for Excellence programme launched in 2002 helped leverage about USD 110 million in private sector donations. Started initially as a matching grant only for the University of Auckland's business school, it was later extended to all tertiary education institutions in New Zealand.

Hong Kong's matching fund programme has been so successful that the UK put in place a similar scheme to encourage its universities to seek private donations. In April 2008, the British government announced the formal launch of a GBP 200 million matching grant scheme administered by the Funding Council (HEFCE), with a sliding matching proportion (from 1:1 to 3:1) depending on the fund-raising experience of the participating universities.

Similarly, in the Canadian Province of Alberta, the government underestimated the potential of its Access for the Future Fund established in March 2005. Philanthropists responded so generously to the scheme that, by the end of 2006, the government had exhausted the money set aside to match private donations.

Source: Gerritsen, J. (2008), "NZ: Government Scheme Encouraged Donations", *University World News,* 15 June 2008; and Tetley, D. (2006), "Alberta Can't Match Donors - Government Vows to Fix Problem", *Calgary Herald,* 14 December 2006.

Conclusions and recommendations

To cater to the learning and training needs of its increasingly diversified population, Southern Arizona has in place a comprehensive network of tertiary education made of a major research university, three community colleges and several private institutions. Most of these institutions are embedded in their communities to better serve the needs of the local population. In addition, the multiple pathways and bridges across the various types of institutions make it easy for students to move from one type of institution to the other.

Through its diverse offering of degrees and programmes, the network of tertiary education institutions that operate in Southern Arizona provides an extensive range of education and training qualifications that closely meet the

needs of the labour market and the local economy. There is unanimous recognition that the University of Arizona and the community colleges effectively contribute to the formation of a quality labour force for the region, thanks to their relevant programmes and close linkages with industry. One of the special strengths of the University of Arizona is the marked emphasis on an inter-disciplinary approach, which characterises many of its colleges and programmes.

The OECD review team suggests that the human capital formation efforts of the Southern Arizona's region would be further enhanced if the following measures were implemented:

- To improve the quality of high school graduates, the local school authorities should address existing academic and equity gaps in a comprehensive manner and mobilise appropriate levels of financial resources in spite of the economic downturn.

- In order to widen access to tertiary education, especially among underserved population groups, all concerned tertiary education institutions should step up their outreach efforts and share good practices among themselves in a more systematic manner. The joint admission programme between the University of Arizona and Pima Community College appears to operate smoothly in that respect. A similar mechanism to link the University with Cochise Community College and Tohono O'odham College could be envisaged. It would also be useful to implement a common course numbering system for the entire State along the lines of the Florida system. Furthermore, in implementing its strategy to cope with the financial crisis, the University of Arizona should carefully monitor the rise in the proportion of out-of-state students to avoid any adverse equity impact in the medium term. Access to the University must be improved.

- Tohono O'odham College needs to be included more systematically into the tertiary education community of the Southern Arizona Region. All parties concerned should identify ways of supporting the efforts of the younger public institution to draw more extensively on existing resources in the community.

- Tertiary education institutions should continue to align their educational provision with the needs of the region, and address also needs of skills development in tourism which is one of the key drivers of the regional economy.

- To further improve its pedagogical practices the University of Arizona should ensure a more systematic and widespread sharing of

experiences across colleges and programmes. All students should be able to benefit from innovative and experiential learning models including entrepreneurship education. The expertise of the McGuire Center for Entrepreneurship should be mobilised to transform education provision throughout the university and other tertiary education institutions in the region and to scale up the entrepreneurial activities of the university faculty. The challenge will be to facilitate increased cross-fertilisation and institutional learning without stifling the existing culture of faculty-driven innovation. Appropriate incentives need to be in place to ensure that faculty members are equally devoted to undergraduate teaching as to their research and technology transfer activities. The University of Arizona should also consider applying evaluation instruments, such as the Collegiate Learning Assessment (CLA), to measure the generic competencies and higher order skills that students are acquiring in the course of their programmes.

- To improve the overall governance of the regional tertiary education system, the authorities and interested parties in Southern Arizona should work together with the other regions in the State to propose the establishment of a tertiary education co-ordinating body that would help define state-wide goals, policies and priorities.

- The Arizona legislature should make a long-term commitment to increase educational attainment in Arizona backed by a sustainable financial expansion plan. A two-pronged strategy could be articulated and implemented to achieve this goal: *i)* mobilise a greater share of public expenditures for tertiary education in the State of Arizona budget; and *ii)* increase resource diversification in the public universities. Furthermore, an adequate information system needs to be established to monitor the performance of tertiary education in Arizona and benchmark its progress with appropriate comparators in the US and among other OECD countries.

Notes

1. K-12 is a designation for the sum of primary and secondary education. It is used in the United States, Canada and Australia, where P-12 is also commonly used. The expression is a shortening of kindergarten (K) for 4–6-year-olds through twelfth (12) grade for 16–19-year-olds.

2. The Access to Success Initiative (A2S) is a project of the National Association of System Heads and The Education Trust that works with 24 US public higher education systems that have pledged to cut the college-going and graduation gaps for low-income and minority students in half by 2015. Each Access to Success participating system sets its own improvement targets and agrees to a common set of metrics to evaluate progress. Much of the information in the baseline reports, including the graduation rates of low-income and non-traditional students, has not previously been publicly available. A2S systems are drafting their own plans to cut achievement gaps and increase degree production through strategies attuned to the needs of their campuses and students. They have pledged to release progress reports every two years. A2S systems are joining forces with NASH and The Education Trust to pursue eight lines of work to build system capacity to lead change and engage and mobilise campuses around critical issues. The systems-change work focuses on assessing and building capacity, managing and leveraging costs and resources, and using "leading indicator" data to track progress toward A2S goals. The campus-change work focuses on such issues as using enrolment management to increase campus diversity, redesigning developmental math courses and improving degree completion.

3. The Collegiate Learning Assessment (CLA) helps higher education institutions improve undergraduate education through assessment, professional development, best practices and collaboration. There are two programmatic areas that support educational improvement: CLA Assessment Services and CLA Education. CLA Assessment Services provide a means for measuring an institution's contribution to the development of key higher order competencies, including the effects of changes to curriculum and pedagogy. CLA presents realistic problems that require students to analyse complex materials and determine the relevance to the task and credibility. Students' written responses to the tasks are evaluated to assess their abilities to think critically, reason

analytically, solve problems and communicate clearly and cogently. Scores are aggregated to the institutional level to provide a signal to the institution about how their students as a whole are performing. This signalling quality allows institutions to benchmark where they stand and how much progress their students have made relative to the progress of students at other colleges. CLA Education was launched in the 2009-10 academic year and offers programmes that are designed to assist and empower faculty. The two primary programmes include: Performance Task Academies (where faculty members can learn more about the process of creating and embedding their own performance based tasks within the classroom) and student and institutional diagnostic reporting (which provide feedback to faculty to engage students in diagnostic conversations about their critical thinking skills). Over 400 institutions and 165 000 students have participated in the CLA and over 460 individual faculty and administrators have attended over 18 Performance Task Academies.

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Chapter 3

Contribution of tertiary education institutions to regional innovation

Innovation is an important driver of long-term economic growth for cities and regions. This chapter will examine the effectiveness of current innovation policies and practices in Southern Arizona and the role of research and knowledge transfer conducted by the University of Arizona and community colleges. The chapter will consider the efforts made by the federal and state governments, sub-national agencies and tertiary education institutions. It will examine the current knowledge exchange mechanisms in place and highlight good practice from other regions. Finally, the chapter will conclude with specific recommendations to improve regional innovation outcomes in Southern Arizona.

The University of Arizona plays a dominant role in Southern Arizona and has developed a full portfolio of policies and mechanisms to boost R&D, innovation and entrepreneurship. While the university has benefitted from the strong science and high technology push, the regional innovation system remains Tucson-centred and underdeveloped, with limited connections between key actors, including community colleges. The dominant innovation model has a high technology focus, which may limit the mobilisation of tertiary education institutions' full potential for innovation.

The key message is that the University of Arizona should go beyond its traditional role of knowledge production and commercialisation and embrace a more robust and diverse role in the regional innovation system by engaging in long-term industry collaboration, and by creating a well co-ordinated system for people-based knowledge transfer. Concerted efforts are needed to create new businesses and better jobs for the diverse population.

Introduction

Southern Arizona has developed a strong research base and multidisciplinary tradition within the University of Arizona and has potential for a more efficient innovation system. The Tucson metropolitan region has grown into an innovation "ecosystem" in light-based industries and efforts are being made to replicate the successes in biotechnology and other high technology fields.

The Tucson metropolitan area has the scale resources to develop a strong base for a well functioning region-wide innovation system that can contribute to the economic development of entire Southern Arizona and generate sustainable employment among the diverse regional population. However, to date the regional innovation system remains under-developed and fragmented, consisting of a system dominated by the University of Arizona, while community colleges, state and/or local government agencies and industry continue to play a minor role. Furthermore, the economic growth in Southern Arizona is strongly related to that of the Mexican state of Sonora, which is a key manufacturing centre for cross-border trade between the United States and Mexico. Sustainable development on the Mexican side of the border is of vital importance to Southern Arizona and efforts should be made to build a cross-border regional innovation system.

In this context, this chapter examines the following three dimensions to assess the effectiveness and coherence of innovation and R&D policies and practices within Southern Arizona:

- Is the innovation system well connected and responsive to the industrial structure of the region?
- Do the existing tertiary education providers support the regional innovation system in an optimal way? Are there gaps in delivery where performance could be improved?
- What lessons can be learnt from international experience?

3.1 Policy framework and regional actors in the US and Southern Arizona

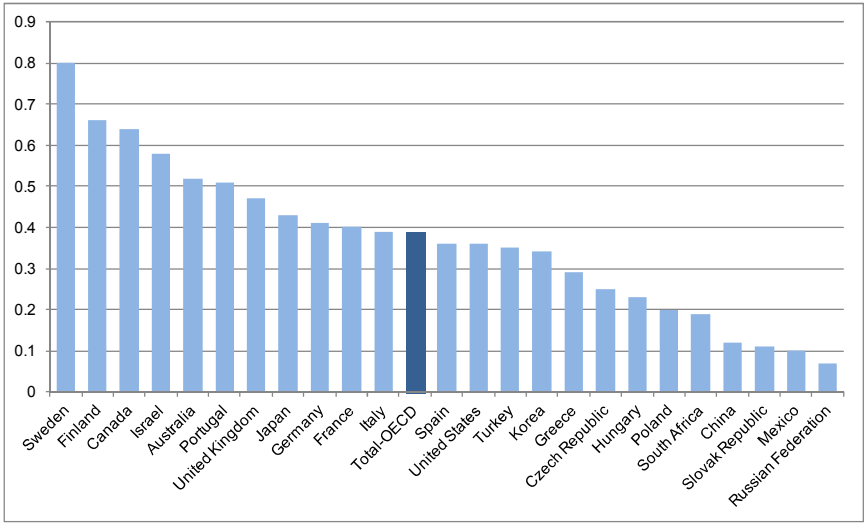
The US pro-innovation policy

The United States has led the way in developing pro-innovation policies. The United States was the first in the world to offer companies a R&D tax

credit and, through the 1980 Bayh-Dole Act, the first to allow universities to patent products originating from public R&D funds.[1] The technology licensing offices of the Massachusetts Institute of Technology (MIT) and Stanford University have been recognised as global leaders in commercialising university research. The examples of the Silicon Valley and Route 128 have inspired, and continue to inspire, many regions and tertiary education institutions worldwide.

While the United States remains strong in terms of the higher education expenditure on R&D (HERD) as a percentage of GDP and the share of funding from industry to higher education R&D, in international comparison, it is among the middle range of OECD countries on both measures: its expenditure on higher education R&D as a percentage of its GDP reached 0.36% in 2008 as compared to OECD average of 0.39%, while business and industry funded 5.6% of the US higher education R&D in 2007 as compared to the OECD average of 6.5%. (OECD, 2009a).

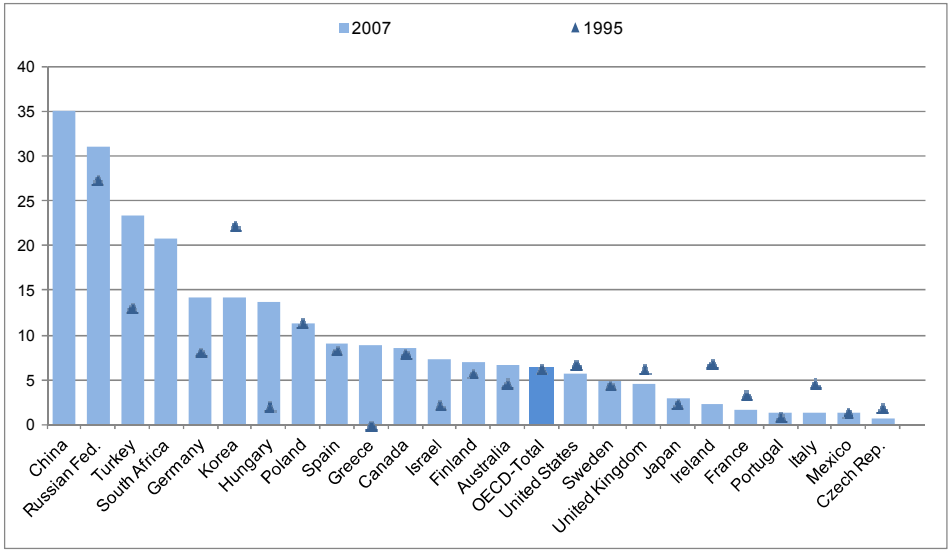
Figure 3.1. HERD as a percentage of GDP in selected countries, 2008[1]



1. Or nearest available year.

Source: OECD (2009a), Main Science and Technology Indicators, OECD, Publishing.

Figure 3.2. Percentage of HERD financed by industry in selected countries, 1995 and 2007[1]



1. Or nearest available year.

Source: OECD (2009a), Main Science and Technology Indicators, OECD, Publishing.

There is growing evidence that other OECD countries are catching up to the United States in terms of capacity for innovation. This catching-up process is taking place in four domains: *i*) human capital development; *ii*) tax credits; *iii*) commercialisation of research; and *iv*) innovation policy framework.

Chapters 1 and 2 have shown that, in terms of human capital development, the United States is falling behind the leading OECD countries in educating younger generations (OECD, 2011). The Americans aged 25 to 34 years are only slightly more likely to have a higher education degree than Americans aged 55 to 64 years (OECD, 2010a). In addition, the United States lags behind other advanced countries in educational performance of 15-year-olds (OECD, 2010a). There are also growing achievement gaps between different groups of students.

In terms of tax credits, the US R&D tax credit generosity has fallen to 17th for large companies (18th for the small and medium-sized enterprises) among the OECD countries. In addition, while the United States offers incremental R&D tax credit, many other countries now offer a flat tax credit for R&D expenditures.

While the Bayh-Dole Act accelerated the commercialisation of university-developed inventions in the United States, research literature has noted a sub-optimal level and pace of research commercialisation.[2] In the US system, a faculty-inventor is restricted to using his/her own university's technology licensing office (TLO) as a licensing agency, irrespective of the TLO's effectiveness and experience. In fact, the majority of the TLOs in the US universities generate less licensing revenue for the university than the cost of their operations (Litan and Mitchell, 2009).[34] In addition, the industry-academia partnerships usually involve only one firm, limiting the diffusion of the benefits throughout the economy (Wial, 2009). In terms of regional development, many universities have focused on technology transfer and developing revenue streams from products that have limited or no relation to the regional economy. Attempts to link tertiary education with regional development through programmes, such as the University Center Economic Development Program,[5] remain underfunded (Christopherson, 2009).

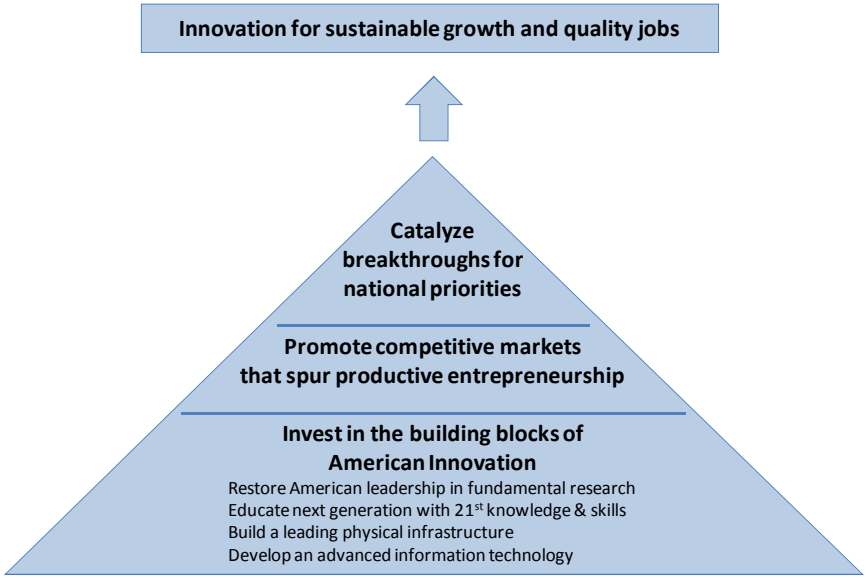
Many OECD countries have created national innovation strategies to link science, technology and innovation with economic growth in order to address challenges rising from expanding health care, digital infrastructure, sustainable energy production and climate change; and to produce skilled workforce for the globalising work economy. In the United States, however, the federal government's role has been limited to funding basic research, subsidising the education of scientists and engineers, and maintaining a system of intellectual property law.

To reassume its leading role in innovation the US Government announced in 2009 the goal to transform the United States into an "Innovation Economy" that will support innovation for sustainable growth and quality jobs (Figure 3.1.). The aim is to: *i)* restore the US leadership in fundamental research in order to lay the foundation for new discoveries and technologies; *ii)* educate the next generations with 21st century knowledge and skills in order to build world-class workforce; *iii)* develop a leading physical infrastructure in order to connect people and businesses; and i*v)* develop an advanced information technology ecosystem. These elements will build the basis for innovation that will promote competitive markets that will spur productive entrepreneurship and catalyse breakthrough for national priority areas such as clean energy, health care and advanced vehicle technologies (NEC, 2009).

As a consequence of the innovation economy initiative, a number of steps have been taken: *i)* the nation's first Chief Technology Officer has been appointed; *ii)* USD 100 million in grants has been provided for the development of regional clusters of high-technology focused areas and USD 50 million to build a national network of business incubators to

encourage entrepreneurial activity in economically distressed areas; *iii)* the Bureau of Economic Analysis has been directed to measure the role of innovation in the economy; and *iv)* as part of stimulus package, considerable investments have been made to boost green R&D, digital infrastructure, broadband, health IT, speed rail and the smart grid for energy distribution.

Figure 3.3: Innovation for sustainable growth and quality jobs



Source: NEC (2009), "A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality Jobs", Report of the Office of Science and Technology Policy, *www.whitehouse.gov/sites/default/files/microsites/20090920-innovation-whitepaper.PDF*, accessed 30 March 2010.

The regional picture in Southern Arizona

While many US state and local governments have established technology-based economic development programmes to promote innovation, these programmes often focus on the same high-technology industries, regardless of whether they are suited to the regional and local economies (Wial, 2009).

In the state of Arizona, considerable investments have been made in high technology, particularly in biotech. In 2000, Arizona voters passed the Technology Research Infrastructure Fund (TRIF)/Proposition 301, a sales

tax levy that benefits universities and the development of new bioscience research centres. In 2003, the Governor's Council on Innovation and Technology (GCIT), which involves Arizona's key business and industry leaders, was established to drive Arizona's knowledge-based economy. The council's main goal is to foster innovation, creation and entrepreneurial expansion of technology-based companies throughout the state of Arizona. The GCIT has supported different initiatives of technology commercialisation, such as the University of Arizona's BIO 5 Institute, McKnight Brain Institute, the Arizona Clinical and Translational Research and Education Consortium (ACTREC) and the C-Path Institute, as well as Arizona State University's Biodesign Institute. It has also supported the joint research facility of the two universities as part of the Phoenix Biomedical Campus. The GCIT has played an important role in the capital formation for business creation through the "Angel Investor's Tax Credit", which spurs investments in life sciences and technology development; and the AZ FAST grants for companies that pursue the opportunities provided by Small Business Innovation Research Program (SBIR) and the Small Business Technology Transfer Research Program (STTR). Since 2004, USD 4.4 million in federal grants has been awarded to AZ FAST participants.

In Southern Arizona, the key players in economic development include Tucson Regional Economic Opportunities (TREO), which is a public-private agency representing strategic economic development interests in the region. It is a result of three key players' efforts that came together in 2005: the City of Tucson Office of Economic Development, Pima County Economic Development and the Greater Tucson Economic Council (GTEC). The University of Arizona is represented in the TREO board. In 2007, TREO released *Securing Our Future Now: An Economic Blueprint for the Tucson Region* that analysed Southern Arizona's economic strengths and weaknesses, and identified policy strategies to capitalise on growth opportunities. Tertiary education resources were identified as one of the leading strengths of the region. One of the strategic priorities of TREO is to strengthen the interaction and exchange between the University of Arizona and local industry. TREO identified seven industry strengths in Southern Arizona: biosciences, environmental technology, aerospace, information technology, optical sciences, advanced composites and tourism. These industries, which have the capacity to attract inward investment, require continued innovation to survive and expand. (Southern Arizona's Regional Steering Committee, 2009) In practice, TREO's activities focus on attracting new industries to the region, rather than upgrading the existing industry or supporting new business formation. Furthermore, despite the identification of key clusters for the region, there appears to be a limited focus on cluster development activities.

Local economic development is addressed by county and municipal governments but there are also many policies and programmes at the federal and state level that encourage economic growth. For example, Tucson's economic development is promoted through federal, state, county and city programmes. Many of these programmes have a focus on tax incentives. Tucson has a federally funded Empowerment Zone, where business gets tax credits for locating in and hiring employees who live in the area; a state-funded Enterprise Zone that offers tax incentives to businesses locating in low-income areas; and city-led programmes to support local small businesses and revitalise the downturn. In contrast, Pima County has a focus on skills development and workforce training (Southern Arizona's Regional Steering Committee, 2009).

Small business development

Entrepreneurship plays an important role in generating innovation and stimulating growth in the United States. Americans are twice as likely as Europeans and Japanese to start a high growth business. As elsewhere, small businesses are big employers in the United States: firms with fewer than 20 employees accounted for approximately 18% of private sector jobs in 2006, but nearly 25% of net employment growth from 1992 to 2005. Small businesses also employ 30% of high tech workers, such as scientists, engineers and information technology workers (NEC, 2009).

Collaboration between tertiary education institutions and SMEs is essential for innovation, as small businesses and universities are now playing an increasingly important role in the innovation process. In the United States, a number of programmes are in place to support collaboration between tertiary education institutions and SMEs, and RDI in SMEs. While these programmes are a-spatial in their design, they have, nonetheless, benefitted SMEs and local industries at the regional level, by creating a "demand pull" for RDI within the SMEs, and also by encouraging them to evaluate commercial potential of research results. This type of "demand pull" policies can be seen as a response to the universities' emphasis on knowledge generation and excellence in research rather than knowledge transfer and diffusion and the fact that publishing is the primary motivation for most professors. Channelling technology transfer funds through tertiary education institutions, or public research laboratories, may therefore not be the best way to commercialise research results.

Demand-pull programmes in the United States include the Manufacturing Extension Partnership (MEP) programme enables small companies to improve their productivity and create the capacity to innovation. This programme has been measurably successful in increasing

small company productivity, but its funding has decreased from USD 138.4 million in 1995 to USD 90 million in 2008 to pick up again in 2009 (Christopherson, 2009).

Other important programmes supporting innovation in SMEs include the Small Business Innovation Research Program (SBIR), the Small Business Technology Transfer Research Program (STTR) and the Advanced Technology Program (ATP) (Box 3.1.). The Small Business Innovation Research Program (SBIR) is the largest US Innovation Partnership Program with a budget of USD 2.3 billion in 2009 and has been in place for more than 25 years with a stable budget: 2.5% of Federal Agency R&D budget have been set aside for small business awards. SBIR has focused on funding proof of concept and prototypes and helped firms cross the "valley of death" and attract private capital or win public contracts.

Tertiary education institutions in Southern Arizona have taken advantage of these programmes although no data is available about the scale of its engagement, the number of companies involved or the outcomes of the collaboration. The importance of the SBIR and STTR programmes has also been acknowledged by the state of Arizona, which since 2004 has supported companies participating in these programmes through the Government Council on Innovation and Technology (CGIT).

Box 3.1. Small business innovation and technology transfer programmes in the United States

In 1982, the United States passed the Small Business Innovation Research Act (SBIR) in order to facilitate the absorption of new technology by small and medium-sized enterprises (SMEs) and in 1992 it passed the Small Business Technology Transfer Research Act (STTR). The SBIR provides up to USD 850 000 in early stage R&D to small technology companies or to entrepreneurs who launch a company. The STTR programme provides up to a similar sum to small companies working in co-operation with academic researchers in public laboratories in order to explore the commercial feasibility of new ideas emerging from these institutions. The different federal departments that allocate R&D funds to private firms run both programmes. In 2007, all departments combined, SBIR was funded at USD 1.14 billion and STTR at USD 131 million. In order to qualify for SBIR grants, firms must have fewer than 500 employees and conduct R&D in the United States. In addition, the principal investigator must work at least half time in the proposing firm.

Box 3.1. Small business innovation and technology transfer programmes in the United States (continued)

The STTR grants have similar firm-size requirements, but the principal investigator may be employed at either the firm or the research institution. Also the SMEs have to be more than 50% owned by its managers and/or employees. This requirement has the benefit of concentrating funds in the early stages of technology development. SBIR and STTR have helped thousands of innovative firms to explore the benefits of academic research results by reducing the cost of exploration and conversion of scientific ideas into commercial products (Auerswald and Branscomb, 2003). An evaluation of SBIR conducted in 2006 concluded that the SBIR programme is sound in concept and effective in practice and achieving most of its specific objectives. SBIR awards played a key role in the decision to pursue a research project and SBIR funding is often used to bring in academic consultants to partner with firms.

The Advanced Technology Program (ATP) was created in 1990 to help US businesses commercialise technologies and refine manufacturing methods. Companies or consortia of companies propose research projects to National Institute of Standards and Technology (NIST), which selects the proposals on the basis of economic potential. Universities can take part in consortia and propose projects but cannot serve as project leaders. ATP is a demand-pull programme: the research priorities are set by industry and not by government, academia or public laboratories. Funding is not confined to only small and medium-sized companies, but large companies can also participate if they cover at least 60% of the costs of the project. ATP helps emerging companies to explore new technologies in partnership with academic or government researchers. In its 2001 report, the US National Research Council concluded that ATP is successful in commercialising early-stage technologies (Niosi, 2008).

Source: Auerswald, P.E. and L.M. Branscomb (2003), "Valleys of Death and Darwinian Seas: Financing the Invention to Innovation Transition in the United States", *Journal of Technology Transfer*, Vol. 28, No. 3-4, Springer Netherlands, Dordrecht, pp. 227-239; Niosi, J. (2008), "Connecting the Dots between University Research and Industrial Innovation", *IRPP Choices*, Vol. 14, No. 14, Institute for Research on Public Policy, Montreal.

Small Business Development Centers (SBDCs) have a 30-year track record in the United States as an SME service network, with 1 100 centres located in tertiary education institutions, which serve annually 750 000 SMEs. Affiliated with the US Small Business Administration, SBDCs also assist clients gain debt and investment capital, as well as domestic and international contracts. In 2007, the network assisted SME

clients to create 73 377 new jobs and save another 93 449 jobs at-risk. It also helped SMEs obtain new growth capital totalling USD 3.3 billion and increase sales by USD 7.2 billion (OECD, 2009b).

In Southern Arizona, Cochise College and Pima Community College each maintains a Small Business Development Center offering free consulting, training and referrals to small business owners and entrepreneurs. Consideration should be given to whether the Tohono O'odham Nation would benefit from a Small Business Development Center linked to its community college. It is also worth noting that in other US states, universities can play a role through Small Business Development Centers. This is the case for example in North Carolina where the university is engaged in long-term counselling programmes for small business owners (Box 3.2).

Box 3.2. Small business development in North Carolina

In North Carolina, US, the federally funded small business assistance programme is a University of North Carolina system-wide programme managed by NC State. Its network of 17 Small Business Development and Technology Centers is based mostly at business schools in other public colleges across the state, providing training courses and counselling for small business owners.

The small business centres are focused on special expertise in technology assistance, by helping small business find local sources of capital and in providing lengthy (20 to 30 hours) and through intensive one-on-one counselling programmes for small business owners. The programme is able to offer intensive consulting services because it relies on faculty and business students, about 650 a year. They provide valuable service and the experience adds value to their education. The programme counts 110 000 counselling clients and 85 000 attendees at training programmes since 1984, with the clients creating 25 000 jobs and growing sales and jobs at more than three times the state average. Separate training programmes are in place to help small investors in the state to understand how to set up, operate and succeed with local "angel capital "networks and to train small business owners how to find investors, understand their expectations and meet their needs.

Source: Schaffer, D.F. and D. J. Wright (2010), "A New paradigm for Economic Development, in Tertiary education", The Nelson A. Rockefeller Institute of Government, New York.

3.2 Southern Arizona – moving towards a high wage economy

During the last decade, the Tucson metropolitan region showed good performance in job creation, particularly in the defence-related sectors. In

the Aerospace Vehicles and Defence cluster, the region created 8 703 new jobs, in contrast to the rest of the country where negative growth was experienced. In business facilities, the Tucson metropolitan region ranked the 6th largest region in the US for aerospace manufacturing (Southern Arizona's Regional Steering Committee, 2009). The biggest employer in Southern Arizona is Raytheon Missile Systems, which employs over 11 500 people and generates over USD 5 billion in revenue. In terms of aerospace products and parts manufacturing, Southern Arizona has a location quotient of 8.35, indicating that the industry is eight times more concentrated in Southern Arizona than elsewhere in the country (TREO, 2009).

In general, however, high value added activities continue to have limited weight in the regional economy and the average per capita income in Southern Arizona remains consistently below the US average. For example in Tucson, average wages were USD 34 511 in 2007, 17.2% below the national average of USD 41 680. Southern Arizona's Aerospace Vehicles and Defence cluster has an average wage of USD 48 765 compared to the national average of USD 71 632, indicating that operations in Southern Arizona focus on manufacturing, rather than R&D. This is further illustrated by the fact that the Analytical Instruments cluster, which represents only a small part of the employment (2 302 jobs in 2007), generates wages equivalent to 63% of those of the Hospitality and Tourism cluster (with 12 145 jobs).

Much of the Southern Arizona's progress in high technology fields can be attributed to its main economic centre, Tucson, which has developed into a hub of light-based technologies. Nicknamed "Optics Valley", the optics industry consists of 150 companies, 4 573 jobs and over USD 650 million in revenue. Most of the optical science firms are small companies dedicated to a small niche of research within the field. Within the state of Arizona, Southern Arizona and, particularly, the Tucson metropolitan region have a high concentration of light-based industries: 60% of Arizona's optical science employment is in Southern Arizona (TREO, 2009).

In a global benchmarking study on optics clusters, performed by the consultancy Competitiveness for the Government of Catalonia in 2007, the Tucson Optics cluster was the only one in the world that demonstrated excellence in four out of eight areas of application: life sciences, lighting, transport, and aerospace and defence. In contrast to other optical clusters, in Southern Arizona, the lack of leading corporations to drive their research agenda has allowed the firms to become more interdisciplinary and helped them cross borders and industries without restrictions. Elsewhere, optical clusters have originated from a dominant industry, usually led by a large

company that has captured the research funds, making it difficult for the cluster to diversify into other areas of knowledge.

Despite the positive track record of light-based industries in Southern Arizona, there are signs that Tucson may be losing ground in this domain. According to the University of Arizona' Office of Economic and Policy Analysis (2008), more than half of the firms in the field reported having difficulty in finding qualified employees, suggesting a mismatch between employers' demand and the supply of the local education institutions. The Arizona optics and nanotechnology cluster is also comprised of older, established firms, indicating a reliance on legacy technologies and a lack of entrepreneurial dynamism. Furthermore, almost one quarter of the firms identified limited local networking opportunities as a challenge.

As a response, Southern Arizona has chosen the path of aiming to replicate the successes of the optics in biotechnology and other high technology fields in order to diversify the regional economy and to create high wage employment. In 2007, Arizona's bioscience industry accounted for USD 12.5 billion and 87 000 jobs. Factoring out healthcare, the industry generated USD 3.6 billion and 13 000 jobs. In terms of employment, six of Pima County's top-30 largest employers are hospitals and health service providers (Southern Arizona's Regional Steering Committee, 2009). The Tucson metropolitan region is also home to over 100 biotech companies that employ an estimated 2 000 workers. The biotech cluster in Oro Valley is home to subsidiaries of pharmaceutical multinational corporations such as Sanofi-Aventis, Roche and Merck, many with close links with the University of Arizona (Alltucker, 2008).

Other important sectors for the regional economy include environmental technology and agriculture, which feature opportunities for new growth through sustainable energy and resources development. Over 37% of Arizona's land area is occupied by agricultural activity with over 7 300 farms and ranches bringing a collective output worth over USD 6 billion annually. Despite decline in employment, agriculture remains important for the economy in Arizona. Sustaining agriculture depends on innovations in land use and water management. The University of Arizona is well placed to support development in this field through its College of Agriculture and Life Sciences, which is dedicated to commercially/industrially oriented research (Chapter 4).

Arizona's environmental technology industry generates USD 2.2 billion in revenue annually, with about one-third of an estimated 1 200 environmental-related businesses, ranging from large businesses to small non-profits, located in Southern Arizona (2001 data). One of Southern Arizona's emerging industries is the solar industry. Regional firms

include Solon Corporation, Schletter Inc., Global Solar and Prism Solar (TREO, 2009). Southern Arizona is well positioned to develop its solar industry not only because of its climate and natural conditions, but also because of its growing research capacity in this field (Chapter 4).

The tourism and hospitality industry continues to be among the most important export industries that drives Arizona's economy. The tourism industry is also a major employer: more than 170 000 people are directly employed in the tourism industry, while a much larger number depends on out-of-state visitors. In Southern Arizona, 39 500 jobs are generated by tourism. Mexican visitors comprise a significant component of the total tourism industry in Southern Arizona, with direct spending of more than USD 1.9 billion in Southern Arizona, of which USD 976 million in Tucson and its metropolitan area. For Arizona's border cities, spending by Mexican residents is even more important due to their small economies (Pavlakovich-Kochi and Charney, 2008; Southern Arizona's Regional Steering Committee, 2009).

3.3 Responding to regional needs and demands

A central concern of this review is establishing the extent to which the University of Arizona and the community colleges respond to the needs of their surroundings and Southern Arizona and what mechanisms are in place to facilitate this. Individually each tertiary education institution plays a role in business and industry. As the key research institution in Southern Arizona the University of Arizona dominates the RDI scene in the region. In 2006, it had nearly USD 407 million in total sponsored research expenditures. Ranked by the National Science Foundation as first in research expenditures in the physical sciences, the university produces research that is nationally and internationally recognised, as evidenced in the number of grants and contracts, the range of academic publications and the University of Arizona's status as a RU/VH (a Research University with a "very high" level of research).The University of Arizona has addressed innovation needs through focused research, collaborations and other activities that open lines of communication between industry and scientists. The university is outperforming peer institutions in industry-funded R&D. 12.5% of all research awards received by the university between 2001 and 2006 were from private industry. 20% of the top-50 industry sponsors were from Arizona firms. In the same time period, 6.2% of all R&D expenditures were from industry – a performance exceeding the peer average of 5.1%. The university conducts research in all of the priority sectors identified by TREO, except tourism, which is a key employer in the region. (Southern Arizona's Regional Steering Committee, 2009).

Knowledge exchange between tertiary education and business and industry can take place through a wide range of mechanisms. Table 3.1. identifies some mechanisms and their presence in Southern Arizona, indicating also key challenges the mechanisms involve. Most of these mechanisms are hosted by the University of Arizona.

Table 3.1. Knowledge transfer mechanisms in Southern Arizona

Type of approach	Southern Arizona	Main activities	Challenges
Licensing	University of Arizona Office of Technology Transfer (OTT)	Selling of licenses by university agents to use university-owned patents, copyrights and other intellectual property.	Alternative commercialisation options should be considered with capacity to generate not only revenues to the university but also economic development outcomes for Southern Arizona. Other strategies are required for intellectual property that cannot be legally protected or where tacit knowledge is attached to an innovation.
Spin-offs		Creation of new firms based on knowledge acquired in the university, by university staff, students or external investors.	Numbers of spin-offs are increasing. The university would like to have the right for equity but taking stakes in spin-off enterprises is riskier than licensing. Given the decreasing state funding, a choice may have to be made between concentrating resources on a few potentially high-growth spin-offs and spreading resources to support a larger number of spin-offs. Successful spin-off activity requires strong investments in entrepreneurial skills and attitudes in university staff, students and graduates.
Technology transfer offices (TTOs)	University of Arizona OTT	Managing the process of selling university patents and other intellectual property, usually through licenses.	Linkages should be built not only with large firm customers but also SMEs. There is a general need to refocus on supporting industry productivity and innovation.
Technology brokers	BIO5	People and agencies to facilitate relationships among academics, entrepreneurs and support institutions that will help identify commercialisation opportunities and create exploitation partnerships.	Brokers need to audit and monitor intellectual property within the university and build relationships going beyond the obvious high technology fields. Brokers need professional profiles with credibility for both academics and business.

Table 3.1. Knowledge transfer mechanisms in Southern Arizona (continued)

Science parks	University of Arizona's Science and Technology Park Biosciences Park	Organisations that aim to increase the wealth of its community by promoting the culture of innovation and competitiveness of associated businesses and knowledge-based institutions. They manage the flow of knowledge and technology amongst HEIs, R&D institutions, companies and markets; facilitate the creation and growth of innovation-based companies through incubation and spin-off processes; and provide other value-added services and high quality space and facilities.	Co-location does not necessarily generate knowledge exchange, but permanent channels for interaction between university staff, graduates and industry must be developed. Location factors (proximity to services and transport) that ensure networking need to be enhanced in the new BioPark in order to ensure that it will not remain a real estate development project.
Incubators	University of Arizona's Center for Innovation (AzCi)	A programme designed to accelerate the development of entrepreneurial companies through a range of business support resources and services, developed and orchestrated by incubator management and offered both in the incubator and through its network of contacts..	Because spin-off numbers can be very low and variable, heavy investments in physical incubators should be avoided.

Source: Adapted from Potter, J. (2008), Entrepreneurship and Higher Education, OECD, Paris.

Managing the university-industry interface

Collaboration between tertiary education institutions and industry requires the development of institutional interfaces that facilitate win-win knowledge exchange and diffusion. Each tertiary education institution in Southern Arizona has created their own mechanisms to manage the external interface, and these mechanisms vary according to the mission of the institutions and their resources.

While community colleges have generally well-functioning mechanisms to respond to workforce development needs, the University of Arizona has developed a wide range of mechanisms for engaging with business and industry through research and technology transfer, including dedicated offices for technology transfer and intellectual property. These mechanisms include multiple links, collaboration mechanisms and support schemes with and for businesses, industries, governments and private organisations or

individuals. The university also offers access to structured programmes that help educate and inform the public about innovation, connect researchers to investors and mentors, and partner researchers with developable innovations with industry stakeholders that can help the innovation make it to market. Table 3.2 shows some examples from University of Arizona and Cochise College.

Table 3.2. Southern Arizona interfaces for knowledge translation and exploitation

NAME	NATURE AND PURPOSE
The University of Arizona's Economic and Business Research Center (EBR). Housed within the Eller College of Management, EBR has been a part of university since 1949.	Economic and Business Research Center provides citizens of Arizona with economic forecasting and analysis. EBR's current roles involve research in the areas of: regional economic and revenue forecasting; border and regional development; environmental/sustainable economics; renewable energy; economic impact; public finance and taxation; industry studies.
The University of Arizona's Office of University Research Parks (OURP). The University of Arizona's Office of Corporate and Business Relations (OCBR).	OURP oversees the University of Arizona's Science and Technology Park (UASTP), Bio Park and AzCI. OCBR aims to increase the revenue potential of research at the University of Arizona, with the hope of increased yields from commercially-viable discoveries.
The University of Arizona's Science and Technology Park (UASTP): A 1 345 acre campus with 1.89 million square feet of usable space and a centralised utility system, opened in 1995.	UASTP provides: *i)* specialised infrastructure and office space for major regional employers, including high-wage technology firms, *ii)* a site to host university-affiliated economic development programmes and *iii)* an environment for the university researchers to explore technology transfer through specialised lab and support staff.
The University of Arizona's Arizona Center for Innovation (AzCI). Founded in 2003. Based at UASTP.	AzCI, Southern Arizona's business incubator, aims to develop innovations created by the university researchers into successful businesses (spin-offs). In addition to the business development assistance, consultation, and mentoring, AzCI provides office space, receptionist and secretarial services, conference rooms, mail service and wet or dry lab space.
The University of Arizona's Bioscience Park (Bio Park).	Bio Park is a science park entirely devoted to research in biotechnology fields. It is located in the immediate vicinity of most bio- medical research facilities in the region (UPH Kino Hospital, C-Path, the University of Arizona's Cancer Center, Tucson Veterans Administration Hospital and the University Medical Center).

Table 3.2. Southern Arizona interfaces for knowledge translation and exploitation (continued)

The University of Arizona's McGuire Center for Entrepreneurship. Located within the Eller College of Management.	McGuire Center for Entrepreneurship is one of best entrepreneurship programmes among public universities in the US. It aims to integrate research into the practice of identifying and transferring technology and innovations to the marketplace, and service to on- and off-campus organisation through technical assistance on entrepreneurship activities.
Global Advantage.	Global Advantage seeks to connect UASTP researchers to researchers at international research Parks.
Desert Angels.	Desert Angels is a non-profit organisation (not affiliated with the university) involved in commercialisation of technology: It *i)* facilitates the introduction of highly qualified start-up businesses to venture capitalists/investors and *ii*) funds the University of Arizona's innovations with commercial potential.
The Critical Path Institute (C-Path)	D-Path helps speed up approval of new pharmaceuticals.
Cochise College's Center for Economic Research	Center for Economic Research engages in applied business and economic research. It provides economic information, analysis and forecasting, as well as personnel to serve on community projects, committees and task forces.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

The University of Arizona sponsors also a number of important programmes and initiatives that link its research capacity to the business sector. These include the University of Arizona's Science and Tech Park and AzCI, the Arizona Center for Innovation (Box 3.3).

Box 3.3. University of Arizona Science and Tech Park and Arizona Center for Innovation (AzCI)

The University of Arizona Science and Tech Park (UASTP) opened in 1995 on an underutilised research campus originally developed by IBM. It provides: *i)* specialised infrastructure and office space for major regional employers, including high-wage technology firms, *ii)* a site to host UA-affiliated economic development programmes and *iii)* an environment for UA researchers to explore technology transfer through specialised lab space and support staff.

UASTP has created 13 676 jobs in Arizona in 2007, 97% of which were in Pima County. Based on 2007 data, 6 175 of these jobs were created directly through employment with the 32 tenants of the park, 6 850 were indirectly created throughout the region, and 220 construction jobs and 2 visitor-related jobs were created. The average wage of a UASTP employee is USD 71 077, far surpassing the Pima County average of USD 38 220 and in total, the Tech Park generated USD 688.1 million in wages in Pima County (Lim, 2009). The tenants of UASTP also generated USD 11.6 million in tax revenue during 2007. Overall, the Tech Park generated USD 2.45 billion in Pima County in 2007 (Lim, 2009). Further expansion plans will focus on building to suit the needs of more high-paying technology firms, which may be attracted to the park. UASTP is home to 40 technology companies and business organisations, including 4 Fortune 500 companies like Citigroup, IBM, Raytheon and Canon USA. In addition to leasing space to private firms, UASTP is also home to Vail High School and UA South. (Lim, 2009)

Arizona Center for Innovation (AzCI) is based at the UASTP and is Southern Arizona's business incubator. AzCI was founded in 2003 with the goal to develop innovations created by UA researchers into successful businesses (spin-offs). AzCI operates with a small administrative staff, working with over 40 partners/mentors (about 50% from private industry) and 15-18 client companies in residence.

AzCI follows an interventionist model of business incubation that places their clients into an active stream of business mentorship. The nine month programme, Commercial Reality, is broken down into three phases. First, a client will participate in "Mentored Launch," a 90-day seminar consisting of six sessions after which clients have completed a business plan, met with financial advisors and regional entrepreneurial supporters, and developed several investor slides. During the six-month start-up phase, new companies meet regularly with AzCI mentors as well as assigned community business mentors in order to secure seed grants from state and federal agencies.

Box 3.3. University of Arizona Science and Tech Park and Arizona Center for Innovation (AzCI) (continued)

In the last phase, companies have the opportunity to complete "Expert Panel", a formal presentation to investors and business experts. Of the 34 companies that AzCI has worked with, 20 have fully-graduated Commercial Reality. Of those 20 companies, three have been sold, seven remain in development, and the rest have ceased to exist (July 2009). In addition to the business development assistance, consultation and mentoring, AzCI provides office space, receptionist and secretarial services, conference rooms, mail service, and wet or dry lab space.

In its seven years, AzCI has grown significantly. Clients in residence have grown from 2 to 15, with a direct job impact of those clients growing from 4 to 37 in 2009. There are eight patent holding companies affiliated with AzCI (up from one), and over USD 5 million in funds have been raised. AzCI co-sponsors (with the McGuire Center) the annual Arizona Innovation Day at the university which allows UA researchers and students share technological innovations with each other, investors and industry. Each year, a faculty member who has successfully moved an innovation to the marketplace is recognised with a USD 10 000 award, while students present their research in competition for a USD 1 000 award.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Despite recent efforts to develop a more streamlined knowledge transfer and university-industry relations, the University of Arizona continues to feature a fragmented approach to managing the university-industry interface with a number of different offices and units.[6] As noted in the regional self-evaluation report, the wide range of offices, parks, institutes, centres and initiatives have lead to overlap, duplication and confusion among the regional stakeholders and companies. The effectiveness of the innovation infrastructure could be improved by a co-ordinated approach between the sub-units to university-industry collaboration, research and innovation (Southern Arizona's Regional Steering Committee, 2009).

Reorganising external affairs under a joint structure could lead to improved communication within the university, cost savings and more approachable structure from the perspective of external stakeholders. In many universities, a single office has been established to manage the institution's external affairs, including regional collaboration (Box 3.4.).

Box 3.4. Reorganising external affairs to enhance co-ordination and focus

In 2003, the University of Wisconsin, a large public university with the oldest Technological Transfer Organisation (TTO) in the United States, established a task force to reorganise external services in a way that reflected the complexity and opacity of the networks linking business to the university, the specific political economy of the United States and the city-region in which the university is embedded in. The objective of the Task Force was to convene focus groups and survey a stratified sample of Wisconsin's and other selected business leaders to determine:

- What kinds of university-business relations programmes and services do business leaders need from the university in the areas of research partnerships, technology transfer and economic development collaborations (*e.g.* employment resources, continuing education, information services, consulting services, patents and inventions, laboratory services, research partnerships, special economic development projects and outreach for fund development purposes)?

- How do business leaders perceive the way UW-Madison currently applies its resources in the areas of research partnerships, technology transfer and economic development collaborations?

- How can the university better communicate its resources in the areas of research partnerships, technology transfer and economic development collaborations?

The findings of the Task Group work led to the creation of a single external office, the Office of Corporate Relations (OCR). The Managing Director of the OCR reports to the Vice Chancellor for University Relations and the Vice Chancellor is charged with "co-ordinating the university's messaging and relationship-building strategies across a broad range of audiences, from the campus community to legislators, parents, alumni, donors and friends across the world", including strategic communications, government and community relations, corporate relations and economic development initiatives, visitor relations and programmes, parent (of students) communications, trademark licensing, and university partnerships with the Wisconsin Alumni Association and the University of Wisconsin Foundation. Such a structure is designed to free the technology transfer office of acting as the main portal into the university, which allows it to concentrate on technology transfer alone.

Box 3.4. Reorganising external affairs to enhance co-ordination and focus (continued)

The new structure includes units for marketing and communication; new venture and private equity, which focuses on start-ups, entrepreneurship and technology transfer; and three university-business liaison offices for IT and engineering; retailing, insurance and banking; and life sciences, medicine and biotechnology.

Source: OECD (2010b), The City-Region of Amsterdam, Netherlands, *Reviews of Higher Education in Regional and City Development*, OECD, Paris.

Collaborative mechanisms between the University of Arizona and the community colleges remain limited in R&D and innovation. There is currently no mechanism of pooling the knowledge and expertise of all tertiary education institutions to deliver support to industry. In particular small and medium-sized enterprises (SMEs) face a range of barriers in accessing the knowledge resources of the tertiary education institutions which may discourage regional university/SME collaboration. While setting up a joint front office for tertiary education institutions is a challenge, modern technology can facilitate collaboration in this area.

People-based knowledge transfer

Population growth is a major strength for Southern Arizona and provides opportunities for many industry sectors. At the same time, however, the region also suffers from outmigration to Phoenix and other US states by a population of young, single and college-educated demographic. While no robust data was available, it was acknowledged that many graduates of the University of Arizona in science, technology and engineering are recruited by national companies outside the region. The top destinations for outmigration outside of state of Arizona are the states of California, Washington, Nevada, New Mexico, Texas and Illinois. Between 2005 and 2007, 547 000 people left Arizona for other states, mostly California. The region also loses talent to the Phoenix metropolitan area in Arizona: between 2004 and 2005, a total of 4 364 migrants moved north to Maricopa County.

In light of this development, it is surprising that there are only fragmented knowledge transfer programmes based on people mobility in Southern Arizona to help retain talent in the region. While a number of

ad hoc systems are in place, including individual agreements with firms for internship arrangements for students, these are usually developed by the most entrepreneurial departments and schools within tertiary education institutions. Systematic programmes linking all students, graduates and post-graduates in the regional industry, were, however, not in evidence.

In the University of Arizona, work-based learning opportunities are administered on a departmental level. As of 2007, 59% of students had participated in some internship, research or clinical placement. The university's research centres provide a broad range of work-based learning opportunities in collaboration with industry partners. In aerospace and mechanical engineering, all undergraduate students are required to undertake work-based learning as graduation requirement. Many Pima Community Colleges professional programmes include an internship of work component. Cochise College offers both cooperative credits for work experience related to the student's field of study, as well as a service learning opportunity that places students in local schools as tutors. Tohono O'Odham College offers apprenticeship programmes that have open enrolment and are free (Southern Arizona's Regional Steering Committee, 2009).

To improve graduate retention, and quality and attractiveness of local jobs, Southern Arizona's tertiary education institutions and the region's key stakeholders could consider establishing programmes linking tertiary education and industry, students, post-graduates and faculty with the local industry. This type of programmes would improve the competitiveness of the local firms through the recruitment of the interns or the introduction of some form of innovation or new technology garnered from the mobility programme. This could be partly achieved by rethinking the SBIR programmes. Inspiration could also be sought from the United Kingdom where the Knowledge Transfer Partnership Scheme has been running successfully (previously as Teaching Company Schemes) since the 1970s. Knowledge Transfer Partnerships improve the competitiveness of the companies through introduction of some form of innovation or new technology, while an additional benefit is usually the recruitment of the postgraduate associate; around 75% of associates in projects lasting from one to three years are offered jobs in the company (Box 3.5.).

Box 3.5 UK Knowledge Transfer Partnerships

The Knowledge Transfer Partnership programme in the United Kingdom was launched in the 1970s as the Teaching Company Scheme, and was designed specifically to foster close collaborative partnerships between universities and companies with an explicit focus on the transfer of knowledge into company practice rather than supporting research in universities. The main focus is on improving the competitiveness of the industrial partner, through the work of post-graduate "associate" working in the company with supervision from the academic partner.

The scheme is partly funded by the companies involved and partly by a public organisation such as the Technology Strategy Board or a Research Council, with more advantageous terms available for small and medium-sized enterprises (SMEs). Typically an SME would pay around GBP 20 000 per year for involvement. The projects are usually 2 years in duration and the postgraduate associate is employed to work in the company during this period on a pre-defined project. The associate is paid a salary and in some cases is registered for a higher degree (usually devoting 10% of their working time to professional development), and forms the linkage between the company and the supervising academic in a university or research organisation. The academic partner is compensated for some of the time of the supervisor and for university overheads.

The primary outcome of the project is usually the implementation of some form of innovation or technology in the company, although an additional benefit is usually the recruitment of the associate and around 75% of associates in projects lasting 1-3 years are offered jobs in the company. The 2008/09 annual report for the scheme reported 977 active projects and estimated the benefits to UK business would be over 6 500 staff trained, 1 119 new jobs created and an increase in pre-tax profits of GBP 126 million.

Source: TSB (Technology Strategy Board) (2009), "Knowledge Transfer Partnerships Annual Report 2008/09", *www.ktponline.org.uk/content/libraryMaterial/KTPAnnualReport0809.pdf,* accessed 30 March 2010; TSB (2010), "Knowledge Transfer Networks", *www.innovateuk.org/deliveringinnovation/knowledgetransfernetworks.ashx*, accessed 5 April 2010.

Commercialisation

There has been considerable encouragement for the US universities to promote the commercial exploitation of their technologies. Much of this

activity is based on a technology-push model as inventions developed in the university are marketed to potential licensees in industry.

In Southern Arizona, the commercialisation of intellectual property (IP) of the University of Arizona is co-ordinated by the Office of Technology Transfer (OTT), which mediates the transfers of IP to industry sectors through various legal mechanisms. The OTT has a mission to protect, manage and transfer the University of Arizona-owned intellectual property to benefit society, expand public-private relationships and further the university's mission of teaching, research and service to the people of Arizona. It acts as a bridge between research and innovation; between research at the university and private industry, beginning with disclosure and ending with license agreements; and development of spin-off companies. In 2009, 107 researchers contacted OTT to begin the process by describing their intellectual property (IP), its uniqueness, and potential commercial prospects. In recent years, the OTT has garnered approximately 100 disclosures annually, and aims to increase that total to 140 by 2014. The University of Arizona's knowledge transfer path from discovery to commercialisation is highlighted in Box 3.6.

Box 3.6. UA knowledge transfer from discovery to commercialisation

Disclosure is the first step in technology transfer. In the University of Arizona, researchers are required to disclose ABOR-owned intellectual property (IP) through the Office of Technology Transfer (OTT). A researcher will first contact OTT for a pre-disclosure counselling session, in which an OTT counsellor confidentially discusses the IP with the inventor. Discussions typically include an exchange of information on why the innovation is unique, what commercial prospects it may have, and the innovation's stage of development. Following this discussion, innovators will submit a full-disclosure packet with detailed information needed to assess, protect, and manage the innovation. The information includes: a description of the innovation and its practical applications, names of all contributors and their roles in the innovation, funding sources for the research project (some sources of support may be entitled to compensation/shared-license), and any information on the future of the innovation (marketing, potential collaborators, potential licensee).

Box 3.6. UA knowledge transfer from discovery to commercialisation (continued)

Following disclosure, OTT researches the IP for future development options, including licensing the IP to an existing company or "spinning-off" a new company focused on the IP's development. If the IP was created under a federally-funded project, the federal government will have a two month privileged option to license the invention. After these two months expire, OTT is able to commercially license the IP. Negotiations of the licensing rate depend on a number of factors including: robustness of patent claims, the degree to which the licensed IP is evolutionary or disruptive to competing technologies, and whether or not the licensed IP is a stand-alone invention, or an innovation on an existing invention. OTT will negotiate contracts with private companies on terms including: one-time license issue fees, patent cost reimbursement, milestone payments and royalties.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

The US legal framework for intellectual property rights is helpful in protecting ideas and research of the members of the academia.[7] However, US universities have identified legal costs; lengthy time for patent issuance (sometimes technologies are outdated by the time patent is granted); limited budgets; and the limited long term return on investment as barriers to patent and commercialisation activities. Formal partnerships may also be difficult to establish because of disagreements between the university and the industry partner on the ownership and rights of university generated intellectual property (OECD, 2010c). The state of Arizona features an additional disincentive to commercialisation and technology transfer: the University of Arizona is not allowed to own equity in firms.[8]

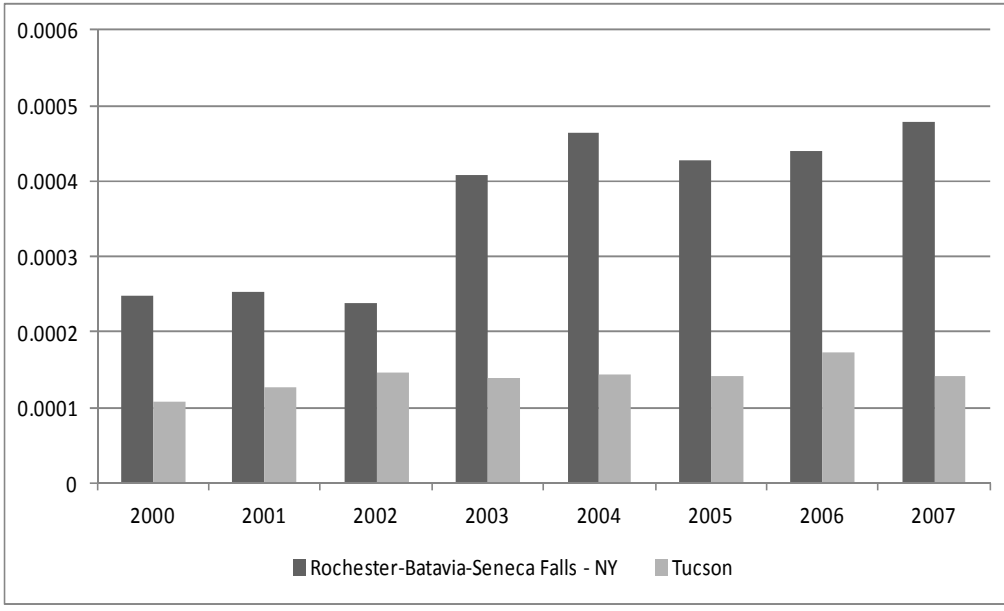
In Southern Arizona, the Arizona Board of Regents' (ABOR) retains ownership of all IP created by employees at the University of Arizona if: *i)* a university employee creates an invention while employed in a related field at the university; *ii)* intellectual property is created under sponsored funding; or *iii)* university resources (lab space, office space, etc.) have been used in the creation of intellectual property. Notable exceptions include: *i)* IP created in coursework by student and not related to a sponsored project; *ii)* printed publications and artistic works; and *iii)* digital publications published in scholarly applications (ABOR retains ownership of

commercially published, digital applications) (Southern Arizona's Regional Steering Committee, 2009).

The scale of commercialisation activity in Southern Arizona has developed positively in high technology fields. While the number of patent applications of the Tucson metropolitan region is significantly below that of the Rochester region, top performer in the United States (figure 3.4.), the Tucson metropolitan region has for years outperformed many regions in terms of the number of patents per 10 000 employees, ranking 50th among 361 statistical metropolitan areas in the United States (Porter, 2008).

Figure 3.4. Patent applications

Fractional count; by inventor and priority year



Source: OECD Patent Database.

Table 3.3. provides data about the University of Arizona's license agreements and patents, which, considering the size of the university and research strengths, remain at a low level. Furthermore, the revenue generated by these activities has ranged from USD 989 000 to USD 1.5 million between 2007 and 2011, indicating a fluctuating trend (Table 3.4.). It can be expected that the University of Arizona's Office of Technology Transfer may be losing money as is the case with many other technology

licensing offices in the United States. Given the fact that the national pharmaceutical industry is concentrated in Southern California and New England, it can also be expected that much of the current activity involves commercialisation outside of Southern Arizona and the state of Arizona, hence benefiting other regions. With the decreasing state funding for the university, OTT is also faced with pressures to maximise university revenue, rather than spur regional economic growth.

Table 3.3. University of Arizona – License agreements and patents

	University of Arizona
License agreements implemented	3
License agreements in negotiations	3
Patents awarded	3
Patent applications filed	11
Provision patents filed	5
Disclosures filed	12
Foreign patents awarded	3

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Table 3.4. University of Arizona licensing revenue (USD in thousands)

Fiscal Year	2007	2008	% change	2009	% change	2010	% change	2011	% change
Licensing Revenue	1 076 989	583 007	-46	520 634	-11	562 014	8	718 449	28
License legal Reimbursement	310 358	435 700	40	301 988	-31	540 324	79	432 790	-20
Options and Other Revenue	114 141	107 183	-6	166 476	55	156 013	-6	263 046	69
Total	1 501 488	1 125 890	-25	989 098	-12	1 258 351	27	1 414 285	12
Sponsored Research Facilitated by OTT-UA	459 929	1 001 716	118	1 857 451	85	4 701 776	153	5 918 193	26

Source: Office of Technology Transfer, University of Arizona

Given the limited scope of the revenues generated by the University of Arizona's Office of Technology Transfer (OTT) and the decreasing trend, broadening the understanding of knowledge exchange, knowledge utilisation and exploitation would be useful. By placing less emphasis on financial returns to the university and focusing on how the university research can support jobs, industry productivity and innovation in the region, the University of Arizona could move away from the current transaction-based system to a system that is based on developing continuous partnerships with industry, government and other partners. Key aspects of knowledge mobilisation include working to develop open access/open source systems and inventions that have low revenue potential but high societal return. This type of broader knowledge transfer would have the potential to build support among broader segments within the university (beyond high technology) and within non-profit sectors located in the region.

Many research-intensive universities in the United States are moving to a more holistic approach in knowledge exchange. For example, the University of California, Berkeley reformed its commercialisation infrastructure in 2004 in order to achieve a more holistic approach to industry collaboration in recognition that in many cases there is no need for a discussion over Intellectual Property (IP). The new office has seen a reduction in cultural and negotiation biases; an increase in industry and foundation funding as well as collaboration types and number; a reduction in barriers to giving donations to the university; and a formation of greater numbers of contracts and strategic alliances (Box 3.7.).

Box 3.7. The University of California, Berkeley and knowledge exchange

The University of California Berkeley reformed its commercialisation infrastructure involved with industry contracting in 2004 to adopt a holistic approach to research commercialisation. It recognised that industry could approach the university from many different directions, some of which require contracts while others do not. By merging the activities of the Office of Technology Licensing and Industry Alliances Office into the Intellectual Property and Industry Research Alliances (IPIRA) office, Berkeley was able to streamline industry transactions and increase corporate sponsored research. IPIRA identified the following programmes:

- Philanthropy (no strings attached to gifts).
- Open collaboration model where firms undertake research alongside academics and students with an open dissemination framework.
- Industry Affiliates Program where firms pool resources to fund common research around particular expertise.
- Corporate sponsored research (large and small) including the establishment of large scale cross-disciplinary university-industry research institutes where the results are taken up and commercialised by industry research, including through start-ups.
- Socially responsible Intellectual Property Rights management to promote widespread availability of technology and healthcare in developing countries.

Source: PACEC – Public & Corporate Economic Consultants (2010), The Higher Education Knowledge Exchange System in the United States. A report to HEFCE by PACEC and the Centre for Business Research, University of Cambridge.

Also the University of British Columbia's University-Industry Liaison Office has gone through a strategic change to provide a broad set of support services to the region (Box 3.8.).

Box 3.8. Enlarging TTO perspectives and shifting to a broader set of support services: The experience of the University of British Columbia

Over the past two years, the University of British Columbia's University-Industry Liaison Office (UILO) has been examining and changing its practices to adapt to the new environment, developing standards appropriate for the university's status as a leading international institution. As a result, the office has launched a broader spectrum of support services that embrace the concept of industry engagement through multiple channels: people, knowledge, collaborative research, intellectual property, entrepreneurship and economic development. While these changes will continue over the coming years, the UILO has already:

- Shifted the control of intellectual property to individual researchers in order to become more flexible and sensitive to industry sector considerations.
- Developed new ways of distributing discoveries that may not have a large financial potential but can support a broader level of innovation.
- Created principles to allow the developing world to access university inventions.
- Developed new opportunities and resources for entrepreneurs within the university.
- Devised ways of measuring the effectiveness of technology transfer and sponsored research activities that go beyond financial values.

Source: OECD (2010b), *The City-Region of Amsterdam, Netherlands*, Reviews of Higher Education in Regional and City Development, OECD, Paris.

International experience shows that while university technology transfer models may lead to saleable intellectual property and start-ups, they seldom produce enterprises that grow in the region and contribute to regional economic development. The creation of localised supply networks is critical to the process through which innovation is transferred to enterprises enabling the creation of new innovation that transforms and upgrades existing industries. A well functioning regional knowledge transfer model is

based on ongoing relationship between the university and industry to determine what innovations have the best opportunities for adoption and commercialisation, creating an industry-university learning environment. It supports the human capital development required to adopt and apply process and product innovations and works with SMEs as well as large corporations. It measures success in terms of the sustainability and transformation of regional industry and employment growth. University entrepreneurship programmes should therefore also support the existing industries and SMEs.

The University of Arizona's College of Optical Sciences is a good practice example which combines leading-edge research with industry collaboration, through multiple mechanisms including joint appointments, industry affiliates programme and student internships.

Box 3.9. UA's College of Optical Sciences

The University of Arizona is world-renowned for its research in the optical sciences and its College of Optical Sciences (OSC) is the bedrock of the optical industry. In 2007, optics was awarded USD 20.6 million in research contracts or industry sponsored research. The college maintains close industry relations. It has 38 joint appointment positions out of a total of 93 full time faculty, covering areas such as astronomy, biomedical engineering, chemistry, electrical and computer engineering, materials science, mathematics, ophthalmology, physics and radiology. Joint appointments promote interdisciplinary research and entrepreneurial scientists.

The college runs an Industrial Affiliates Program, which partners with optics corporations and organisations to support its optical science and engineering programmes. The "Industrial Affiliates" programme connects industry partners with education efforts, and provides a channel for local firms to meet, interview and hire graduates. Approximately 50 industrial affiliates support the academic programme. The income from the Industrial Affiliates Program helps recruit students, provide student scholarships, pay for student travel to industry conferences, pay for graduate student teaching assistantships, buy optics library material, provide equipment for teaching laboratories and sponsor senior capstone projects. The meetings with Industrial Affiliates facilitate research contracts with industry, consulting jobs for faculty and graduates, and internships for students. Local firms can rent specialised lab space and equipment, for both proprietary and collaborative research.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*

New business formation

Southern Arizona suffers from brain drain of college-educated graduates and low levels of per capita income, which suggests that finding ways to increase entrepreneurship could be an effective strategy in regional development.

Entrepreneurship plays an important role in generating innovation and stimulating growth in the United States. Americans are twice as likely as adults in Europe and Japan to start a business and grow it rapidly. Firms with fewer than 20 employees accounted for approximately 18% of private sector jobs in 2006, but nearly 25% of net employment growth from 1992 to 2005. Small businesses employ 30% of high tech workers such as scientists, engineers and information technology workers (NEC, 2009). Spin off companies are also often likely to be locally based and offer the potential of indigenous industrial development.

The Southern Arizona tertiary education institutions are in different stages of developing entrepreneurial activities. The University of Arizona has a long tradition in the development of entrepreneurial activities, by boosting university spin-offs and graduate entrepreneurship, and encourages entrepreneurship through a number of programmes that develop business acumen. Its Outreach College offers several small business development non-credit courses for starting and managing an entrepreneurial business. Eller College of Management houses the McGuire Center for Entrepreneurship which provides resources and education to encourage entrepreneurship (Chapter 2). Discipline-specific courses are offered in agriculture and resource economics, entrepreneurship, finance, law, management, marketing and pharmacy.

In 2009, the University of Arizona spun off seven new companies, surpassing the record of six in the previous year. Additionally, the Office of the Technology Transfer (OTT) lists an additional six companies "in the pipeline" or in negotiations over IP licensing. OTT estimates that about 80% of the university start-ups have remained in Arizona following incorporation. In recent years, this number has improved. In 2007/08 and 2008/09, all 13 of the university start-ups were based in Tucson. There is limited focus on job generation: employment figures for the university spinoffs are not available and limited information is collected about university start-ups which often generate more jobs that the academically-driven high tech spin-offs.

Box 3.10. University of Arizona spinoffs in optics and biotech

The University of Arizona has seen its optics faculty spin off five "first generation" companies of at least 15 employees. These companies, in turn, have spawned an additional 32 "second generation" companies. Recent start-up activity features TIPD, LLC (2008) which is developing photonic devices and Nonlinear Control Strategies (2009) which provides software and services for high-powered vertical cavity emitting lasers and fibre laser systems. Other companies are in "the pipeline" and negotiating license agreements with the university's Office of Technology Transfer (OTT).

In biotech, there are three historical spin-offs from university bioscience industry that have grown into subsidiaries of multinational companies and remain critical elements of Southern Arizona's bioscience cluster. In 1990, four researchers of the University of Arizona spun-off Selectide Corp., a drug development company. After several mergers and acquisitions, Selectide became a subsidiary of Sanofi-Aventis (Paris) in 2004. Sanofi-Aventis is the world's third largest pharmaceutical company and has expanded its operation in Southern Arizona around the basic foundation of Selectide. Ventana Medical Systems, a diagnostic medical device company, was spun-off by a researcher from the university's Department of Pathology in 1985. In 2008, Roche Laboratories, a Swiss pharmaceutical firm, acquired Ventana Medical for USD 3.1 billion to finalise its RDI chain. Finally, HTGenomics, a genetic research company with a long history of collaboration at the university, has secured financing agreements with Merck Capital Investments, an investing branch of the pharmaceutical giant, for technological development (Bio-SA, 2007).

More recent spin-off companies from the university include Phoenix Biometrics, Inc. (2008, College of Medicine), Luceome, LLC (2009, Chemistry and Bio5), BioVidria (2009, Chemistry and Bio5), and Cancer Prevention Pharmaceuticals (2009, Cell Biology, Anatomy, and Bio5). (Southern Arizona's Regional Steering Committee, 2009).

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

In the University of Arizona, spin-offs are usually managed by the researchers who discovered the invention. While faculty inventors have an implicit self-interest in developing the innovation, they might lack entrepreneurial and management skills and drive for rapid growth. The University of Arizona could consider whether privatisation of innovation process would work better. For example in Technion in Israel, the university technology transfer office plays a role in matching researchers with serial

entrepreneurs in order to ensure that new companies have professionally led management from the very beginning.

One of the barriers to new high technology business formation is the limited access of so-called "gap funding" which lead into a so called "valley of death". In the US, during the discovery and disclosure of IP phases, research is typically funded by a federal agency, while the period of technology development that results in a prototype often remains underfunded. The average venture capital investment is USD 8.3 million, but most early stage US firms are in need of investments in the range of USD 100 000 to USD 700 000. Venture capital firms find it also too risky to invest in early-stage firms (the proof of concept/prototype is not yet achieved) and are reluctant to manage numerous small investments (Wessner, 2009).

In Southern Arizona, two initiatives have been launched to address this "valley of death", namely the Desert Angels and the Critical Path Institute (C-Path) for the biotech industry. Both of these initiatives are run by private non-profit groups but remain closely connected with the University of Arizona.

Box 3.11. Desert Angels, DesTech and the Critical Path Institute

The Desert Angels project is a non-profit group of 70 Tucson-based philanthropists, venture capitalists and angel investors. Since 2000, Desert Angel members have invested over USD 13 million in more than 45 presenting companies. Not directly affiliated with the university, their Executive Director is a mentor-in-residence at UA's McGuire Center, and has expertise in the commercialisation of technology. The Desert Angels facilitate the introduction of highly qualified start-up businesses to venture capitalists and angel investors.

The Desert Angels are also involved in DesTech, a prototype funding programme and a partnership between the Office of Technology Transfer (OTT), the Desert Angels and the Ewing Marion Kauffman Foundation to fund prototype research of the university of Arizona innovations with a high chance of commercial success. The Desert Angels contributed USD 300 000 towards the endowment, the University of Arizona contributed USD 100 000 and the Kauffman Foundation the final USD 100 000. OTT acts as a sentinel for potential innovations, and encourages researchers to apply. After screening, the researcher's application will be presented to DesTech reviewers for consideration of a grant worth up to USD 50 000. Successful applicants will receive mentoring assistance from the Desert Angels and network contacts with potential investors and acquisition partners. DesTech is a for-profit organisation. If an innovation funded through DesTech proves commercially viable, it will have the option to license the innovation and share revenue with UA/OTT and the researcher.

Box 3.11. Desert Angels, DesTech and the Critical Path Institute (continued)

The Critical Path Institute (C-Path) is a non-profit organisation created in 2004 by the University of Arizona, the US Food and Drug Administration (FDA) and SRI, a technology development firm in order to address the time lag between development, testing and regulatory approval for new pharmaceuticals. C-Path creates a space for collaborations between the FDA and drug development scientists, with the goal of speeding up the approval process and bringing new, safe drugs to market faster.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Given the growing number of technologies owned by the University of Arizona as well as its industry links, resources and a reputation in interdisciplinary research, the University of Arizona could consider establishing a stronger mechanism for screening faculty inventions. The MacGuire Center has already taken steps to this direction with the help of graduate students and should be supported in its efforts. At the same time, the university could consider whether the graduate students or student teams should have an option to license the technology, giving them an incentive to ensure a successful venture. Similar efforts have been made for example by the University of Illinois which provides a benchmarking example for the University of Arizona (Box 3.12).

Box 3.12. The Technology Ventures programme at the University of Illinois at Chicago

The Technology Ventures programme at the University of Illinois at Chicago (UIC TVP) makes use of graduate students to launch businesses that commercialise promising technologies. Chicago lacks a vibrant community of technology SMEs looking for new technologies and serial entrepreneurs. Although the Chicago investment community has shown keen interest in high tech spin-offs from the HE system, few have been established. At the same time, investors are often not able to see the potential in raw technologies. UIC TVP was established to provide a mechanism to bring high-potential technologies to the attention of investors.

Box 3.12. The Technology Ventures programme at the University of Illinois at Chicago (continued)

Teams of graduate students (including MBA, MD, pharmacy and engineering) select technologies from amongst the hundreds owned by the university. They conduct market research, draft business plans on how to commercialise those technologies, negotiate with the faculty inventor to join their team and approach investors.

In its first year (2005-06), UIC TVP launched two start-ups. One was a biotechnology firm launched to commercialise a revolutionary cancer treatment. The other firm was seeking to bring to market an orthodontic device that reduced the time required for correcting orthodontic malocclusion (crooked teeth). During its second year, UIC TVP launched four more high-potential, high-tech firms, including a medical device for non-invasive cornea reshaping, an umbilical cord stem cell technology, a vascular imaging technology and a micro-fluidic device. Without UIC TVP, these technologies would have remained "on the shelf", out of sight of potential investors. UIC TVP has received national attention from the media, HEIs and investment groups.

Reasons for the success of UIC TVP include: *i*) hundreds of technologies owned by the university; *ii*) university's expertise, resources and a solid reputation in life sciences; *iii*) university's inventions, links to established biotech firms and recognition by potential investors; *iv*) support from university administration; *v*) student teams, that had an option to license the technology, giving them an incentive to ensure a successful venture; and *vi*) requirement to involve the faculty inventor in return for an equity stake in the business, providing incentives for the inventor to help the company to succeed.

The UIC TVP has faced obstacles such as: *i)* lack of capacity of local investors to evaluate business plans and risk aversion and reluctance to invest in businesses launched through the UIC; *ii*) lack of perceived legitimacy of student-owned businesses in the media and business/investment communities; *iii)* challenge to convince stakeholders that students were prepared to step aside when professional managers were successfully recruited; and *iv*) heavy work load on students.

Source: OECD (2007), Entrepreneurship Environment and Policies: Exploiting the Science and Technology Base in the Region of Halle, LEED Discussion Paper, OECD, Paris

Southern Arizona could also consider whether concerted efforts to support entrepreneurship activities within the university and among the university and community colleges would benefit the region. The good practice examples provided by the Macguire Center and some of the most entrepreneurial faculty in the university should be shared. These current programmes in place need to be extended and tied more closely to regional

efforts and community engagement activities. An international example from Brandenburg in Germany highlights collaborative efforts by tertiary education institutions and the regional development agency to pool resources in order to gain critical mass.

Box 3.13. BIEM - The Brandenburg Institute for Entrepreneurship and SMEs

The Brandenburg Institute for Entrepreneurship and SMEs (BIEM) is the entrepreneurship institute of the regional development agency and nine public tertiary education institutions including universities and universities of applied sciences. BIEM was founded in 2006 as a registered non-profit organisation to reinforce, complement and co-ordinate the entrepreneurship support activities offered by Brandenburg's education institutions by pooling resources and enhancing collaboration and exchange. BIEM helps to achieve the "critical mass" needed to realise projects with wide ranging impact. The annual budget of EUR 100 000 is financed by the European Structural Funds, the Ministry of Economics of Brandenburg and other project-related revenues (*e.g.* fees for services). BIEM has eight employees. Each partner organisation runs additional projects and employs additional personnel according to project needs or the overall management of an entrepreneurship institute/centre.

Activities include entrepreneurship education, start-up support, entrepreneurship research and networking with business support organisations and other universities. BIEM focuses on the expansion and integration of entrepreneurship education into curricula, including innovative teaching methods, broad communication of activities, and an expansion of co-operation beyond BIEM's core partners (*e.g.* by involvement of university staff and external experts, agencies and companies). Partnering education institutions benefit from rising numbers of students participating in entrepreneurship education activities and an increase in the number and variety of courses available for their students. Education institutions have established "entrepreneurship location managers/animators" (Standortmanager), who act as "one-stop-interlocutors" for would-be entrepreneurs. This structure contributes to building stronger linkages between the university's internal and external support services and to integrating entrepreneurship education and start-up support services. Other projects include "Entrepreneurship ACs" that evaluate entrepreneurial potential and learning needs before start-up and match them with adequate mentoring during start-up, "Team Competency Lab" that focuses on team building and coaching.

In 2009, 370 would-be entrepreneurs received initial consultation by BIEM, 203 were referred to external business support structures and 86 business start-ups were supported. The key elements for the institute's success are the multidimensional co-operation between all tertiary education institutions and their external partners, the involvement of education institutions in regional leadership and a phase approach to entrepreneurship.

Source: OECD (2009c), Universities, innovation and entrepreneurship: Criteria and Examples of Good Practice, OECD Publishing, Paris; and BIEM-Brandenburg (2010), Brandenburg Institute for Entrepreneurship and Small and Medium Sized Enterprises website, *www.biem-brandenburg.de*, accessed 10 February 2010.

Engagement with clusters and industry sectors

Internationally many tertiary education institutions and their regional partners are focusing on particular cluster development as a way of maximising the impact of their industry engagement and tapping into existing industry networks. Clusters, *i.e.* agglomerations of firms, supporting institutions and infrastructures in inter-related industry areas, may have been initiated by government. However, often the most successful clusters evolve independently of government support. Government cluster policies may be targeted on existing operating clusters or may be directed towards the development of new clusters from some pre-existing core activity (Hertog *et al.*, 2001). In 2009, the US Federal Government provided USD 50 million in regional planning and matching grants within the Economic Development Administration to support the creation of regional innovation clusters that leverage regions' existing competitive strengths to boost job creation and economic growth.

Cluster development in Southern Arizona

There are considerable disparities across Southern Arizona. Evidence suggests that income inequality will continue to increase with growth in high wage jobs related to the US federal investments and with continued inflow of poor people over the border. The region will need to continue its efforts to expand higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bi-lingual and bi-cultural environment and the ability to reach markets across NAFTA countries and Latin America. At the same time, the development needs of sectors currently neglected by the tertiary education institutions, including tourism, need to be addressed.

Southern Arizona is a home of a number of defence-oriented organisations that play an important role in the regional innovation system by generating or using considerable amount of R&D. Due to their economic size, measured in hundreds of millions of US dollars, they are of critical importance for the regional economy and innovation system. They strengthen the local economy by their annual expenditure and offering employment opportunities for tertiary education graduates in science and engineering. While the local communities are the direct beneficiaries, the indirect economic spill-over may benefit the entire region. At the same time, however, the salary levels in the defence industry remain at a low level, indicating that the bulk of operations remain in manufacturing rather than RDI. Diversification of the economic base and creation of quality jobs remain a key challenge for the region.

The University of Arizona is world-renowned for its research in the optical sciences and its College of Optical Sciences is the bedrock of the optical industry (Box 3.9.). It maintains close industry relations through industry sponsored research, joint appointments that promote interdisciplinary research and entrepreneurial scientists and an Industrial Affiliates Program, which partners with optics corporations and organisations to support its optical science and engineering programmes and lab space and equipment for local firms for proprietary and collaborative research. (Southern Arizona's Regional Steering Committee, 2009). Despite efforts made by the college as well as the industry association, local firms have identified limited networking opportunities as a challenge.

Multiple colleges and research units of the University of Arizona have research programmes focused on bioscience research.[9] Currently, a bulk of bioscience research takes place in the confines of the Bio5 Institute, an interdisciplinary centre, supported by TRIF funds, that brings together more than 300 researchers from five biologically-focused disciplines: agriculture, medicine, pharmaceuticals, basic science and engineering. Bio5 does not hold any faculty research lines at the university, but uses new, modern laboratory space and administrative support, and develops relationships with industry. For example, HTGenomics, a local gene research company, shares lab space at Bio5 with the university partners. Bio5 also organises and hosts "Meet Your Neighbour" symposia with researchers and local industry to share ideas and explore collaborative options and has a dedicated Director of Business Development who works as a liaison between Bio5 researchers and the university's Office of Technology Transfer (OTT). Cluster development is driven by the Bioindustry Association of Southern Arizona (Bio-SA) which hosts annual conferences and meetings for Southern Arizona's life science community and by Bio5.

Table 3.5. shows examples of research activities of the University of Arizona, through programmes or long-established centres, institutes or departments, in the cluster areas identified by Tucson's Regional Economic Opportunities (TREO) as important for the region's economic growth and increased competitiveness. The table shows also examples of collaboration and of start-up and spin-off businesses that have been created through the university's activities.

Table 3.5. Examples of UA research activities in TREO identified strength areas

AREA (Main venues) – ACTIVITIES	PARTNERS - SPIN-OFFS
AGRICULTURE (UA, College of Agriculture and Life Sciences, Agriculture Experimental Station). Cotton integrated pest management; Maize genome based microarrays; Low input barley; Shrimp pathogens research; Arid land crop plants with anticancer and drug potential; Genomics of maize chromatin proteins; agriculture-specific meteorological data.	Translational Genomics Institute, Josephine Ford Cancer Center, Harvard University, Whitehead Institute, China Pharmaceutical University, South Carolina Oncology Institute and DuPont Crop Protection Division.
BIOSCIENCES (UA Colleges of Medicine, Pharmacy, and Agriculture and Life Sciences, Arizona Cancer Center, Bio5 Institute). Animal and plant sciences; biology; bioscience; chemistry, engineering, pharmaceutics and other in multidisciplinary research projects.	Selectide (Now of Sanofi-Aventis); Ventana Medical Systems (now of Roche); HT Genomics; Phoenix Biometrics; Luceome; BioVidria; Cancer Prevention Pharmaceuticals
ENVIRONMENTAL TECHNOLOGY (UA Colleges of Engineering and Mines, Arizona Research Institute for Solar Energy, Sustainability of Semi-Arid Hydrology and Riparian Areas, Institute of Sustainable Minerals, Institute of Environment and Society) Applied environmental research; Sustainable development; Climate, land use, water consumption, wildfire, and other environmental issues; Solar energy storage and transmission; Photovoltaic membranes, material application solar energy solutions.	Renascent Material
AEROSPACE (UA College of Engineering). Wind technology research; Fluid dynamics; Rocket science and technology.	
INFORMATION TECHNOLOGY (UA Colleges of Engineering, and Management).	International BioComputing; Avirtec; and Zonebee.
OPTICAL SCIENCES (UA College of Optical Sciences) Quantum optics; Applied optics; Opto-electronics; and Optical engineering.	Five “first generation” companies, that, in turn, have spawned an additional 32 “second generation” spin-off companies

Table 3.5. Examples of UA research activities in TREO identified strength areas (continued)

ADVANCED COMPOSITES (UA College of Engineering) Plastics, glass materials; Novel materials chemistry; Advanced ceramics and composites.	Energy Materials Solar Technology Research
TOURISM	Eller College's Economic and Business Research Center's economic impact studies commissioned by tourism-related organisations

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

Optics and biosciences feature the strongest cluster development through associations which are able to articulate generic needs and purchase services collectively on behalf of industry. In general, however, Southern Arizona's industry clusters remain disorganised and non-functional. As a result, there is a poor articulation of demand for services from the tertiary education institutions for SMEs.

The University of Arizona is shifting its focus on high technology fields. This focus needs to be balanced with developing a private sector base in the related industries. Currently, the collaboration with industry is spurred by public investments from federal government in fields such as defence, biotech & health, environmental technology. Challenges here are linked to publicly-driven innovation strategies that may have negative impact on entrepreneurship attitudes.

Broadening the sectoral orientation and the disciplines that underpin engagement could be beneficial for large and growing clusters in the service sector. Within the University of Arizona, industrial engagement is seen by the faculty as a science and engineering pursuit rather than a role that could embrace business schools, social sciences and the humanities. For example, a sector such as tourism, which has growth potential in the region, could draw on the faculty expertise in historic preservation, fine arts and cultural studies as well as business studies and ICT and also provide work-based learning for students and outreach opportunities.

New emerging sectors such as a logistics provide opportunities for collaboration between community colleges and the University of Arizona as

well as cross border collaboration with Mexico. Currently, however, only limited efforts are made to support RDI and skills development in logistics.

Box 3.14. Hull Logistics Institute

The Hull Logistics Institute in UK is a teaching, research and consultancy organisation. Its main activities are teaching, research and consultancy in the logistics industry. It offers master and doctoral programmes, as well as short courses. Research and consultancy projects are undertaken involving local firms in the industry. The institute draws on business and engineering expertise from the relevant university departments to provide research and consultancy support to the logistics industry. The institute is managed as a unit of the business school, reporting ultimately to the main university academic and governing body. An advisory group, with external membership, advises its director.

The institute began operations in 2005 with initial capital costs of EUR 7 million. This has led to the development of a master's degree in supply chain management, which is now recruiting internationally; there is also some doctoral work. Graduates of the institute are now in influential positions in industry internationally. There are signs that this is leading to new teaching and consultancy business. The institute provides incubator units for start-ups in the logistics field.

This initiative has been successful for five reasons: *i)* there was a real demand from the regional industry that the university was equipped to support because of its existing areas of academic strength; *ii)* there was a flexible organisational response by the university to creating a new structure to meet these needs; *iii)* regional development funding was available to start-up costs; *iv)* new activities were developed to extend the partnership's strength; and *v)* a realistic business plan was developed to guide development of partnership.

Source: Detmer, A., J.G. Mora and M.-J. Vieira (2010), *Good Practices in University-Enterprise Partnerships GOODUEP*, *www.gooduep.eu.*

Conclusions and recommendations

The University of Arizona is a national leader in inter-disciplinary research, evidenced by the creation of Bio5 and the cross-college and cross-departmental collaborations on sponsored projects. It is strong in R&D expenditures, in 2006 ranking 21st among all US research universities in R&D expenditures and 13th among public universities. Southern Arizona benefits from relationships between the University of Arizona research and industry, particularly in two fields – optics and biosciences. The College of

Optical Science and the local optics industry have made the Tucson metropolitan region a centre for innovation in light-based industries. In recent years, the university has made concerted efforts to develop a stronger entrepreneurial spirit among the faculty that traditionally do not see merit in IP disclosures, patents and spin-off development. The McGuire Entrepreneurship Program and the involvement of the non-profit Desert Angels in technology transfer opens up possibilities for small business creation. There is evidence of enterprise support within the student and graduate community being mainstreamed within degree programmes and through supporting infrastructures. However, this support is fragmented with limited collaboration within the university and across tertiary education institutions in the region.

As a response to the recent cuts in the state funding, the University of Arizona is shifting its focus on high technology areas with the hope of drawing national and international funding. Much of the University of Arizona's research infrastructure, for example Bio5, is being subsidised by TRIF/Prop 301 sales tax revenue. Funding critical research infrastructure from a fluctuating revenue stream threatens the sustainability of many research programmes. As universities elsewhere, the University of Arizona has a tendency to measure success in innovation by the amount of (public) investment made, not the amount of commercial return generated or jobs created. This approach is likely to strengthen with the decreasing state funding for tertiary education.

Industrial engagement is seen by the university faculty as a science and engineering pursuit rather than a role that could embrace business schools, social sciences and the humanities. A sector such as tourism which has potential in the region is not seen as a focus for university activity. Broadening the sectoral orientation and the disciplines that underpin engagement could be beneficial for large and growing clusters in the service sector. There is a weak focus on meeting the needs to generate high wage jobs in other economic sectors, including the fields where Southern Arizona has a comparative advantage.

Support for innovation remains fragmented within the University of Arizona, each department and office in charge of regional development developing their own initiatives often in isolation from each other. There appears to be no effective guidance system for business to identify where best to source support for innovation. The university's main emphasis is on science and technology-driven innovation, whereas community colleges focus on incremental demand-led innovation important to small and medium-sized enterprises. There seems to be few attempts to connect up technologically-oriented centres with business faculties and with other disciplines to provide support for service sectors.

Overall in Southern Arizona there seemed to be limited evidence of the development of a regional innovation system. The current university system is Tucson centre with limited spill-over to other counties. The University of Arizona's different units and offices did not present themselves as a coherent system, and there was no attempt to set out the collective needs of the region in terms of innovation infrastructure or for the university and community colleges to co-ordinate their actions in meeting such needs. The situation has led to gaps in delivery and reduplication of efforts and initiatives within the university, and an overemphasis on science disciplines rather than wider coverage of the needs of business and industry.

To improve innovation outcomes in Southern Arizona, the OECD Review Team recommends that the following measures are taken to promote regional innovation:

- A systemic perspective should be applied in developing a regional development strategy by improving the connectivity in the regional innovation system through stronger collaboration and networking, consensus building for economic development and partnering between the educational institutions and industries in order to create close research collaboration across tertiary education and research and industry, particularly small and medium-sized enterprises. Consistent innovation indicators should be developed and monitored over time.

- The state government and regional/local agencies should ensure that research on clusters and the demands of industry extend into the service sector. Clusters should also be conceptualised as cutting across the manufacturing-service divide. For example manufacturing innovations should increasingly incorporate service components. Tertiary education institutions should be encouraged to draw upon business schools, humanities and social sciences in providing assistance to business.

- Southern Arizona, its tertiary education institutions, public and private sector should make systematic concerted efforts to support new business formation and build an environment and mechanisms that support start-up and entrepreneurial companies through aligning incentives for a sustained period of time. Building on the experience of the University of Arizona's MacGuire EntrepreneurshipProgram, the tertiary education institutions should support entrepreneurship throughout the curriculum and build comprehensive support programmes encompassing entrepreneurship training, practical experience of creating new businesses for groups of students and incubation and hatchery facilities together with seed funds for new

graduate ventures. Private funding sources willing to invest in "ideas" rather than real estate should be strengthened.

- The tertiary education institutions should play a more active role in helping the region to build a more diversified and robust economy based on knowledge and innovation. The University of Arizona should broaden its understanding of knowledge transfer, knowledge utilisation and exploitation and place less emphasis on financial return to the university. By focusing on how the university research can support jobs, industry productivity and innovation in the region, the university technology transfer offices could move towards a system that is based on continuous collaboration with industry, government and other partners. Stronger emphasis on the development of open access/open source systems and interventions with low revenue potential but high potential to yield societal returns in order to build support among broader segments within tertiary education institutions (beyond business and engineering faculties) and within non-profit sectors in the cross border region.

- State government and regional agencies should balance the current focus on high tech R&D with considerable efforts to develop general competencies among the population to help adjustments to rapid changes in the labour market and to facilitate lifelong learning. Systematic concerted efforts should be made by the State of Arizona, educational institutions and key stakeholders to raise the levels of education attainment.

- The tertiary education institutions should focus their concerted efforts on challenge-driven innovation on the key issues in the cross border region, such as water, Hispanic/border health and border security in its broader sense and use the region as a "laboratory" for research, knowledge transfer and outreach to reach global levels of excellence. Job creation should be seen as the focus of innovation activities.

- Incentives for tertiary education institutions should be strengthened to increase their capacity to act as technology transfer "agents" to bring non-local knowledge to the region and to create community partnerships. Incentives for tertiary education institutions and their staff to engage in local and regional development should be developed. The state government should seek to encourage greater collaboration between tertiary education institutions through joint investments in research facilities and incentive programmes.

Notes

1. Recognising the economic potential of research conducted at universities, the US Congress enacted the Bayh-Dole Act in 1980. The Bayh-Dole Act allows universities and small business to retain control of patents created at their institution using federal money. This law led to the creation of university technology transfer offices and a developing science of the practice of technology transfer.

2. Evidence on the effectiveness of the Bayh-Dole Act is mixed. The US Expert Panel on Commercialisation concluded that it was directly responsible for the creation of thousands of new firms and added tens of billions of dollars to the US Economy. However, an earlier study of Stanford, MIT and Columbia found very little change in these universities' patent and licensing portfolios in the 120 years following the passage of the act and concluded that it had very little, if any, effect on technology transfer (Mowery *et al.*, 2001 in Niosi, Connecting the Dots between University Research and Industrial Innovation).

3. According to Stanford University's Office of Technology Licensing, for the last 15 years, Stanford has received an average of three to four new invention disclosures weekly, for a cumulative total of more than 3 200 disclosures. Of this total, Stanford has licensed over 800 inventions (+ over 400 licenses for the DNA patents alone), approximately one in four. Of these 800, about one-third produce income, but of these, only 22 inventions produce at least USD 100 000 per year.

4. As noted by Southern Arizona Regional self-evaluation report, the variation in revenue generated by licenses is dependent on the licensee's success in developing technology into a marketable product and/or further innovating on the underlying intellectual property (IP) to maintain a competitive edge. If a company fails and the license is terminated, a considerable reduction in revenue can occur through no direct fault of the technology licensing office (TLO). Some TLOs can rely on only one or two licenses to generate the bulk of their revenue. Furthermore, revenue figures reflect a significant lag time from the time of disclosure to the point of license, ranging from six months to three years. After licensing, it may take several years for a company to establish a marketable prototype and begin manufacturing. In some industries, like pharmaceuticals, drug development can be up to a decade.

5. The University Center Economic Development Program funds efforts at universities in over 40 states to connect with their local and regional economies, but the programme is limited to a funding base of USD 7.2 million.

6. At the time of the OECD review visit, the University of Arizona's knowledge transfer structure was in flux. The Office of Economic Development with the responsibility for regional development had been closed down. The overall engagement of the University of Arizona in economic development takes place in the Office of University Research Parks (OURP). There is also the Office of Corporate and Business Relations (OCBR) which aims to "maximize private investment opportunities and nurture productive, long-term strategic partnerships between companies and various colleges and departments campus wide." The long-term goal of the OCBR is increase private industry investment in the university research in order to generate commercially-viable discoveries. OURP and OCBR are expected to work closely with OTT and the Office of Research and Contract Analysis (ORCA).

7. In the United States, the national legal framework for intellectual property rights helps support the role of universities in research and innovation. By obtaining patents, trademarks and copyrights, the faculty-inventors can protect their work, freeing them to foster relationships with industry.

8. According to PACEC (2010), the University of North Carolina at Chapel Hill identified a number of factors hindering the start-up of new firms, including: *i)* excessive demands for equity in Intellectual Property (IP), often exceeding 15%, *ii)* royalties being required to exceed cash flows, *iii)* the expectation of external financing and unpredictable or unreasonable licensing terms and *iv)* concerns that the process of launching a company involved competitive, rather than collaborative, negotiations between faculty and the university. In response to these challenges, the Carolina Express License Agreement was designed to reduce barriers to firm formation, addressing the issues of universities taking substantial equity position in start-ups and unhelpful royalty structures.

9. The College of Medicine, the College of Pharmacy and the Arizona Cancer Center all contribute to the emerging pharmaceutical research cluster in Southern Arizona. The College of Agriculture and Life Sciences and College of Science both house numerous projects focused on bioscience research including chemistry, biology, animal and plant sciences. Similarly, Arizona Research Labs conduct bioscience research through its Biomedical Engineering Programme, Division of Biotechnology, Center for Insect Science, Microcirculation Programme, and Neuroscience Programme.

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Chapter 4

Social, cultural and environmental development

Social, cultural and environmental development underpins and stabilises economic growth and improve community health and welfare, social cohesion as well as clean, healthy and sustainable environment.

This chapter focuses on how the University of Arizona and the community colleges address the challenges and opportunities arising from two factors of critical importance to Southern Arizona: i) *environmental sustainability and green growth in desert conditions; and* ii) *demographic transition and ethnic diversity in the context of a border region.*

The key message is that the Southern Arizona tertiary education institutions have developed a wide range of activities for the promotion of environmental sustainability and green growth, integration of migrants and ethnic minorities, widening access to education, supporting urban renaissance, and empowering minority and at-risk communities. These initiatives need to be better co-ordinated, scaled up, institutionalised, profiled and rewarded.

The opportunities for sustainable and extended third mission activities in Southern Arizona tertiary education institutions lie in building the region's reputation as a model of environmental sustainability and addressing the demographic transition in the region and the economic, social, cultural and health-related needs of the diverse population. These areas should be recognised by the public and private stakeholders as important to the region's future.

Introduction

The University of Arizona and community colleges have the distinct advantage and challenge of operating in a diverse social, cultural and environmental setting. This border region, in the vicinity of the Mexican state of Sonora, is faced with major challenges and opportunities arising from: *i)* environmental sustainability and green growth in the desert environment; and *ii)* demographic transition and diversity of population. Without decisive action, there is a risk of growing disparities in education, socio-economic and health outcomes of the regional population. While collaboration does not come naturally in the absence of strong public regional and local agencies, endowed with a diverse tertiary education sector, Southern Arizona is well positioned to transform the challenges into assets for the local economy. The advantage that a research-based university brings to the region is the ability to address, through research and outreach, the issues that have long-term implications and that require institutional capacity, whereas community colleges are well placed to respond to changing workforce training needs in the region.

The University of Arizona and other tertiary education institutions are aware of the considerable challenges and opportunities in social, cultural and environmental domains; and have taken steps to respond to these individually, each guided by their different missions, by engaging in a wide range of activities, such as R&D, outreach and educational programmes. In times of financial stringency, the challenge for the region and its tertiary education institutions is to identify and prioritise critical social, cultural and environmental issues and gaps in knowledge and action where they can make – individually and collectively – contributions to build regional sustainability through critical mass, collaborative effort and long term action.

In this context, this chapter examines:

- What is the contribution of the University of Arizona and community colleges to Southern Arizona's social, cultural and environmental development, particularly in the context of ethnic diversity in a cross border setting and desert environment?
- Are the activities of the tertiary education institutions appropriately targeted to address the key challenges in Southern Arizona? Are there gaps in delivery and are the resources and incentives aligned with the objectives?
- What lessons can be learnt from international experience?

4.1. Environmental sustainability and "green" industries

Southern Arizona covers a large geographical area with well-defined climatic zones and a sparsely distributed population. Climate change and water use and supply are important challenges for the region. Due to the combination of the fragility and limits of the desert environment, and population growth comprehensive approach is needed in water planning and growth management, but so far the progress in this domain has remained limited.

Universities and other tertiary education institutions can contribute to sustainable environmental development in their regions in many ways.[1] In Southern Arizona, the University of Arizona and the community colleges have developed a wide range of activities to change the public attitudes and behaviour toward water issues and environmental sustainability in general. They have adopted campus-specific environmental sustainability programmes operating as models for their local communities. These range from guidelines for the building of new infrastructure to recycling programmes and campus-specific uses of alternative energy sources. For example, Pima Community College's "Strategy 5.3," involves integrating environmentally sustainable design and maintenance practices into their 2008-11 campus planning initiatives. According to the Environmental Protection Agency (EPA), the University of Phoenix is among the top ten national colleges and universities that utilise green power, purchasing nearly 47 million kilowatt hours of green energy annually which is the equivalent of powering more than 4 000 average American homes per year. (Southern Arizona Regional Steering Committee, 2009)

The University of Arizona's initiatives include campus-wide and residence-hall specific recycling programme, installation of solar panels for targeted structure energy consumption (*e.g.* parking garages); storm-water mitigation and water harvesting demonstration sites, both on- and off-campus. Its "Campus Sustainability" initiative acts as an environmental sustainability information gateway for a diverse set of stakeholders that includes students, faculty, staff and the regional community.

The University of Arizona has taken a lead, both within the region and the US university community at large, in addressing local to global climate change issues and policies, including economic impacts and the development of best practices in urban planning, architecture, transportation and water management. The University of Arizona and Pima Community College have also been instrumental in initiatives that aim at greening the city and the county initiatives. However, with budget cuts and downturn of the economy, it has not been possible to make significant progress

The University of Arizona has developed initiatives, programmes, centres and institutes devoted to the research on climate change, the development and application of green technologies and the provision of timely advice regarding environmental risks to agriculture, urban environments, life species and water resources. The university uses the regional environment as a laboratory for its research to address the challenges in water supply and climate change through its Carnegie Institution's Desert Laboratory in Tucson and the Laboratory of Tree-Ring Research. The university's College of Agriculture and Life Sciences' Cooperative Extension Service undertakes research and application on sustainable land use practices, across a regional and state-wide venue. The Arizona Research Institute for Solar Energy aims to drive innovation between university and private industry to achieve solar energy solutions. The Water Resources Research Center has a focus on assisting Arizona communities with water management. The university has five water centres and a 400-600-strong faculty engaged in water research (water supply, utilisation of water and contamination).

Table 4.1. Examples of environmental sustainability institutes and programmes in Southern Arizona

Tertiary education institutions	Example
University of Phoenix	Go Green Initiative
Pima Community College	Strategy 5.3
University of Arizona	Institute for Environment and Society Climate Assessment for the Southwest Translational Environment Research Sustainability Under Uncertainty Arizona Research Institute for Solar Energy Sustainability of Semi-Arid Hydrology and Riparian Areas Laboratory of Tree-Ring Research Campus Sustainability Water Resources Research Center Institute for Environment and Society Biosphere 2 Campus Sustainability Office of Arid Lands Water Quality Center Udall Center for Studies in Public Policy Arizona Master NaturalistProgram, UA Cooperative Extension Service Arizona Master Watershed Steward, UA Cooperative Extension Service

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/imhe/regionaldevelopment*.

Renewable energy research and development

The inventions in green technologies tend to be highly concentrated in all OECD countries. The ten most productive regions (TL3) account for 13.7% of overall green patenting[2].This geographical concentration is higher than the overall one (for green and non green technology, the ten most productive regions account for 12.1 % of overall patent applications). Table 4.3. shows the regions with higher rates of patents applicants in 13 environmental technologies. In addition to Los Angeles, Tokyo, and Oxfordshire, there are regions with lower aggregate patenting capacity that have managed to specialise in green technologies. The US regions play a key role in the renewable energy patent applications; however, Arizona does not (yet) feature in the list. (OECD, 2011a, forthcoming).

Table 4.2. Application in renewable energy technologies in OECD regions (2004-2006)

Technology	Region	Patents
Wind	Ost-Friesland (DE)	340
	Los Angeles-Long Beach-Riverside (US)	129
	Tokyo (JP)	81
	Navarra (ES)	81
	Berlin (DE)	64
	Schleswig-Holstein Mitte (DE)	58
	Osaka (JP)	58
	Seoul (KR)	49
	Fyns amt (DE)	47
	San Jose-San Francisco-Oakland (US)	43
Solar	San Jose-San Francisco-Oakland (US)	323
	Los Angeles-Long Beach-Riverside (US)	191
	Tokyo (JP)	151
	Boston-Worcester-Manchester (US)	148
	Detroit-Warren-Flint (US)	141
	Sydney (AU)	139
	Munchen (DE)	137
	Washington-Baltimore-N.Virginia (US)	129
	Melbourne (AU)	94
	Kyoto (JP)	87
Hydropower	Ostwurttemberg (DE)	28
	New York-Newark-Bridgeport (US)	28
	Isère (FR)	22
	Los Angeles-Long Beach-Riverside (US)	22
	Sydney (AU)	19
	Linz-Wels (AT)	18
	Rogaland (NO)	18
	Melbourne (AU)	16
	Philadelphia-Camden-Vineland (US)	16
	Osaka (JP)	15

Table 4.2. Application in renewable energy technologies in OECD regions (2004-2006) (continued)

Geothermal	Aichi (JP)	21
	Los Angeles-Long Beach-Riverside (US)	19
	Stuttgart (GE)	14
	Houston-Baytown-Huntsville (US)	14
	Atlanta-Sandy Springs-Gainesville (US)	13
	Aachen (DE)	13
	Zug (CH)	12
	Hamburg (DE)	10
	Industrieregion Mittelfranken (DE)	10
	Greater Vancouver (CA)	10
Biomass	Oxfordshire (UK)	148
	New York-Newark-Bridgeport (US)	142
	Cleveland-Akron-Elyria (US)	135
	San Jose-San Francisco-Oakland (US)	128
	Cheshire (UK)	62
	Rheinpfalz (DE)	53
	Houston-Baytown-Huntsville (US)	50
	Philadelphia-Camden-Vineland (US)	41
	Unterer Neckar (DE)	30
	Berkshire (UK)	29

Source: Data are extracted from the OECD REGPAT dataset. Counts of patents are weighted according to the methodology described in OECD (2008d), The OECD REGPAT Database: A Presentation OECD STI Working Paper, OECD, Paris.

First movers in green research can benefit from substantive return on investments. Deloitte's 2009 survey on Global Trends in Venture Capital reports that, despite the economic and financial crisis, 63% of venture capitalists anticipate an increase in their investment in clean-tech, the highest percentage among all sectors considered. Green jobs are projected to increase to several millions worldwide by 2030, most of them emerging in a small number of innovative regions (Ditlev and Kammen, 2009; OECD, 2009). Green technologies rely on local know-how and generate new applications and higher demand for technologies developed by traditional industries. For example, the design of the new type of wind-energy clusters of Aalborg and Arhus in Denmark was influenced by the advances of the Danish agricultural engineering industry which benefited from university research. These knowledge spill-overs and technological branching of eco-innovation raise overall innovation capacity of a region, as well as productivity and growth (OECD, 2011a, forthcoming).

According to 2001 data, Arizona's environmental technology[3] industry generates USD 2.2 billion in revenue annually, with about one-third of an estimated 1 200 environmental-related businesses located in Southern Arizona (TREO, 2009). Companies focusing on environmental

technologies range from Freeport-McMoRan Copper & Gold Inc. (5 987 employees) and ASARCO Mining (2 575 employees) to small non-profits (Southern Arizona Regional Steering Committee, 2009). One of Southern Arizona's emerging sub-industries in environmental technology is the solar industry. Regional firms include Solon Corporation, Schletter Inc., Global Solar and Prism Solar (TREO, 2009).

Southern Arizona is well positioned to develop its solar industry not only because of its climate and natural conditions, but also because of its strong research-based university and research excellence. Interdisciplinary research is one of the key strengths of the University of Arizona and solar research is no exception: collaborations on solar research span dozens of departments at the University of Arizona, notably optics, materials science engineering and Electrical Engineering (Southern Arizona Regional Steering Committee, 2009). The University of Arizona is home to the Arizona Research Institute for Solar Energy (AzRISE), a multi-disciplinary institute that span academia and industry with the goal of driving innovative solar energy solutions. AzRISE affiliates work on both material applications of solar energy research and policy research. Researchers are collaborating with faculty from other colleges on photovoltaic cell development, including the Department of Chemistry and College of Optical Sciences.

In 2009, the University of Arizona received USD 15 million grant from the United States Department of Energy to fund one of only 46 Energy Frontier Research Centers (EFRC). The University of Arizona's EFRC focuses on the development of solar energy storage and transmission through research on photovoltaic innovations. The Center for Interface Science: Hybrid Solar-Electric Materials is led by a well known scholar whose research is focused on the development of products like "solar fabric," a thin, portable photovoltaic membrane.

To reap greater benefit from green research, Southern Arizona should unlock its green innovation capacities through cluster policies. Many OECD countries are building partnerships between government and academia as eco-innovation clusters. These clusters merge skill development and education, cutting-edge research in environmental technologies and job creation through spin-offs, venture capital and integration of enterprises. International examples show that the universities' research specialisation and research institutes play important roles in the development of the industry in the renewable energy sector.[4]

Eco-efficiency of the regional industry

Generating eco-efficiency means creating more goods and services while using fewer resources and creating less waste and pollution.

Universities and other tertiary education institutions can play an important role in supporting technical, organisational and process improvements for eco-efficiency of the existing industry.

In Southern Arizona, progress has already been made in eco-efficiency efforts. For example, the resource-intensive semi-conductor industry uses large amounts of water: each microprocessor manufacturing line uses as much water as a medium-sized city. Thanks to the research collaboration between the University of Arizona and the semiconductor industry, 30-40% reduction in water usage has been achieved.

Southern Arizona could build a stronger portfolio of specific programmes targeting emission reduction in businesses that have been directly initiated by the university and community colleges. Experience from OECD countries shows that universities can become successful partners of local businesses who want to upgrade their environmental standards (Box 4.1).

Box 4.1. Design programmes for sustainable urban growth

Faculties in architecture and design are increasingly developing projects branching out into urban smart design, environmental management and policy, greenhouse emission reduction and behaviour change. These programmes provide advice to governments and technical assistance to local industries through developing and demonstrating new design strategies, support tools and processes and assisting industry to design and use greener products, buildings and services and to develop more strategic environmental directions.

- The Faculty of Environmental Design (EVDS) at the University of Calgary in Canada provides an interdisciplinary teaching and learning environment that emphasises a co-operative, collegial approach to research, scholarship, creative endeavour, professional practice and outreach.

- The Centre for Design, at the Royal Melbourne Institute of Technology (RMIT) in Australia, works with industry to develop and demonstrate new design methods, tools and processes aimed at improving the environmental performance of buildings, products and services.

- The Centre for Sustainable Design, University for the Creative Arts, UK, facilitates discussion and research on eco-design in product and service development.

Box 4.1. Design programmes for sustainable urban growth (continued)

- Green Design Initiative at Carnegie Mellon University, US promotes environmentally conscious engineering, product and process design, manufacturing and architecture. The initiative involves forming partnerships with industrial corporations, foundations, and government agencies to develop joint research and education programmes.

Source: OECD (2011a), forthcoming, *Higher Education in Cities and Regions – For Stronger, Cleaner and Fairer Regions*, OECD, Paris.

The University of Arizona, Pima Community College and other community colleges could also consider increasing their co-operation with local or regional one-stop-shop agencies for business support. By training the trainers, the institutions could help these agencies acquire the skills to advice firms on the cost-effective ways to reduce emissions. The training could, for example, focus on technologies and tools available to business to monitor the environmental sustainability of their production (*e.g.* sustainability audits) and improve environmental performance (*e.g.* systematic use of life cycle assessments practices), (OECD, 2011a, forthcoming).

Sustainability in rural and agricultural areas

Arizona's agriculture has been organised around cotton, cattle and citrus. Over 37% of land is occupied by agricultural activity and the state is home to over 7 300 farms and ranches with a collective output worth over USD 6 billion annually. Today, while employment in agriculture is declining, it remains a key sector of the economy in Arizona. Sustainable agriculture in the state depends on innovations in crop management. Agriculture has become under increasing pressure as regards to land use (grazing) and water management. While technology and innovation have allowed farms and ranches to increase employee efficiency, the future of agriculture depends on its ability to become more productive in resource management (Mortensen, 2004).

The contribution of tertiary education institutions to sustainable production can be effective in rural areas. For example, university research on sustainable food systems is making rapid progress. Much of this research

is developed through applications and testing in the proximity of the universities. The main areas of progress have been: *i*) lifecycle analysis of key food products, enabling measures to correct market failures and support modelling of the impacts of policy interventions throughout the food system; *ii*) measurement of the effectiveness of innovations and agricultural techniques in different climate conditions; and *iii*) collection and processing of information on ecosystems, especially the quality and condition of soils. Foot-print assessments and technological improvements can help avoid the need for structural "corrections" (*e.g.* cuts in the support to the highly emission-intensive dairy sector).

The University of Arizona's College of Agriculture and Life Sciences is dedicated to commercially/industrially oriented research. It's Agriculture Experiment Station and the Cooperative Extension Program continues to carry out basic research for the benefit of Arizona's agricultural industry and aims to maintain a state-wide non-formal education network by bringing research-based information into Arizona agribusiness communities. The Cooperative Extension has developed effective channels for knowledge transfer: it operates in Southern Arizona through three county extension offices, smaller satellite offices and the main office at the university. The Cooperative Extension specialists focus on water management, climate change, sustainable agriculture, range management and youth development in order to foster smart practices for long-term environmental and economic sustainability and growth. New initiatives include 4-H youth programmes with a focus on urban environmental conservation methods, forestry practices with a focus on tourism rather than harvesting and education programmes on climate change.

The university knowledge transfer has responded to the sustainability issues in the region. The College of Agriculture and Life Sciences (CALS) research projects and innovations include research on genome of maize for the purpose of more efficient production; research on improving cotton production and development; and release of barley seed requiring less water and fertilizer application, while maintaining or improving yields. Since 1996, the college has developed an integrated pest management system of Arizona's cotton crop using insect growth regulators and transgenic cotton. The benefits of the system are increasingly realised every year of application. The system saves growers money by reducing the need for toxic, expensive pesticide sprayings. Since the inception of plan in 1996 (revised 2006), cotton growers have seen a 37% reduction in crop damage and cumulatively saved over USD 200 million in pesticide costs and crop damage. In 2008, growers reported zero sprays from pink bollworm, the first time since the mid-1960s. The system has been exported to California, New

Mexico, Texas, Mexico, Australia and several Latin American Countries. (Southern Arizona, Regional Steering Committee, 2009).

Despite commendable progress, the university could consider more structured R&D efforts targeted at the local agricultural and agri-business production structure to reduce emissions related to agriculture and dairy production, and to ensure food security and sustainable rural development.

In some countries, educational institutions are also active in facilitating agri-food cluster development. The following example comes from Australia, where the dairy industry launched long term collaboration with the education institutions to address the skills needed and the need to improve the attractiveness of agricultural occupations.

Box 4.2. The National Centre for Dairy Education

The Australian dairy industry employs 40 000 people on farms and in manufacturing plans, related transport and distribution activities and on research and development projects. Dairy is one of Australia's major rural industries, with AUD 3.3 billion (2005/06) in farm gate production and AUD 2.7 billion a year in exports, making it the country's fifth largest agricultural exporter. However, the industry is facing considerable challenges: the number of farms has steadily decreased and input costs, such as water and feed have risen. This has intensified the need for farmers to be more cost-effective.

In 2005, The Australian Senate Inquiry into Rural Skills Training and Research found that it was increasingly difficult to attract and retain young people in agriculture, The range of jobs available, the training and educational opportunities and pay conditions in rural and regional areas were not as attractive as those in cities. Other industries were out-competing agriculture in the attraction and retention of talented, well-trained people. Furthermore, the "baby boomer" generation of farmers was coming up to retirement. Agricultural faculties and teaching staff at educational institutions across Australia contracted, reducing career opportunities for the young and restricting the learning system's capacity to meet the industry's needs. The Senate Inquiry concluded that agricultural industries should get involved with vocational training to ensure it is relevant, timely and aligned with the needs of the industry. In response to the inquiry, national dairy industry representatives and key industry bodies identified future education and training directions and Dairy Australia formed a partnership with Goulburn Ovens Institute of TAFE (GOTAFE) to address the dairy industry's education and training needs.

Box 4.2. The National Centre for Dairy Education (continued)

The National Centre for Dairy Education is an initiative of Dairy Australia and GOTAFE at Shepperton. It delivers nationally accredited short courses and customised programmes for dairy and processing organisation, individual farmers and people in the dairy service industry. Courses are offered in agriculture, food technology and food processing as part of a framework of re-skilling and up-skilling. An Industry Education Steering Committee (IESC) guides the direction of education and training, and ensures that the programmes remain relevant to the sector. A national network of nine industry advisory committees provides industry guidance on course content, priorities and outcomes. School-based apprenticeships or traineeships enabling secondary school student the opportunity to work with an employer and complete a nationally recognised qualification are also available. GOTAFE has responsibility for delivering the programme across Victoria.

Source: NCDEA (2010), National Centre for Dairy Education - Australia, *www.ncdea.edu.au*, accessed 16 April 2010; and OECD (2011), *Higher Education in Regional and City Development. State of Victoria, Australia*, OECD, Publishing.

Skill development for green growth

Many national and regional governments in the OECD area are developing skill strategies to address the demand for new skills in the green industries, by introducing incentives to re-skilling and facilitating mobility of learners between vocational institutes, universities and industries. Creating skilled human capital is critical for improving the opportunities for wider market penetration of renewable energy and low carbon technologies. Emerging green jobs will require the development of new industry-recognised credentials and training programmes, and modifications of training packages for workers in traditional occupations (OECD, 2011a, forthcoming).

In Southern Arizona, skill development for green jobs could be efficiently organised by pooling resources of educational institutions and industries. Some steps have already been taken to this direction. The demand for low-carbon products will require the development of diverse skills, developers, engineers and designers, manual workers with the technical capability to install and maintain these products, and marketing and sales. Arizona could also take steps to anticipate what the employment effects are and labour re-allocation needed across industries.

There is also need to collect labour market information about the demand for green jobs. Forecasting employment trends in the clean energy economies is difficult, as uncertainties remain regarding technological patterns (*e.g.* future upgrading of solar panel technologies) and policy developments (carbon pricing, adjustments in industrial policies and regulations). Partnerships between the university, community colleges and industrial associations could stimulate innovation in the modes of delivery of education and training. The University of Arizona, Pima Community College and other institutions could make concerted efforts with industry to retrain (re-skill and up-skill) workforce in low-skilled occupations.

4.2 Demographic change and ethnic diversity

Since World War II, Arizona has had one of the fastest growing populations in the United States.[5] The state of Arizona has also the fastest growing Hispanic population in the country, comprising about 25% of the state population and 27% of that of Southern Arizona. In Tucson, 40% of the residents claim Hispanic identity in whole or part of their background. In Santa Cruz, the majority of population are Hispanic. Population growth in Southern Arizona is also influenced by high birth rates and migration of retirees from other US states. The ethnically diverse population includes also Native Americans. About 23% of the land in Southern Arizona is owned by Tohono O'odham and Pascua Yaqui Nations (Southern Arizona Regional Steering Committee, 2009).

Population growth is a strength in the region and an opportunity for many industries. Hispanic population are often in the prime working age, but marry at a younger age than Arizonans in general and have more children. At 16.6% per thousand people, Arizona has the third highest birth rate in the US (US average 14.2) (CDC, 2009 in SARSC, 2009). The children of minority groups will constitute a growing portion of the population available to fill skilled jobs.

Furthermore, Southern Arizona's border state in Mexico is Sonora, a key manufacturing centre for cross-border trade between the United States and Mexico. The economic growth in Southern Arizona and Sonora is strongly related. For example in tourism, Mexican visitors comprise a significant component of the total tourism industry in Southern Arizona, Mexican visitors spend directly more than USD 1.9 billion in Southern Arizona, of which USD 976 million in Tucson and its metropolitan area. For Arizona's border cities, spending by Mexican residents is even more important due to their small economies (Pavlakovich-Kochi and Charney, 2008).

The ethnically and economically diverse population and cross-border relations are also a challenge for the economic, social and cultural development of Southern Arizona. GDP per capita and average earnings in the state of Arizona consistently lag behind the US averages. While there are also growing intraregional disparities in Southern Arizona, poverty rates have increased in all three counties during the past 30 years. Santa Cruz, with majority Hispanic population, has a particularly low income average and high poverty rate at 18.6%, compared to the national and state averages, both at 13.3% (2000 figures). Unemployment figures vary by county, Santa Cruz again featuring higher levels of unemployment than the US or Southern Arizona as a whole.

Arizona's approach to migration has been controversial. In 2000, Arizona repealed the bilingual education laws in order to require that all classes are taught in English. Since 2008, high school graduates from undocumented immigrant families have been prevented from enrolling in public tertiary education institutions, leading to a considerable decrease in the number of community college learners. Recently, in 2010, the Arizona senate authorised local police to require anyone whom they reasonably suspect of being in the United States illegally to provide evidence of their lawful presence. This act (The Support Our Law Enforcement and Safe Neighbourhoods Act) is currently subjected to federal injunction and not implemented.

The political volatility of the issue of the illegal status of immigrants creates barriers to promoting tertiary access to a significant segment of the graduating high school student population. There are also concerns about racial profiling and the negative impact on the internationalisation among the state's tertiary education institutions. The migrant population may also choose to move to other US states from Arizona, which already faces workforce shortages for example in health care due to a large number of retirees.

Migration and ethnic diversity are posing social, economic, health and cultural challenges and the challenge of social inclusion and integration. The University of Arizona and the community colleges are taking on both R&D and outreach programmes to address the societal challenges. The mechanisms range from widening access, research, to community development and education programmes.

Widening access and retaining talent

There is an important, but currently insufficiently tapped potential for students in Southern Arizona among the minority populations and lower socio-economic groups. For example, the representation of Hispanic

students in tertiary education varies across institutions, from 16% of the student body in the University of Arizona to 30% at Pima College and 35% at Cochise College (Southern Arizona Regional Steering Committee, 2009). Given the growth projections, a large influx of non-traditional students is expected in the near future.

All children, regardless of their citizenship and legal status, should have access to education. The Southern Arizona tertiary education institutions have launched programmes that address the needs of underserved communities, raising aspirations and improving preparation to education. For example Pima Community College has developed the "Family Literacy Project" in which the parents acquire their General Education Diploma (GED), English language, job and parenting skills, and the children co-participate in educational activities. The "Refugee Education Project" offers classes in English and vocational skills for refugee populations in Southern Arizona. Examples of the children's programmes are "Pima for Kids" which includes one-day workshops, summer camps and four-to-six week courses in different languages, social sciences and science (as well as the arts and sports). For teenaged youth, Pima community college offers four different programmes to facilitate college preparation: "Aztec Middle College" (programme for students to complete high school and college simultaneously), "Upward Bound" (a federally funded college preparation for lower-income and first generation students), "TRiO Talent Search" (mentoring support for low-income, first generation students) and "Tech Prep" (a vocational programme) (Southern Arizona Regional Steering Committee, 2009).

Cochise College, close to the US-Mexico border, offers for example the "Family Literacy Project", a free programme that serves adults seeking GED, English language and civics classes, and also promotes family learning by including activities through which parents and children write, read and play together. The Summer Bridge Program serves high school students who are Latina/o and first generation or lower income, by preparing them for initial college courses at Cochise College and later transfer to University of Arizona-South (Southern Arizona Regional Steering Committee, 2009).

Widening access to education is a key challenge in Southern Arizona. Positive outcomes in this domain will require long-term public-private multi-stakeholder action to reach out to schools in vulnerable areas in order to raise aspirations among under-represented groups and to improve the quality of K-12 education. Current collaborative efforts include "Tucson Values Teachers" that addresses the need to have motivated and highly skilled teachers at schools (Chapter 2). In general, however, the widening access measures in Southern Arizona remain limited in scale and impact,

underfunded and without the necessary collaborative action. One example of a comprehensive university approach to widening access and improving success for non-traditional students is provided by Victoria University in Australia (Annex 4.1).

The University of Arizona should increase its efforts to become more accessible and ensure access and affordability to all students prepared to succeed, including those transferring from the community college. However, faced in financial cuts the University of Arizona appears to lack a strong corporate approach to widening access, and creating and enforcing mechanisms to facilitate access of students from lower socio-economic and migrant backgrounds. This is evidenced for example by the increasing portion of out-of-state students in the university. New measures such as "10K by 2020" should be carefully implemented and monitored. This initiative aims to increase the University of Arizona's student enrolment form 38 000 to 52 000 by 2020, while at the same time reducing per student programme costs (also Chapter 5).

Despite the population growth, Southern Arizona continues to experience brain drain as those who move out are primary of a young, single and college-educated demographic (Southern Arizona Regional Steering Committee, 2009). The region lacks employment opportunities to attract and retain a highly-skilled workforce. With limited availability of high-wage jobs, the graduates of the University of Arizona tend to leave the region. In addition to jobs, college-educated graduates also look for a lifestyle – vibrant downtown and cultural scene, and around the clock activity. There is a growing recognition among the key public and private stakeholders about the need for an urban renaissance in Tucson.

Urban renaissance: building on creativity and urban development

The Tucson metropolitan region plays an important role in the development of Southern Arizona. Like city regions elsewhere, it is home to the majority of jobs, firms and tertiary education institutions. It is also the focal point of innovation, entrepreneurship and economic growth and hence key to increasing global competiveness of Southern Arizona.

At the same time, the Tucson region has many other positive, more intangible attributes: it is a place of natural beauty with diverse people, rich cultural heritage and a wide variety of outdoor and cultural opportunities. It is one of only 14 US cities hosting all major performing arts – professional opera, symphony, orchestra, ballet and theatre companies. This "mini-Mecca" of arts also embraces experimental, culturally diverse and emerging arts as well as a cultural and art community. The University of Arizona

supports the city's cultural strength through its education programmes, performances and other outreach activities, art venues and museums.

Cultural and creative industries could contribute to the growth and development of Southern Arizona, through attraction and retention of talent and knowledge-intensive industries that tend to move to regions with a high concentration of talents and creative workers. The attraction of talented people helps provide fertile ground for competitive business climate which in turn will help attract high tech firms bringing about economic growth (Florida, 2002). In spite of many positive attributes, the Tucson city region has not sufficiently developed its cultural and creative potential, and arts, culture and recreation remain significantly underfunded. New public-private efforts are needed to bridge the gap.

Building on the expertise within its university, Tucson could also strive to become known for the quality and ambition of its physical planning, innovative approaches to socially and environmentally sustainable city development, as well as environmental and urban planners' ability to integrate the new with the old Pueblo and Mission style architecture. In the first instance, there should be a more serious attempt to extend the "Downtown Tucson" to span from the historical core of downtown to the University of Arizona. This would help draw the community onto the campus and campus into the community. This approach would gain momentum if the public transportation plans (including the modern street car) were implemented and scaled up. At the time of the OECD review visit, the BioPark was under planning but did not feature integrated inner city public transport solution. There is also a need to create a more vibrant downtown, with around-the-clock activity, and linking it with surrounding neighbourhoods, developing a pedestrian-friendly region with safe public spaces, bike paths and public cycle hire network.

International examples in this domain come from Amsterdam and Barcelona, Spain, where the city government has developed an innovative approach to urban development through transforming old industrial and/or distressed areas into multi-functional urban areas (Box 4.2.). While tertiary education institutions have been key elements in the Barcelona urban renewal efforts, the drivers are much broader. Critics have referred to many real estate developments where the university facilities have been used as an anchor. There is also controversy around the potential and real displacement of migrant communities and lower socio-economic groups. Despite these shortcomings, there are clear socio-economic benefits in Barcelona's urban regeneration model that develops vibrant and safe multi-functional areas by combining creativity, social cohesion and economic development.

Box 4.3. City of Barcelona and urban regeneration

The City of Barcelona has an innovative approach to urban regeneration, transforming old industrial and/or distressed areas into multi-functional urban areas, with mix of living space (including social housing), business and knowledge-intensive activities. Part of the strategy is to bring in or relocate universities as early movers.

One of the examples is the 22@Barcelona innovation district, an urban renewal model that offers modern, technologically advanced and flexible spaces for the top economic activities. The initiative that involves 2 km^2 nearby the downtown waterfront is also a way of revitalise its industrial heritage and an economic development project aimed to stimulate the creation of a scientific, technological and cultural pole. There are 25 000 students in the area who study at tent university faculties and centres that have moved to 22@Barcelona District. These include communication campus of the University Pompeu Fabra. The university, in partnership with the Barcelona City Council and 14 companies have established the Barcelona Media Research Centre aimed to perform applied research in the area of communications and the media.

The concept has been measurably successful: between 2000 and the end of 2009, over 1 500 companies have been established in the district, of which 45% are new businesses. About 75% of the 45 000 new employees are linked to 22@Barcelona activities.

The model is being reduplicated in a contiguous area under the project of the Diagonal-Besòs Campus. This aims to revitalise a distressed area with immigrant population and high levels of delinquency.

Source: *www.22barcelona.com* and *www.barcelonamedia.org* and OECD (2011b), *Higher Education in Regional and City Development. The Autonomous Region of Catalonia, Spain*. OECD, Publishing.

Empowering communities

Economic development can only be sustainable, when it is accompanied by measures designed to reduce poverty, social exclusion and environmental problems. Tucson and Southern Arizona would benefit from an integrated public-private multi-stakeholder approach that not only encourages growth and jobs, but also pursues social, cultural and environmental objectives. Economically disadvantaged and undocumented immigrants represent a significant portion of the regional population. Strong efforts are needed to foster economic growth and provide educational opportunities for all.

Tertiary education institutions in Southern Arizona have generated a wide variety of programmes, initiatives and facilities to address the key social and cultural challenges in the region. There are hundreds of examples that range from help and assistance to migrants or the provision of health care, legal aid, women advocacy and other services to individuals and communities in need, to personal enrichment programmes, autochthonous languages and traditions study and preservation, or neighbourhood planning and policy advice, and cultural performances and facilities. Table 4.1 lists a few of these.

Table 4.3. Some examples of social development contributions by Southern Arizona's tertiary education institutions

Tertiary education Institution	Examples
Pima Community College	Civic/Citizenship Programme Family Literacy Project Project RAISE Refugee Education Project Community Learning Centres Upward Bound Pima for Kids
Cochise College	Center for Lifelong Learning Family Literacy Project Summer Bridge Program
Tohono O'odham Community College	Tohono Land Connections Building Trades Apprenticeship *Bajdaj* Camp Project NATIVE
University of Phoenix	Nursing programme University of Phoenix Foundation
University of Arizona	Southwest Institute for Research on Women Peter and Paula Fasseas Cancer Center Drachman Institute The Udall Center for Studies in Public Policy and the Native Nations Institute James E. Rogers College of Law Cooperative Extension

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

The University of Arizona is well positioned to not only operate as the basis for relevant social research, but also as a conduit between community members and groups, as well as governmental agencies. This work impacts policies from the local to federal levels, while other projects provide health care, pro-bono legal aid, child and women advocacy and other social services. Success is measured by programme retention and future lifestyle choices of participants, such as employment or tertiary education, and low substance abuse and crime rates.

Health care accessibility is an acute problem for the working poor and for those living in remote and tribal areas in Southern Arizona. Approximately 20% of the region's population is uninsured. Native Americans rely on Indian Health Care Service and the Bureau of Indian Affairs, which are not fully serving their needs. Hispanic and Native American populations have at least twice the risk of developing diabetes as the rest of the population, Arizona featuring the highest incident of diabetes in the US. Furthermore, the regional workforce shortage in the health care industry impacts access and quality of care. Efforts have been made by the University of Arizona and Pima Community College to address the workforce shortages in healthcare. At the same time, there is evidence of a brain drain with a number of doctors, including highly-trained specialists educated in the University of Arizona, leaving the region.

The University of Arizona has research centres in health as well as faculty who create projects in Southern Arizona and on the US-Mexico border region. The University Medical Center (UMC) and the Paul and Paula Fasseas Cancer Clinic are examples of research units that directly impact the health of the local community and focus their efforts on border health issues. These health centres serve the region while producing award-winning research (Southern Arizona Regional Steering Committee, 2009).

In the 1960s and 1970s, there was a pressure from the Hispanic community for the University of Arizona to address community health issues; with the budget cuts this is back on the agenda and minority communities are organising themselves to ensure that university's outreach services are not closed down. Mel and Enid Zuckerman College of Public Health runs several centres that aim to improve community health promotion, equality and access targeting especially Hispanic and Native American communities. It provides service learning opportunities in the centres, continuing education and workforce development and certificate programmes. The university's cross border indigenous health programme offers cross border internship, medical and nursing student exchange and two border sites for medical student clinical experiences in programmes for developmentally disabled citizens.

Southern Arizona features a large portion of population that is in need of legal services but cannot afford the services. The University of Arizona's nationally recognised James E. Rogers School of Law hosts four pro-bono clinics that provide an opportunity for faculty to develop research, for law students to acquire professional skills, and for local clients to acquire top legal aid. The co-director of Immigration Law Clinic serves as an advocate for international immigrants to Southern Arizona and serves as a public figure on immigration issues (Southern Arizona Regional Steering Committee, 2009).

The University of Arizona policy and applied research units combine research and outreach to the community. The university's research units include: the Drachman Institute, the Udall Center for Studies in Public Policy, the Mexican American Studies and Research Center, and the Bureau for Applied Research in Anthropology (BARA), which implements research and outreach in several community projects, which focus for example on urban poverty and social justice. In the "Social Justice Project," BARA faculty and students work with 50 Tucson-area Latina/o high school students to conduct action research in their schools and communities. BARA is able to procure research information from the students (who experience social inequalities) and are simultaneously teaching young people how to do research and participate in their communities (Southern Arizona Regional Steering Committee, 2009).

Table 4.4. University of Arizona's social development provision

Unit or programme	Type of social development	Service population	Service number	Collaborative Partner(s)
Southwest Institute for Research On Women (SIROW)	Health policy and care (AIDS, sexual health and substance abuse); legal aid; youth intervention; education initiatives	Women, adolescents, minority populations (Latino/a & American Indian)	2 000 people	Federal, state & county agencies; rehabilitation groups; local women's groups
Peter and Paula Fasseas Cancer Clinic	Outpatient treatment centre, preventive and rehabilitative care	Cancer patients	30 000 patient visits annually	Arizona Cancer Center
Drachman Institute	Neighbourhood planning and policy	Regional communities	N/A	State, municipal & neighbourhood groups
The Udall Center for Studies in Public Policy and the Native Nations Institute	Indigenous policy, research and executive education, local environmental advocacy and resource management	American Indian, southern Arizona rural and urban populations	N/A	Native nations, community non-profits, local businesses, federal and state governments, international bodies
James E. Rogers College of Law	Pro-bono legal clinics centred on immigration law, domestic violence, child advocacy and American Indian	Lower income or populations who cannot afford legal counsel	N/A	Community groups, Native nations
Cooperative Extension (in the College of Agriculture and Life Sciences)	Youth and American Indian outreach; rural community development; leadership training for working with community	Tohono O'odham and Pascua Yaqui young people, rural populations	N/A	Tohono O'odham Nation; Pascua Yaqui Nation, 4-H

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Southwest Institute for Research on Women (SIROW)

The University of Arizona's Southwest Institute for Research on Women (SIROW) is a regional research and resource centre serving Arizona, New Mexico, west Texas, Colorado, Wyoming, Nevada, Utah and north-western Mexico. Founded in 1979, SIROW researchers work collaboratively with University of Arizona colleges and departments, other educational institutions, governmental agencies and community-based organisation with regard to issues pertinent to the lives of women and girls. SIROW develops, conducts and disseminates inter-disciplinary and inter-institutional collaborative outreach, education and research projects of importance to the diverse groups of women and girls in south-western US and north-western Mexico. SIROW has developed an effective system to secure external funding to projects that address local community needs. Considerable share of SIROW funding is drawn from external sources, while only 10% comes from the University of Arizona.

SIROW incorporates social and community development with academic research. It is worth noting that community-based participatory research faces special difficulties; it takes longer time to do and publish and at times, there is no possibility to publish the results. Within the university, single author papers are more valued, while the work of SIROW is collaborative in nature and relies on multiple authors.

SIROW works to ensure sustainability of its project through collaboration with, and training of local public agencies or NGOs who take over the activities when research funding has ended. It has contributed to public health research and advocacy for the homeless, lower income and Latina/o communities. SIROW's projects on STD testing and substance abuse, *Mujer Sana* and "Her Story to Health," incorporate federal funding with faculty-driven research to provide health care for at-risk populations. Both projects recognise the different cultural and gender needs of participants in their health education, and have a small off-campus unit based in their service community for accessibility. (Southern Arizona Regional Steering Committee, 2009).

The *Mujer Sana* Center is located in the disadvantaged part of Tucson (the so called death row) which has high incidence of drug trafficking, prostitution and violent crime. The *Mujer Sana* community-based outreach and research site of SIROW provides Hispanic and Afro-American women with HIV and VD testing, individualised health programmes and capacity building. Homeless or near homeless women, often suffering from continuous trauma, benefit from psychological and healthcare services and help in job search strategies and capacity building. *Mujer Sana* has cared for

850 women and changed public health policy in Pima County to include hepatitis screenings for sexual health and substance abuse patients. With their cases, SIROW faculty collected data showing high rates of hepatitis and published the results, subsequently influencing the Pima County Department of Health to now include the hepatitis screenings.

Another SIROW project addressed the illicit substance use among adolescents in Southern Arizona (Box4.4). This initiative influenced not only local and regional communities but also policy making at the national level. In this and other activities, SIROW serves as a broker between the individuals, groups or communities involved and government agencies, non-profit organisations or political and economical groups or institutions.

Box 4.4 Adolescent substance abuse treatment initiative by UA Southwest Institute for Research on Women (SIROW)

In 1997-98, community members and service agency personnel expressed increased concerns with regard to illicit substance use among adolescents in Cochise, Pima, Santa Cruz and Maricopa counties in Arizona and the lack of evidenced-based and effective treatment approaches for working with these youth. Individuals and agencies approached SIROW researchers, requesting them to address adolescent substance abuse and investigate what treatments are most effective in reducing substance use. SIROW wrote several grants to investigate various treatment approaches. Partnering at a national level, SIROW was able to secure funding for itself and collaborating treatment agencies to conduct research.

Using a participatory framework, data was shared and interpreted by community members and agency personnel. Data was also shared across the ten national sites. Outcomes were compared and a deeper understanding of what works (treatment type) and with whom was achieved (for example boys vs. girls, ethnic groups, type/intensity of substance use, more/less criminally involved, more/less mental health related symptoms).

Out of this work a book/edited volume was written detailing effective programmes, numerous products and publications were realised, a national conference was created, and evidence-based programmes were reviewed and made available nationally. The national conference (The Joint Meeting on Adolescent Treatment Effectiveness) brought together not only researchers and service providers, but also adolescents and their families, for whom travel scholarships and a family respite room at the conference were made available. In 2008, a plenary session featured the "Clean and Sober Theater" (CAST), an adolescent theatrical group that gave a performance on the substance abuse on their lives. SIROW personnel served as Conference Chair in 2008 and 2010.

Box 4.4 Adolescent substance abuse treatment initiative by UA Southwest Institute for Research on Women (SIROW) (continued)

Leadership from the U.S. Substance Abuse and Mental Health Services Administration and Chestnut Heath Services inspired this work. Across the US communities and researchers came together to advance the health and well being of youth. SIROW played a small part in the US-wide initiative – but a critical one for Arizona's adolescents and their families.

The success of this project was based on five aspects inherent to SIROW's work: *i)* continuous presence in the community, including the community-based outreach/research site; *ii)* leadership style; *iii)* effective collaboration techniques; *iv)* financial investment and commitment to the community; and *v)* genuine concern for the issue.

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/imhe/regionaldevelopment.*

Community colleges

Community colleges are equally engaged with their local communities, but due to their mission tend to have stronger focus on education and training. Pima Community College's focus in social development is three-fold: *i*) to provide quality, affordable tertiary education opportunities for all inhabitants; *ii*) to facilitate partnerships within the region that enhance the quality of life for different populations, especially economically challenged groups; and *iii*) to improve the human capital of different stakeholders through a series of "special projects." Pima Community College has programmes for youth and senior populations, as well as college-attending adults. The community learning centres are accessible to senior populations and offer personal enrichment courses, including health and safety classes, exercise and career management skills. (Southern Arizona Regional Steering Committee, 2009).

Table 4.5 Examples of PCC social development provision

Unit or programme	Type of social development	Service population	Collaborative Partner(s)
Civic/Citizenship Programme	Immigrant support and education	Non-U.S. citizens	PCC Student Council
Family Literacy Project	GED, job and literacy classes for families	Low-income populations	Head Start (federal program), Pima County school districts
Project RAISE	Adult education in basic reading, math, computer skills, art and creative movement classes	Adults with developmental disabilities	AZ Department of Economic Security
Refugee Education Project	English and vocational instruction	Refugees	AZ Department of Economic Security
Community Learning Centres	Personal enrichment	Seniors, non-degree seeking students	
Upward Bound	College preparation	Low-income, first generation college students	Federal agencies
Pima for Kids	Children's education and development	Young children	Area social and cultural institutions

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Cochise College (CC) is located close to the US-Mexico border, and to Fort Huachuca, a US Army installation located 15 miles north of Mexico. These factors influence the social development priorities of the college, including serving the needs of military service men and women and bilingual communities. The Center for Lifelong Learning offers programmes to address social needs, including: *i*) all-age enrichment courses; *ii*) border-related research; *iii*) American Heart Association and America Red Cross health training; *iv*) workforce training programmes; and *iv*) a free public lecture series. CC offers several social programmes for specific community populations (Southern Arizona Regional Steering Committee, 2009).

Native Americans

Before Southern Arizona became part of the United States in the mid-19th century, it was under the geopolitical control of Mexico and Spain, and before that under the care of a number of Native American nations. Today,

Southern Arizona has the third largest Native American population, numbering 250 000 people. In Southern Arizona, 23% of the land is owned by two Native American nations: Tohono O'odham, and Pascua Yaqui, both in Pima county. Native Americans continue to have lower educational, labour market and health outcomes.[6]

Tohono O'odham Nation is the second largest reservation in the United States (2.8 million acres, comparable in size to the state of Connecticut) with 28 000 enrolled members (15 000 live on the reservation and 1 800 enrolled members in Mexico). The nation's revenue comes mainly from casinos and to a lesser extent from mining. There is a limited number of indigenous businesses (mainly small entrepreneurs selling lunches from their cars) and a reliance on non-nation people. The one grocery store has a monopoly position and the money spent there goes out of the nation.[7]

Tohono O'odham Community College lies at the heart of the Tohono O'odham Nation. Established in 1996, it is one of 33 members of the American Indian Higher Education Association (an association of tribal colleges). It is built on the traditional life-way principles called the *himdag* or "core". Himdag has four dimensions ("Beliefs, well-being, deepest respect, working together") which were developed through broad consultation with the community. The vision is "to become the TO nation's centre for tertiary education and enhance the nation's participation in local, state, national and global communities." Himdag is integrated throughout the science curriculum that emphasises respect for the environment and stewardship of the earth.

Tohono O'odham College requires all students to learn the Tohono O'odham language which is seen as valuable in transmitting culture. Drawing from the ancient principles as the mission for the college, the college pursues social development in youth, community enrichment and apprenticeship programmes. The college contributes to community development through health education, for example, by prevention of diabetes which is the main health threat to the community.

Social development for the Tohono O'odham nation is interwoven with students' learning experience at the college. Student apprentices in the "Building Trades" programme (in collaboration with the Arizona Department of Commerce) not only provide construction skills, but also assist in the building of two new campus sites.[8] The apprentices receive on-the-job-training through community service, repairing roofs and plumbing (There are about ten students per trade). Despite the progress made, graduate employability remains a challenge as the nation offers few job opportunities. The creation of long term employment would require the development of the local market in the nation and also engaging in business activities in the rest

of the regional economy. Consideration should be given whether the nation would benefit from a Small Business Development Center linked to the community college.

Table 4.6. Examples of TOCC social development provision

Unit or programme	Type of social development	Service population	Collaborative Partner(s)
Tohono Land Connections	Youth education and outreach	TO youth	UA, US Department of Agriculture
Building Trades Apprenticeship	Job training and community development	TO students and communities	University of Massachusetts, Arizona Department of Commerce
Bajidaj Camp	Diabetes prevention, traditional foods education	Diabetes and/or health risk participants	Tohono O'odham Community Action, Diabetes Education Program
Project NATIVE	Teacher preparation and placement	TO and PY communities	UA College of Education, US Department of Education, Tohono O'odham and Pascua Yaqui Nations

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf*.

At the time of the OECD review visit, the relations between Tohono O'odham Community College and other tertiary education institutions were distant, with the exception of Pima Community College, with whom the collaboration is based on personal links: Tohono O'odham Community College's first president came from Pima Community College, which has also helped in curriculum development, and offers co-enrolment and courses on the TOCC campus. With other tertiary education institutions, the connections are based on links with individual academics or departments, or have a narrow focus on articulation arrangements. The latter are facilitated by agreements with the three public universities and the state-wide agreement about the General Education (AGEC) curriculum and periodic meetings to review guidelines.

An example of collaboration with the University of Arizona is "Project NATIVE" a joint collaboration between Tohono O'odham College, the University of Arizona, the US Department of Education (providing two grants totalling USD 1.7 million) and the Tohono O'odham (TO) and Pascua Yaqui Nations. The programme supports American Indian students to acquire education degrees and work in either reservation schools or schools with high American Indian enrolment. In addition, the university's 30-year-

old American Indian Language Development Institute supports the efforts to maintain Native American languages, while the university broadcast communication media ("Arizona Public Media") provides programming in Tohono O'odham language along with news, educational, and entertainment programming that reflects the interests of Southern Arizona. The University of Arizona also has facilities for major events, such as the University of Arizona Wildcat Powwow, which includes participants from a number of regional Native nations and highlights cultural aspects of Native nations. (Southern Arizona Regional Steering Committee, 2009).

There is a room for greater multi-stakeholder collaboration between the Tohono O'odham College, other tertiary education institutions and business and society, for example, in terms of community development action to empower the nation to address its challenges in job creation and economic sustainability. Greater efforts should be made at both sides to facilitate this interaction. Native American nations and at-risk populations (lower-income, substance abuse and homeless communities) have experienced negative relationships with universities and exploitative research. While social development needs are high in these communities, universities often have to work harder to build trust in service allocation and research collaboration.

International examples of universities collaborating with indigenous populations come from the Bío Bío Region in Chile where, the Universidad Católica de la Santísima Concepción has taken an important role in supporting sustainable community development in two rural areas of Coronel and Arauco. In Coronel, the university supports a project of mussel aquaculture developed by a private sector company and is carrying out research in fish farming. Collaboration encourages the local fishermen communities to move away from capture fisheries to aquaculture and builds value added segments. In Arauco, the university has launched the Agricultural Technology Transfer Centre to address the situation of the Mapuche population's economic needs. These two projects not only address the needs of local low income minority populations, but aim to collaborate with the communities to build their capacity to face the challenges of the changing world.

Box 4.5. UCSC building sustainable communities

Coronel and move away from capture fisheries

The community of Coronel, located in the province of Concepción, has the highest concentration of fishery production in the Bío Bío Region. Unemployment and youth out-migration rates have been at high levels for several decades. In 2008, the Universidad Católica de la Santísima Concepción (UCSC) embarked on a project of mussel aquaculture in collaboration with the biggest local employer in the fishery industry. The aim of the mussel farming project was to develop an economically efficient aquaculture system for *Mytilus Chilensis* in the micro areas of Llico and Dichato.

In this collaboration, the university undertook research in fish farming and played an important brokerage role between the fishermen and the firm. The fishermen's associations provided farming spaces, raw materials, experience and work input, while the firm provided commercialisation channels, purchasing capabilities, technology, and financing. The costs, USD 570 000, were evenly divided between *Innova Bío Bío* programme and the company. Collaboration has built on a win-win basis for all participants: the university has benefitted from R&D work and practical learning experience for its students (the research team includes three students who are developing their thesis); the fishermen have profited from higher income and improved quality of life; the company has gained from new business opportunities, production lines and markets; while the region has benefitted from the economic and social impact through wealth creation, employment and move from capture fisheries to aquaculture.

Thanks to the R&D efforts, the mussel growth rate has been faster and compares positively with the existing operations in Los Lagos Region. It is estimated that the production would amount to 72 tons of mussels per each centre. Job creation will be directly related to the level of mussel production. In order to exploit 20% of the sea area assigned (3.4 km^2), 15 permanent jobs will be created and, in addition, 40 support staff functions will be added. So far, the collaboration has generated 10 new permanent jobs and 100 temporal positions. The collaboration has contributed to the re-training of the workforce away from capture fisheries to aquaculture which is important to the future of the fisheries cluster. A new vocational education institution has been established in Coronel to support the development of aquaculture.

Box 4.5. UCSC building sustainable communities (continued)

Cañete Agricultural Technology Transfer Centre building sustainable rural development on Mapuche tradition

The Bío Bío Region has the fourth biggest indigenous population in Chile (54 000 in 2002), mostly Mapuche (53 000). There is a high concentration of Mapuche in the Arauco province which is one of the poorest areas in Chile. While progress has been made in access to formal education, the generation gap among Mapuche is greater than among non-indigenous population. The Universidad Católica de la Santísima Concepción is the only higher education institution with a permanent presence and a campus in the province. Around 1 500 students attend the University's Cañete Agricultural Technology Transfer Centre.

In 2009, the centre launched technology transfer activities to serve 200 rural and Mapuche families. The aim is help improve graduate retention and build entrepreneurship based on Mapuche traditions. Based on a 70 hectare area, the centre aims to develop a productive cluster extending from environmentally sustainable cultivation, fertilisation technology and organic production to management and entrepreneurship training. The purpose is to develop and produce wine, livestock (beef and pork) and vegetable products for export purposes. The university has identified an export company that will support the pursuit. Albeit at early stages and too new to be evaluated, this initiative holds much promise and represents the single most important response of the tertiary education institutions in the Bío Bío Region to collaborate with the Mapuche population.

Source: OECD (2010b), *Higher Education in Regional and City Development: Bío Bío Region, Chile*, OECD, Publishing. *www.oecd.org/dataoecd/50/5/46340678.pdf*.

Conclusions and recommendations

The University of Arizona and community colleges actively contribute to social, cultural and environmental development in Southern Arizona, using the region as a laboratory for their research, outreach and student learning. In collaborations with stakeholders, they act as conduits for information and funding between state and federal agencies, Native nations, local school districts, businesses, military personnel, young people and at-risk populations, such as homeless communities. They not only collaborate with diverse stakeholders, but also in key areas such as youth programmes and partner with each other to build local capacity. They serve as brokers in

regional policy-making between communities, non-profit organisations and government agencies, advocating for at-risk populations in public health policy, preparing new citizens for civic duties (brokering between recent immigrants, established community members, federal agencies and local governments); and prioritising youth development, eliminating public fears on border security and xenophobia. They act as a source of expertise in sustainable development through research, education, consultancy and demonstrating good practice through on-campus management and development activities.

The opportunities for sustainable and extended third mission activities in Southern Arizona tertiary education institutions lie in building the region's reputation as a model of environmental sustainability and addressing the demographic transition in the region and the economic, social, cultural and health-related needs of the diverse population. These areas should be recognised by the public and private stakeholders as important to the region's future. The universities' and community colleges' continuing collaborative engagement in these areas could enhance support for tertiary education, influence public opinion and emphasise their critical role in social and economic leadership. Sustainable engagement in these areas will require prioritisation, building critical mass, pooling resources, new research incentives, re-conceiving incentives for faculty and staff responsibilities and developing new approaches and metrics to measure progress and participation.

In economic downturn, community programmes are vulnerable to cuts and downsizing. There is also a risk that the university will focus solely on high-tech fields. There appears to be a lack of focus of the social and cultural dimensions of the third mission activities: in spite of important world class examples of good practice, they have developed tentatively and inconsistently across the university without institutional support. The "publish or perish" environment may impede service-minded faculty. As a result, limited resources have been spread thinly; there are fragmented and non-co-ordinated initiatives; and a lack of critical mass to generate projects, which would have greater impact at the local and regional level and generate multiplier effects.

Southern Arizona has many activities for the promotion of environmental sustainability and green growth, integration of migrants and empowering minority and at-risk communities. These initiatives need to be better co-ordinated, institutionalised, rewarded and profiled within institutions, local and regional communities, Arizona, the US and global setting. To continue to deepen the contribution of the University of Arizona and community colleges to social, cultural and environmental development

of Southern Arizona, the OECD review team recommends the following measures are taken:

- To boost green growth and eco-innovation, there should be collaboration between tertiary education institutions and industry, and among the institutions themselves; for example, through collaborative platforms for eco-innovation and other cluster-based initiatives. Skill creation for green jobs should be organised by pooling learning resources of educational institutions and industries in the region and providing flexible pathways between institutions.

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should develop a strategy that sees arts and culture as an agent of development through: *i)* a direct benefit in enhancing the quality of life of the diverse population; *ii)* indirect economic benefits in attracting and retaining talent that can drive the knowledge society; and *iii)* a direct contribution to the creative industries through enterprise formation, growth, productivity and employment. This strategy should address the needs of the region's diverse communities and also enhance the internationalisation of the region.

- Southern Arizona's tertiary education institutions should support cultural development by increasing multi-stakeholder, public-private efforts to support arts and culture, and entrepreneurial skills among students of arts, humanities and social sciences. Given the high proportion of self-employment and small businesses in the creative sector, the universities and community colleges should contribute to the development of regional creative economy by developing and expanding programmes in entrepreneurship and non-profit management both in formal degree programmes and through extension efforts.

- Building on the expertise within Southern Arizona's tertiary education institutions, regional and local agencies should develop Downtown Tucson into an attractive urban centre known for the quality and ambition of its physical planning. It would span from the historical core of the downtown area to the University of Arizona, The new approach would call for improved public transportation, creation of a more vibrant downtown and linking it with surrounding neighbourhoods, developing a pedestrian-friendly region with safe public spaces, bike paths and public cycle hire network.

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should adopt an integrated public-private multi-stakeholder approach to regional and city development that not only encourages growth and jobs, but also pursues social, cultural and environmental objectives.

- Southern Arizona's tertiary education institutions should engage in long-term community development seeking ways to empower communities to find their own solutions to economic, social, cultural and environmental challenges which are global, national and local in nature. They should continue to collaborate with authorities, schools, NGOs and the private sector, to reach out to under-served communities, such as migrants, to ensure social and economic cohesion. They should scale up current activities in a systematic way, including long term multi-stakeholder collaboration with schools to raise aspiration among youth in under-served communities. They should provide training and capacity building so that the communities can do the work themselves; and continue to see the region as a laboratory for developing research, students' work-based and experiential learning and developmental projects in different fields. Tertiary education institutions should reward and recognise faculty who are involved in these activities. Provide centralised support services for student and staff for community engagement (for example internship oversight).

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should develop a forum for social, cultural and environmental development. A systematic exchange of information should be put in place to track and monitor different initiatives and their outcomes and identify best practices for publication and policy fine-tuning. Such a forum could organise thematic events with regular information retrieval and exchange facilitated by a dedicated website, and the installation and/or development of new communication technologies, such as long distance learning capabilities that can bridge the physical distances between tertiary education institutions and community stakeholders not only in Southern Arizona, but also in Mexico. As a first step, the tertiary education institutions' current connections, initiatives and projects involving stakeholder collaboration, community development and/or outreach should be mapped.

- Southern Arizona's tertiary education institutions should improve the monitoring and follow-up of the success and results of the initiatives, projects and programmes to show return on public

investment. The lack of robust and comparable data constrains the visibility and impact of the tertiary education institutions' activities. It also makes it difficult to measure the success or failure of programmes. Building on existing models, capacity should be developed in regional data gathering and sharing regional data repositories and technical skills associated with using regional data.

- In collaboration with Southern Arizona's tertiary education institutions, regional and local agencies should capitalise on Arizona's multicultural heritage. The University of Arizona should take a leadership role in regional initiatives to develop strategies to integrate immigrants, including those from families with low educational attainment. The university would benefit from an active role in international study of immigration and integration, and from participation and implementation of relevant integration plans and seeking multidisciplinary approach in its community action. The university should continue to raise public officials' and other stakeholders' awareness of labour market and educational strategies and encourage positive action.

Notes

1. Tertiary education institutions can support environmental sustainability in their cities and regions, for example by: *i)* developing skills and human capital through their learning and further education programmes; *ii)* acting as a source of expertise through research, consultancy and demonstration; *iii)* playing a brokerage role in bringing together diverse regional actors to the sustainability process; *iv)* demonstrating good practice through on-campus management and development activities, strategic planning, building design, waste minimisation and water and energy efficiency practice, responsible purchasing programmes and pursuing good citizen type initiatives like a "green campus"; and *v)* offering recognition and reward incentives for staff to be involved in sustainable development leadership groups in the regional community (OECD, 2007).

2. Regions in OECD countries are classified on two territorial levels to facilitate greater comparability of regions at the same territorial level. The lower level (TL3) consists of 1 681 regions. All the regions are defined within national borders and in most of the cases correspond to administrative regions.

3. Environmental technology refers to any product or process that can reduce, eliminate, prevent or mitigate deleterious effects on the natural environment.

4. For example, Bavaria, heavily dependent on agriculture in the early 20th century, has now become Germany's leading state for photo-voltaic technology, partly due to the collaboration between the Max-Planck-Institute and the GSF national research institute, operating under the umbrella of the Bavarian Energy Technology Cluster initiative.

5. Between 1990 and 2000, Arizona experienced a 40.0% population increase which slowed down to 26.7% between 2000 and 2008. In Southern Arizona, the corresponding figures were 26.0% and 18.4%.

6. A generation of Native Americans lost their indigenous culture and language by forced removal to boarding schools run by the Bureau of Indian Affairs, and became disconnected from the community.

7. The Community Financial Development Institute has allocated USD 20 million to support nation in loans, but it was not clear how much of this supported new businesses.

8. At the end of 2009, the TOCC campus was still in temporary quarters, pending the construction of a new campus about 16 km (10 miles) away. The new campus will be an expensive and ambitious undertaking. The nation has provided USD 6 million; also grants from HUD for faculty housing (USD 750 000); the US Department of Agriculture has given two grants of USD 270 000 and USD 220 000 for construction. The overall cost will be USD 50 to 60 million and will be constructed in phases of USD 5 to 6 million. The operating budget is about USD 4 million per year and USD 2.7 million comes from the nation. There is no state funding. The rest of the budget comes from federal property tax rebate. Only 1% is tuition (USD 47 per credit hour).

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Annex 4.A1 Victoria University access and success programme

A comprehensive approach to widening access to education is provided by Victoria University, whose catchment area is one of the fastest growing but poorest areas of Melbourne. Victoria University's broad equity and diversity strategy comprises also other student equity initiatives, such as: *i*) the investigation of secondary school students' educational aspirations; *ii*) strategies to address student finances and financial literacy; *iii*) provision of access to IT resources for low SES students; *iv*) provision of education for students with a disability; *v*) recognition of the cultural diversity of students; *vi*) provision of programmes designed to increase the participation of students from equity groups through Access and Equity Scholarships; and *vii*) a Portfolio Partnership Programme that provides an alternative pathway to university for capable students that do not have a competitive ENTER score. Victoria University has adopted a number of innovative ways to reach out to people who have traditionally been outside the TAFE/university education, for example through information stands in shopping malls as a way to directly meet. The university has been commended by the Australian Universities Quality Agency (AUQA) for its success in building effective relationships with schools. One of the examples is the Access and Success programme, which provides a valuable example for higher education institutions worldwide aiming to widen access to harder-to-reach communities (Box 4.A1.1). This work demonstrates a strong commitment to collaboration across sectors. It involves both school and community partners in designing and delivering interventions to increase their relevance to particular contexts. It builds relationships between school students and mentors, such as university students or prominent community figures. It constitutes early, long-term and sustained interventions.

Box 4.A1.1 Victoria University's Access and Success programme

Victoria University provides both tertiary education and technical and further education (TAFE). It has over 50 000 local and international students enrolled at campuses across the city-centre and western suburbs of Melbourne which experience below average educational outcomes. The university serves a student population with a higher than average representation of students from low SES backgrounds and non-English speaking backgrounds.

The Access and Success programme is a major initiative, working with schools in the west of Melbourne to improve access to and successful participation in post compulsory education. It has established collaborative teaching and research partnerships with schools and has implemented programmes across more than 70 different sites. It comprises different "arms", which involve university staff and students working in schools (Learning Enrichment); the professional development of teachers via their participation in post-graduate education (Teacher Leadership); working with senior secondary students to support their aspirations and provide information on pathways to tertiary education and employment (Youth Access); enhancing students' educational engagement through school-based programmes with community partners (Schools Plus); and developing and disseminating research about the work undertaken (Access and Success Research).

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The Learning Enrichment arm involves learning teams of school and university staff and students working on projects to enrich learning environments. Continuous university presence in the schools improves student achievement and raises aspirations. One programme involves pre-service teachers working with in-service teachers and university researchers to design action research projects that investigate issues of student disengagement. Another programme involves pre-service teachers participating as literacy mentors in a whole-school literacy intervention at the secondary level, while also researching the effectiveness of this intervention with school staff. A programme addressing student aspirations for university and TAFE takes place at another secondary school and involves pre-service teachers working with a small group of Year 9 and 10 students that have high academic ability but low aspirations. This work in and with the schools responds to the specific needs of particular sites. The "immersion" approach to intervention, in contrast to approaches that target specific equity groups, increases the potential for continuous cross-sector collaboration between schools and the university when designing interventions and undertaking school-based research.

Box 4.A1.1. Victoria University's Access and Success programme (continued)

The Teacher Leadership arm aims to engage teachers and principals in professional learning that increases teaching capacity in the schools. This has involved delivering professional development that articulates with the university Graduate Certificate or Masters of Education programmes. Research partnerships are based on participatory methodologies, which give teachers and principals control over the research agenda in their schools.

The Schools Plus arm involves brokering partnerships with community organisations and agencies that work collaboratively to support school student learning and engagement. It aims to build school-community connections and increase the engagement of students and families with education and community life. One programme involves the Australian Football League (AFL) players, specifically from the Western Bulldogs, visiting 30 primary schools in Melbourne's west. The Kinda Kinder programme seeks to address low levels of pre-school participation by engaging with parents and children in non-threatening environments. It is a literacy-focused, play-based learning environment for children aged from birth to four years. The children attend once a week with a parent or a caregiver for one hour free programme. Kinda Kinder has been designed to engage and work with children whose parents lack connection with education, and who may be less likely to enrol their child in pre-school or kindergarten. Operating in public libraries, other community settings and schools, the programme uses pre-service early childhood teachers to provide early childhood education in the form of storytelling and other play activities, while also supporting young parents to develop both social networks and their familiarisation with formal education and community services.

From its beginning in 2005, the Kinda Kinder programme has expanded and in 2009 operates in 19 sites including three libraries across the western region of Melbourne. Kinda Kinder has also enabled disengaged carers to re-engage with education. A new generation of adult learners including parents and grandparents are learning along with the children, the pre-service teachers and university staff in the Kinda Kinder setting. Kinda College is being developed in conjunction with the TAFE arm of the university and will involve offering parents the opportunity to gain further education accreditation for the skills they develop when participating in these groups. Regardless of accreditation, parents' increased involvement with education enables them to support their own children's educational experience. The multifaceted approach to building the educational capacity of communities that characterise this programme is a significant strength.

Box 4.A1.1 Victoria University's Access and Success programme (continued)

The research arm supports and contributes to the sustainability of the Access and Success programme by recording the work of different programmes, as well as facilitating the production and dissemination of knowledge about equity issues and the effectiveness of intervention strategies. A range of different quantitative and qualitative research methodologies are used to evaluate and inform collaborations with school and community partners; to track the impact that Access and Success projects have on student engagement, achievement and aspiration; and to advise equity policy and practice. This investment in research and the emphasis on building community capacity through cross-sector and cross-agency partnerships has increased the reach and sustainability of the project.

Source: Sellar, S., et al. (2010), Interventions Early in School as a means to Improve Tertiary Education Outcomes for Disadvantaged (Particularly Low SES) Students: Case Studies of Selected Australian University Outreach Activities, Department of Education, Employment and Workplace Relations, Canberra; See also OECD (2011), *Higher Education in Regional and City Development. State of Victoria, Australia*. OECD. Paris

Chapter 5

Capacity building for regional co-operation

This chapter examines how effectively tertiary education institutions in Southern Arizona contribute to capacity building, co-operation and engagement in order to sustain their contribution to regional development and innovation. It addresses, in particular, the existing leadership and partnership opportunities for regional engagement in social and economic development, focusing on the actions needed in order to maintain and increase the region's attractiveness, to support regional innovation and to build capacity for regional co-operation. The chapter provides recommendations to sustain and rethink engagement for social, cultural and environmental development, and to support regional innovation and capacity building for regional co-operation.

The chapter concludes by suggesting three major actions: i) *strategic co-ordination between tertiary education institutions;* ii) *building critical mass; and* iii) *evaluation of outcomes.*

Introduction

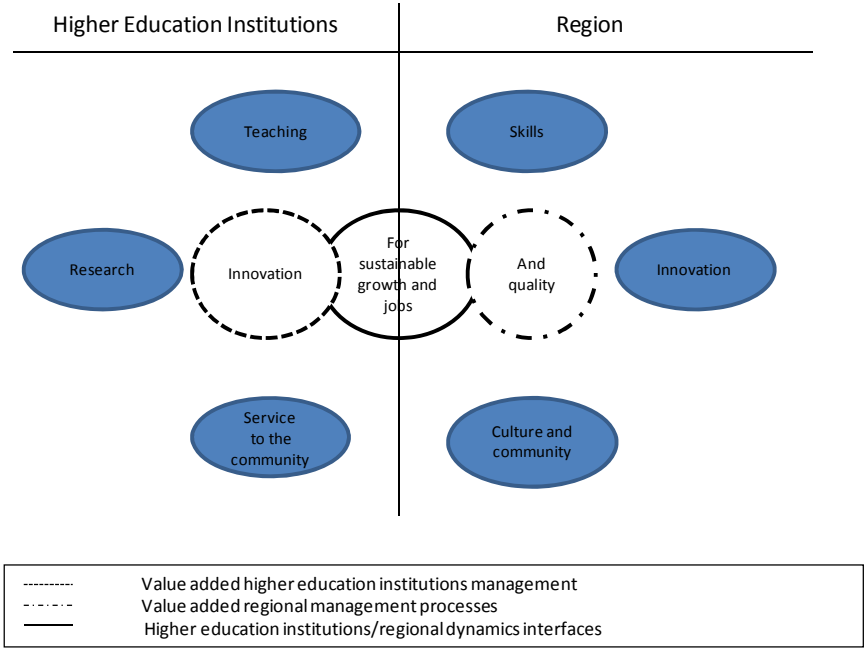
Tertiary education institutions in Southern Arizona make important contributions to the social, cultural and economic development of the region. In addition to their educational and research roles, they represent a significant share of the regional economy; they support and are a source of the region's innovative edge/drive; and sustain and promote many initiatives that help maintain the attractiveness and quality of life of Southern Arizona.

The creation of the Commission on the Future of Higher Education and its final report (USDE, 2006) signalled that the United States was beginning to address the challenge that the advances and policies in other countries had posed for its long-standing dominance in tertiary education and research. The National Community College initiative (introduced in July 2009) and President Obama's Innovation Strategy show that those pre-occupations are shared by the present Federal Administration.

Capacity building is necessary because of four main reasons: first, globalisation has brought awareness of the important role regional innovation capacity has within national innovation systems; second, the dynamics and evolving nature of American society have meant that universities and community colleges have become more deeply engaged with the communities and cities where they are located; third, although the US tertiary education system remains preeminent, international comparisons indicate that there is no room for complacency, particularly when its K-12 education[1] has lost ground; and finally, while progress has been made, collaboration and co-ordination remain a challenge.

To assess the impact that the Southern Arizona's tertiary education institutions have in sustaining the region's competitiveness and in increasing its attractiveness it is necessary to investigate how tertiary education institutions and the government agencies, businesses, industries and other actors interact (Figure 5.1.). Capacity building for regional co-operation refers to the development of the capacity to build bridges between tertiary education institutions and the region. This depends not on isolated actions of individual some actors, but on joint collaborative work.

Figure 5.1. Innovation for sustainable growth and quality jobs



Source: OECD (2007), *Higher Education and Regions; Globally Competitive, Locally Engaged*, OECD, Publishing.

This chapter examines two topics related to capacity building in Southern Arizona:

- How tertiary education institutions help maintain the region's attractiveness through their contributions to social, cultural and environmental development.
- How tertiary education institutions' support regional innovation and capacity building for co-operation between tertiary education and the region.

5.1 Maintaining the region's attractiveness

In a globally competitive world, cities and regions depend on their capacity to attract and retain highly skilled individuals and innovative entrepreneurs; this attraction and retention capacity requires a set of life and

leisure surroundings, business climate as well as natural and environmental conditions.

The ways by which tertiary education institutions impact on regional development can take many forms besides teaching and research activities. Not only do they attract students and staff to the region as well as the different visitors, services and businesses thus creating jobs and wealth; the institutions, their communities and individuals also engage in many other actions and services that help maintain or increase the region's quality of life. Many of these were traditionally considered as part of the universities' third role, but of late they have grown in number, reach and importance extending to all tertiary education institutions (Box 5.1.).

Box 5.1. Summary of the UNESCO World Declaration on Higher Education

The core missions of higher education systems (to educate, to train, to undertake research and, in particular, to contribute to the sustainable development of society as a whole) should be preserved, reinforced and further expanded, namely to educate highly qualified graduates and responsible citizens and to provide opportunities for higher learning and for learning through life. Moreover, higher education has acquired an unprecedented role in present-day society, as a vital component of cultural, social, economic and political development and as a pillar of endogenous capacity building, the consolidation of human rights, sustainable development, democracy, and peace, in a context of justice…

Higher education institutions…should preserve and develop their crucial functions…They should also enhance their critical and forward looking function, through the ongoing analysis of emerging social, economic, cultural and political trends, providing a focus for forecasting, warning and prevention…

Relevance in higher education should be assessed in terms of the fit between what society expects of institutions and what they do. For this, institutions and systems, in particular in their reinforced relations with the world of work, should base their long-term orientations on social aims and needs, including the respect of cultures and environment protection. Developing entrepreneurial skills and initiatives should become major concerns of higher education.

Box 5.1. Summary of the UNESCO World Declaration on Higher Education (continued)

Special attention should be paid to higher education's role of service to society, especially activities aimed at eliminating poverty, intolerance, violence illiteracy, hunger, environmental degradation and disease, and to activities aiming at the development of peace, through an interdisciplinary and trans-disciplinary approach.

Higher education is part of a seamless system, starting with early childhood and primary education and continuing through life, The contribution of higher education to development of the whole education system and the reordering of its links with all levels of education, in particular with secondary education, should be a priority. Secondary education should both prepare for and facilitate access to higher education as well as offer broad training and prepare students for active life…"

Source: World Conference on Higher Education Higher Education in the Twenty-first Century. Vision and Action, UNESCO, Paris 1998.

By the end of the 20th century the tertiary education institutions' task of "serving" the community had acquired, in many places, new forms and meanings besides outreach activities and openness to society. The growing acknowledgement of the importance of tertiary education in building knowledge-based societies not only changed the way institutions engage with governments, firms and organisations to further regional innovation, but has also brought social responsibility and civic engagement to the forefront.

> *In terms of community it presents a challenge to universities to be of and not just in the community; not simply to engage in "knowledge-transfer" but to establish a dialogue across the boundary between the university and its community which is open-ended, fluid and experimental.*
>
> *(Watson, 2003)*

Governance

Southern Arizona is governed by the United States federal government, the state of Arizona and local governments. Both the federal and state governments have executive, legislative and judicial branches. The Governor of Arizona leads the state's executive branch and Arizona also has

a state-level supreme court. The Arizona State Legislature consists of the Senate and the House of Representatives, who are elected by legislative districts. There are thirty legislative districts in Arizona, six of them in Southern Arizona. Each district elects one senator and two representatives to the state legislature.

Local government is at the county and municipal level. Pima, Cochise, and Santa Cruz Counties each provide public works services, police and court services, health and human services, parks and recreation facilities and management, and property assessment and taxing. The counties are financed by property taxes and other local income generation, Arizona state funds and some federal funding. County governments also provide a significant amount of employment in Southern Arizona. Southern Arizona is also governed at the municipal level by different elected mayors and councils for each municipality. These municipalities are responsible for land use planning and zoning, as well as local public works, police and fire services, parks and recreation, and other duties.

Management and financing of tertiary education

There is no over-arching state-wide mechanism to co-ordinate the entire tertiary education system in the state of Arizona.

The management and financing of public tertiary education institutions in the region occurs largely at the state and local level. The Arizona Board of Regents (ABOR) acts as the primary governing board for the University of Arizona and the UA South. ABOR also has the authority to spend income of land funds, to spend money for the use and benefit of the institution, to accept grants of money, and to issue bonds and manage money and property, including research parks.

As of July 2003, the Arizona Community College Association (ACCA), a voluntary, dues-paying organisation, has taken several co-ordinating functions regarding the Arizona community college system, including the submission of statutory reports to the legislature, and collecting data requested by the legislature on behalf of the community college system, the rest being the responsibility of the individual community college districts. In 2008, the Arizona Community College Council was created to give community colleges a seat during state budget negotiations, as well as co-ordinate with other agencies to improve co-ordination and effectiveness at all institutional levels. Each community college has an institutional board of trustees who belong to the local community and who serve the institution on terms ranging from four to six years.

Economic development

Local economic development in Southern Arizona is addressed by county and municipal governments, but there are also many policies and programmes at the federal and state level that are aimed at encouraging economic growth. For example, Tucson's economic development is promoted through federal, state, county, and city programmes. Tucson has a federally funded Empowerment Zone; businesses get tax credits for locating in and hiring employees who live in the area. Tucson also has an Enterprise Zone; this is a state programme that offers tax incentives to businesses locating in certain low-income areas of the city. Pima County funds workforce training, and the government of the City of Tucson has programmes to support local small businesses and revitalise the downtown.

The Tucson Regional Economic Opportunities (TREO), Tucson's leading economic development agency, offers services that simplify the many layers of economic development provision and assist businesses interested in operating in Southern Arizona.

Box 5.2. Tucson's Regional Economic Opportunities (TREO)

Formed in 2005 as a private, non-profit organisation to serve as the lead economic development agency for the region. TREO focuses on business attraction, retention and expansion through primary or base jobs, as a method to create wealth, and also provides strong leadership for community development and improvement of the Tucson "product".

TREO and its community partners develop markets and strengthen the Tucson region by providing a comprehensive menu of solutions and offering an integrated approach of programmes and services to support the creation of new businesses, the expansion of existing businesses within the region, and the attraction of companies that offer high impact jobs and share the community's values.

With this mission and purpose in mind, in 2007 TREO developed and adopted an Economic Blueprint to act as a guide in the advancement of a competitive position for the region. Within the Blueprint framework, TREO is focused on the following:

- Creating opportunities that will give a greater number of people better access to wealth through economic growth.
- Increasing the tax base of governments/communities in order to provide higher quality services to citizens.

Box 5.2. Tucson's Regional Economic Opportunities (TREO) (continued)

- Diversifying the economic base, thereby cushioning the community against economic shocks.

In response to the economic recession and the needs of the local community, TREO generated a plan to diversify the region's economy and improve its economic outlook. Launched in Spring 2009, "Tucson: Job One" is an immediate action plan with priorities defined within five focus areas:

- Acceleration of regional and national markets
- Local company assistance
- Enhanced tools to spur job creation
- Creating a strong and unified voice
- Leveraging Federal stimulus funding

Source : www.treoaz.org/.

Southern Arizona's tertiary education institutions play an important role in the region's economy not only by education students and conducting research, but also by providing employment, attracting students and visitors, and generating tax revenue. The University of Arizona has an enormous impact on the economy of Southern Arizona. Table 5.1 shows it is the major contributor in ranking Arizona 16th amongst the states in the country when ranked by the total research dollars brought by their public universities, a position much higher than the share of students. In total, in 2004, the University of Arizona generated 41 272 jobs, USD 1.2 billion in earnings, and USD 2.3 billion in total dollar impact in Arizona. Some units on campus have an especially large impact on the region. For example, the University of Arizona Health Services Center contributes more than USD 2.5 billion annually to the state's economy, and the University of Arizona Science and Technology Park (UASTP), founded in 1995, created 13 676 jobs in Arizona in 2007, 97% of which were in Pima County (Southern Arizona's Regional Steering Committee, 2009).

Also the community colleges have a positive economic impact in the region. Pima Community College has 371 full-time instructional and educational support faculty and 995 other employees. Cochise College is the

eighth largest employer in Cochise County, with 348 full-time and 464 part-time employees. The college has a large impact the regional economy. In fiscal year 2009, college employees were paid a total of USD 18.1 million, which in turn created an additional 190 local jobs and USD 6.8 million in earnings, according to estimates by the college's Center for Economic Research. Tohono O'odham Community College had 49 full-time employees and four part-time employees in 2005. TOCC generates highly skilled employment on the reservation for qualified Tohono O'odham citizens, where such jobs are often scarce. These positions also create an environment for other TO members to access affordable and local higher education, which builds a highly skilled workforce for their community and region in general (Southern Arizona's Regional Steering Committee, 2009).

Table 5.1. Top 25 states by total research dollars brought by their public universities, together with enrolment data

State	Total Research USD (thousands) 2006			Enrolment			
	Rank	Number of public universities		Rank	Number 4-year students	Number graduate students	% (grad/ total)
		Total	In top 25*				
Alabama	21	4	0	15	119 822	31 263	20.7
Arizona	16	2	1	20	102 391	25 324	19.8
California	1	11	5	1	510 404	107 573	17.4
Colorado	15	3	0	14	120 525	30 731	20.3
Florida	5	6	1	3	340 975	50 590	12.9
Georgia	10	4	1	8	173 714	31 817	15.5
Illinois	9	3	1	11	152 095	46 065	23.2
Indiana	17	3	1	9	172 050	30 587	15.1
Iowa	20	2	1	36	51 905	12 234	19.1
Kentucky	24	2	0	23	95 008	19 593	17.1
Maryland	8	5	2	17	105 785	34 567	24.6
Michigan	3	4	2	5	222 795	59 597	21.1
Minnesota	19	1	1	22	104 196	21 091	16.8
New Jersey	18	3	0	16	119 660	30 532	20.3
New Mexico	25	3	0	37	42 999	12 858	23.0
New York	11	5	0	4	295 133	62 992	17.6
North Carolina	14	2	1	10	160 192	38 724	19.5

Table 5.1. Top 25 states by total research dollars brought by their public universities, together with enrolment data (continued)

Ohio	6	4	1	6	224 519	46 775	17.2
Oregon	22	3	0	31	66 182	15 306	18.8
Pennsylvania	4	4	2	7	217 591	38 389	15.0
South Carolina	23	3	0	29	76 132	17 854	19.0
Texas	2	11	3	2	433 654	101 007	18.9
Virginia	13	6	0	12	147 070	45 178	23.5
Washington	7	2	1	25	91 582	17 232	15.8
Wisconsin	12	2	1	13	133 019	21 502	13.9

* In research dollars per institution

Source: Data drawn from: Shaffer, D.F and D. J. Wright (2010), "A New Paradigm for Economic Development: How Higher Education Institutions are Working to Revitalize their Regional and State Economies", The Nelson A. Rockefeller Institute of Government, University of Albany, State of New York, United States, *www.rockinst.org/pdf/education/2010-03-18-A_New_Paradigm.pdf*.

Social development

The ethnic and economic diversity of the population in Southern Arizona is a key social and cultural asset in the region, but also a challenge. Tertiary education institutions have generated a wide variety of programmes, initiatives and facilities that embrace many stakeholders through different forms of collaboration and many levels of participation. There are many examples that cover a broad range of activities, from help and assistance to migrants or the provision of health care, legal aid, women advocacy and other services to individuals and communities in need, to personal enrichment programmes, autochthonous languages and traditions study and preservation, or neighbourhood planning and policy advice (Table 5.2. for examples).

Many of these contributions are faculty-driven and aimed at establishing close institutional and personal connections with groups and communities as well as being the basis for research, grant application and external funding. An example of this is "*Mujer sana,*" a programme at University of Arizona's Southwest Institute for Research on Women (SIROW). In this case, the university serves as a broker between the individuals, groups or communities involved and government agencies, non-profit organisations or political and economical groups or institutions.

Table 5.2. Some examples of social development contributions by Southern Arizona's tertiary education institutions

Tertiary education institution	Contribution
Pima Community College	Civic/Citizenship Programme Family Literacy Project Project RAISE Refugee Education Project Community Learning Centers Upward Bound Pima for Kids
Cochise College	Center for Lifelong Learning Family Literacy Project Summer Bridge Program
Tohono O'odham Community College	Tohono Land Connections Building Trades Apprenticeship *Bajdaj* Camp Project NATIVE
University of Phoenix	Nursing programme University of Phoenix Foundation
University of Arizona	Southwest Institute for Research on Women Peter and Paula Fasseas Cancer Center Drachman Institute The Udall Center for Studies in Public Policy and the Native Nations Institute James E. Rogers College of Law Cooperative Extension

Source: Southern Arizona's Regional Steering Committee (2009), "The Southern Arizona Region, United States: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, *www.oecd.org/dataoecd/19/11/44269085.pdf.*

Although difficult to measure and difficult to sustain, these collaborations are vital for community development and social cohesion since they rely on engagement, partnership and trust by at-risk or minority population.

Environmental and cultural development

Southern Arizona covers a large geographical area with well-defined climatic zones and a sparsely distributed population. The environment, its study and care, has become a distinctive mark of the region and a concern of both the private and public sectors including urban development, waste

management, water conservation and management, energy use, transportation, agricultural and life sustainability.

All tertiary education institutions in the region have campus-specific environmental sustainability practices as well as on and off campus guidelines. In addition, many of them, but particularly the University of Arizona, have initiatives, programmes, centres, museums and institutes devoted to the study of and research on local and global climate changes, the development and application of technologies to reduce adverse environmental impact, and the provision of timely advise and warning regarding possible dangers to agriculture, towns, life species, and water resources. Many of these institutions, for example the University of Arizona's College of Agriculture and Life Sciences' Cooperative Extension Service, are leading the research in this field in both the US and in the rest of the world.

Southern Arizona's low population density, together with the desert and distance between its towns, has also made an imprint in the region's cultural development. The tertiary education institutions represent a unique provider of cultural programmes and activities that foster liveable communities as well as generate cultural links between the communities themselves. Besides education programmes – including many of an outreach nature on job training, health care and community service – the region's tertiary education institutions provide museums, exhibits, performances and athletic events in many of the towns in the region.

Finally, the Southern Arizona tertiary education institutions contribute to the maintenance and preservation of the region's indigenous languages, folklore and traditions through programmes with the Tohono O'odham and Pascua Yaqui nations while, at the same time, training educators to facilitate the cultural linkage between these communities and the institutions. The institutions also recognise the historic Mexican past of the region and its large Spanish speaking population.

5.2 Challenges

Funding and the scholarship of engagement

The financial crisis has accentuated the reduction of tertiary education funding that Arizona has experienced over the past years, thus posing a threat to its engagement and outreach programmes and initiatives. These do not generate significant revenues nor have the more established institutional support associated with environmental issues, athletics, exhibits and

performances. Furthermore, they are frequently dissociated from one another, in a myriad of small independent activities.

In addition to the funding strategies (Chapter 2), it is recommended that Southern Arizona's tertiary education institutions increase the information and data gathering on their community engagement and outreach activities and further develop the "scholarship of community engagement". In times of financial stringency it becomes necessary to have robust data to convince partners, administrators and funding agencies about the relevance and impact of them.

The Carnegie Foundation for the Advancement of Teaching[2] has initiated an elective classification of the US tertiary education institutions in three categories of community engagement, on the basis of data describing their activities in it (Box 5.3.). The University of Arizona, Pima Community College, Cochise College and Tohon O'odham Community College could well elect to participate in this effort.

Box 5.3. The Carnegie's new elective classification of Community Engagement

In 1970, the Carnegie Commission on Higher Education developed a classification of colleges and universities to support its programme of research and policy analysis. Derived from empirical data on colleges and universities, the Carnegie Classification was published for use by other researchers in 1973, and subsequently updated in 1976, 1987, 1994, 2000, and 2005. For over three decades, the Carnegie Classification has been the leading framework for describing institutional diversity in US higher education.

With the 2005 revision, the single classification system was replaced by a set of multiple, parallel classifications. The new classifications provide different lenses through which to view US colleges and universities, offering researchers greater flexibility in meeting their analytic needs. They are organised around what is taught (Undergraduate and Graduate Instructional Program classifications), who are the students (enrolment profile and undergraduate profile), and what is the setting (size & setting).

Another change is the introduction of "elective" classification. Unlike classifications based on secondary analysis of existing national data, elective classifications rely on voluntary participation by institutions, permitting analysis of attributes that are not available in the national data. The first elective classification, released in December 2006, focuses on community engagement. Because of their voluntary nature, elective classifications do not represent a comprehensive national assessment.

Box 5.3. The Carnegie's new elective classification of Community Engagement (continued)

Community engagement

Describes the collaboration between institutions of higher education and their larger communities (local, regional/state, national, global) for the mutually beneficial exchange of knowledge and resources in a context of partnership and reciprocity.

The classification includes three categories:

- **Curricular Engagement** includes institutions where teaching, learning and scholarship, engage faculty, students and community in mutually beneficial and respectful collaboration. Their interactions address community-identified needs, deepen students' civic and academic learning, enhance community well being, and enrich the scholarship of the institution.

- **Outreach and Partnerships** includes institutions that provide evidence of two approaches to community engagement. "Outreach" focuses on the application and provision of institutional resources for community use with benefits to both campus and community. "Partnerships" focuses on collaborative interactions with community and related scholarship for the mutually beneficial exchange, exploration, and application of knowledge, information, and resources (research, capacity building, economic development, etc.)

- **Curricular Engagement and Outreach & Partnerships** includes institutions with substantial commitments in both areas described above.

Source: Carnegie Foundation for the Advancement of Teaching (2010), Carnegie Classification of Institutions of Higher Education, *www.carnegiefoundation.org.*

Mission erosion

New funding mechanisms and strategies will not increase Southern Arizona's resources for tertiary education in the short term. However, furthering the scholarship of engagement and developing ways to measure and compare the impact, efficiency and sustainability of engagement will facilitate evidence-based decision and help determine priorities. Improved and greater knowledge, together with better metrics, would also help

generate institutional frameworks and guidelines for community engagement that would help institutions to:

- Define which activities to undertake or sponsor, by which norms and under what conditions, and through which mechanisms to assess their advance and outcomes.
- Decide when to co-ordinate or join other institutions in a concerted effort, or leave a particular field or line of activity to others, saving resources.

More importantly, increased scholarship on engagement would help define and clarify the institution's mission, better organise the structure for community engagement and point the way for appropriate recognition, compensation or rewards for this type of activities.

The lack of guiding principles for community engagement contributes to "mission creep" since many institutions find tempting to accept and hard to refuse to participate in this type of activities, frequently ignoring or under-evaluating their impact on the institutional resources and on staff's performance. In Southern Arizona, there are pressures to involve the University of Arizona in many third mission activities.

There is a general movement for all tertiary education institutions to become community engaged (Goddard, 2009) which makes a stronger case for having good metrics, robust data and sound analyses of the cost-effectiveness of engagement alternatives in order to balance the role that each institution will decide to play in the region's efforts to grow while maintaining liveable communities and high living standards.

Engaging with K-12 education

One of the recurrent concerns for tertiary education institutions in Southern Arizona and the US policy makers is the insufficient level of preparation of incoming students into tertiary education institutions, due to serious quality and equity problems in K-12 education. While it is the task of the local authorities and Arizona legislature to address the quality and equity issues in education, tertiary education institutions could do more in this domain.

Irrespective of the historical and national divide between K-12 and tertiary education in the US and the fact that tertiary education institutions have no direct responsibility for overcoming problems at the K-12 level (Kirst and Usdan, 2009), the region's tertiary education institutions could jointly operate various programmes that encourage and facilitate improvement of K-12 education. Comprehensive joint action in this

direction would increase human capital formation and boost the region's attraction and retention power of high tech industries and qualified people. The role of tertiary education institutions in this effort has been highlighted by the P-20 Coordinating Council (Box 5.4.).

Box 5.4. P-20 Coordinating Council: Building a better Arizona

The Governor's P-20 Council was founded in 2005 with the goal of improving education in Arizona, and ensure that more students graduate from high school, succeed in college and are ready for the modern workforce. Bringing together educators, parents, business leaders, philanthropists and policy makers, the Council's activities have focused on defining linkage problems across systems; prioritising issues as informed by community reports, presentations, and invited experts; identifying gaps; and creating a comprehensive set of recommendations for the Governor on how to improve P-20 education.

In December 2006, the Council adopted its first set of recommendations for educational reform – 32 in all – that focused primarily on the K-12 system. In June 2008, an additional 35 recommendations were adopted by the Council to address higher education funding, delivery models, communications and student input, transfer and articulation, advising, and data systems. In November 2008, the Council adopted another 23 recommendations addressing early childhood development and education (Arizona P-20 Council Policy Recommendations 2005-2008).

In August 2009, Arizona Governor Jan Brewer issued an executive order establishing the new "Governor's P-20 Coordinating Council of Arizona".

Source: Arizona Governor, *http://www.azgovernor.gov/P20.*

Focusing on the creative class

Southern Arizona's has a diverse cultural, ethnic and linguistic heritage. This multiculturalism is nurtured and protected by the region's tertiary education institutions through engagement and partnering with communities, businesses, organisations and governments at different levels. These activities that make significant contributions to social cohesion, cultural enrichment and life quality should continue to be supported by the region.

Given the current financial crisis and the tightening of the tertiary education budget, there should be a review of tertiary education institutions' cultural activities to prioritise the activities. In this analysis, tertiary education institutions should also consider their unique contribution (besides teaching and research) to rendering Southern Arizona more attractive to

talent and creative class. This does not imply neglecting at-risk groups or foregoing social development actions. On the contrary, tertiary education institutions should invest in informing policymakers of the outcomes of their social and cultural engagement rather than just promoting the actions themselves.

Southern Arizona has attractive weather and landscape, multicultural communities, technologically rich businesses, industries, hospitals and many other high class institutions, including a prestigious university. What the region might need to do in order to be on the "must-be-there" list of the creative class could be advertising itself to show that it is also sophisticated, tolerant and welcoming to newcomers and creative people.

5.3 Supporting regional innovation and capacity building for regional co-operation

In the context of a severe recession, pressure on the public finances and major societal challenges… governments are quite properly asking: what are universities for?

Goddard (2009)

Although the concept of regional innovation systems is relatively new at the policy level, governments in the advanced economies are actively promoting regional and local innovation and cluster-based policies as a way to boost national competitiveness. The United Nations, the World Bank, the OECD and other international organisations have convened meetings and published reports on the various experiences and strategies for their development, support and application (Cook and Memedovic, 2003; Watkins and Ehst, 2008; OECD, 2009).

The impact of the new world conditions and new innovation perspective on tertiary education institutions was described by Michael Gibbons in a presentation he gave at the 2004 IMHE/OECD General Conference (Gibbons, 2004). Gibbons pointed out, that competition among universities – for students, for staff and for resources – would intensify and operate in two different modes: static and dynamic. In the static and traditional mode, universities compete by offering the same products to national and international markets, externally, and by controlling costs, internally. There are inequities in the established institutional hierarchies. Even though all universities are working within the same framework, universities are not the same.

In the new dynamic mode, present hierarchies dissolve by changing the fundamental advantages upon which present competitive advantage rests. In dynamic competition, collaborations between institutions can be of two kinds: discovery-oriented and innovation-oriented. Discovery-oriented collaborations are for the most part temporary arrangements and increasingly international. To be effective they require a non-trivial allocation of resources. Innovation-oriented collaborations aim to implement some new developments for example pooling resources, exploiting institutional complementarities, capitalising on economies of scale or introducing new modes of delivery.

Gibbons concluded stating that "…competition in both its modes is operative in the higher education sector; … the tension between them explains, on the one hand, the tendency within universities to defend the current design configuration – the disciplinary mode of organisation for both teaching and research – and, on the other hand, the need to free itself from this limitation through engaging in collaborative arrangements of various kinds; … to survive in the new context universities need to take a firmer grip on the management of their institutions by differentiating those collaborations which are aimed simply at discovery to the ones which are aimed at innovation; and finally, that that the locus of choice and responsibility lies in the balance of discovery and innovation based collaborations to which universities commit themselves…"

A significant number of tertiary education institutions, including also research-intensive universities, have aligned their teaching and research activities so as to better respond to new demands and have created offices, programmes and instruments to co-ordinate better both within and outside the institution. The growing recognition of the importance of innovation and the conceptualisation of regional innovation have resulted in closer collaboration between governments, policy makers, business and industry and tertiary education institutions.

Reichert (2006) summarised the implications for tertiary education institutions and regions of this new competitive environment as it is shown in Table 5.3.

Table 5.3. New demands and implications for tertiary education institutions and regions

Transferring technology and knowledge		
Research results are to be transferred into innovation processes and product development, optimising the flow of university knowledge into knowledge-based wealth creation. University research and education has more to offer society than new technology or product-relevant research results. From updating skills of employees in knowledge-intensive professions to identifying and solving social problems, university expertise is needed in an increasingly large range of professional and political fields.	All research-intensive universities have created and expanded their tech transfer offices in the last decade (some before). Tech Transfer offices have extended their portfolio of core competences and tasks which ranges from IP protection, support for fi ling licenses and patents, and helping with industry collaboration contracts, to technology scouting, matchmaking firms and university experts, mobilising university researchers' interest in innovation activities and contacts. Knowledge transfer and communication is increasingly integrated as a core function of university processes. Not only does the university justify its existence through its impact on society but it also needs the latter's support.	University / industry collaboration has to overcome differences of interests, values, and cultures, all of which can be bridged more easily through building a basis of trust with the help of regular meetings, which in turn are more easily supported at a regional level. Knowledge transfer is built on communication and contacts which are most easily fostered in geographic proximity.
Engaging others in knowledge creation		
A knowledge-based economy and society has to value knowledge sufficiently to invest time, imagination and money into it.	Universities have to show not only the value of knowledge to society and economy but also convey the excitement and rewards of the process to help citizens identify with knowledge creation and to attract more young people to such creative processes. Open doors, science exhibitions, university/ school projects, public discussions or lectures on major topics of interest are all expressions of this central concern.	Such communication, projects or events are most often organised for a regional audience.

Table 5.3. New demands and implications for tertiary education institutions and regions (continued)

Creating an attractive knowledge environment		
To be competitive, knowledge economies and societies, regional agencies, knowledge-based enterprises and universities all seek to create environments which attract and foster creative individuals and can support each other in these attempts.	Increasingly, universities are becoming aware of the international competition for talent, at best. Qualified individuals are not just attracted by good graduate and at senior level, and of what they have to offer to attract the infrastructure and resources that allow them to realise their ideas but also by their intellectual environment, as characterised by colleagues in the institution, and possibly also other institutions in the area, and by the ambient communication culture.	Regional actors can do a lot to enhance the "creative environment" for different institutions by fostering inter-institutional exchange, thereby increasing the number of relevant partners in different sectors, by organising events that allow experts to learn from each other and engage in joint learning (new relevant scientific areas) or foresight activities. Urban development can also contribute to stimulating mixes of different groups of creative individuals.

Source: Reichert, S. (2006), *The Rise of Knowledge Regions: Emerging Opportunities and Challenges for Universities,* EUA, Brussels.

The Tucson metropolitan region can be perceived as an innovation ecosystem. While there is a need to maintain the delicate balance of this ecosystem, there is also need to extend it to Southern Arizona. This would require a better understanding of the dynamics of innovation, innovation regions and innovation ecosystems. Much research and data gathering has been undertaken over the last years on these topics. In September 2009, Morino (2009) stated that:

> *[An innovation ecosystem is] a natural, chaotic, unpredictable process that is hard, perhaps even impossible, for well-meaning outsiders to foster. If we try to control or micromanage innovation, we risk squeezing out the very life forces that give rise to successful new ideas. Instead, we must focus on finding ways to nurture and accelerate the natural processes of innovation once they've begun organically.*
>
> *Morino, McKinsey Quarterly (2009)*

In trying to reinforce and reproduce rather than change the fragile though successful conditions of Tucson, there are two non-disruptive ways in which the region's tertiary education institutions can contribute to the capacity building for regional innovation and co-operation: *i*) by engaging in

research, education and community development in fields that address regional needs and demands; and *ii*) by becoming involved and participating in business and government policy boards, regional, local and sector-based study groups, and other developmental projects.

Capacity building for regional development

The new demands on the functions of tertiary education and on its role in the region also have brought a whole range of new co-operation projects and instruments. Many university teachers offer continuing education and professional development courses to professionally active university graduates and researchers engage in projects with private and public partners. In addition, universities are now setting up (sometimes with the help of intermediary organisations) other channels of communication geared at optimising the flow of ideas and mutual stimulus between universities and outside partners (Reichert, 2006).

Southern Arizona tertiary education institutions have supported regional development in many ways, through different mechanisms and at different levels of engagement. In doing so they have responded to the needs and demands of various communities that populate the region, assisted local and state governments, and collaborated with businesses and industry, in many cases taking the initiative or providing the necessary leadership. They have also contributed to the generation, development and spin-off of many companies.

Most of these activities take place at departmental, unit and individual faculty level, and both in formal and informal ways, ranging from student engagement and counselling on local problems to specific research projects and contract technology development at state, national and international levels; from short-lived consultancy and collaboration on specific problems, to long and well-established collaborations. These activities contribute to human capital formation and capacity building; since its participants learn or reinforce their skills in research, proposal writing, information and data gathering, fund seeking, project assessment and reporting. They develop their capacity to conduct, manage and support research and innovation, to engage in and with in regional innovation activities, and to transfer and translate knowledge.

At the same time, there is a lack of national, state and institutional policies to improve the incentive structures to support the regional and local engagement of tertiary education institutions and their faculty and staff. The lack of incentives is a common feature in many institutions and countries where regional engagement is perceived not only as a secondary role for universities when compared with research, but also as a detracting activity.

In Southern Arizona, the recruitment, and promotion of the university staff are nearly exclusively determined by research performance, measured primarily by publications. Management and leadership functions are poorly rewarded and the "third mission" activities have been traditionally absent from the list of factors that have an impact on faculty career development. Tertiary education institutions need to incorporate regional development activities in the criteria for staff promotion and tenure. Furthermore, tertiary education institutions should establish a management position for regional activities (rector or pro-rector) in order to clearly show that they have recognised the importance of a region-wide socio-economic development and engagement.

The University of Arizona has a number of well-defined programmes and long-established centres, institutes or departments in the areas identified by Tucson's Regional Economic Opportunities Agency (TERO) as important for the region's economic growth and increased competitiveness, with the exception of tourism (Table 3.6). In supporting regional innovation the University of Arizona has developed multiple links, collaboration mechanisms and support schemes with and for businesses, industries, governments and private organisations or individuals (Table 3.2). The proliferation of centres, initiatives and units has led to a highly complex system. There are also gaps in important areas.

Capacity building for regional collaboration

The focus of this chapter is tertiary education institutions' contribution to regional innovation, an activity which is not limited to what these institutions do, nor on how they engage with different regional actors and agencies in the pursuit of specific agendas; it is also about how the other pillar –business, governments and society at large – perceives and understands regional development, and how the tertiary education institutions contribute to defining that vision and building on it.

Realising the potential of tertiary education to contribute to regional development implies a network model for moving towards tertiary education and regional development systems. To succeed, regional collaboration needs a consistent framework between the domains of tertiary education and territorial development, which facilitates or permits joint action at the sub-regional level. Greater direct participation of citizens and businesses in the affairs of the state and the region and in the co-production of knowledge reinforces these tendencies and thus assistsS with the building of bridges between regional agencies and higher education institutions. Given the right conditions, regional engagement can become a crucible within which more

dynamic and open tertiary education institutions can be forged, both responding to and shaping developments in the wider society.

Active participation in regional, local and community organisations is important in capacity building. Southern Arizona's tertiary education institutions are on the boards of TREO and Southern Arizona Leadership Council SALC (Box 5.5), the leading regional development organisations as well as in numerous advisory committees of public and private organisations, while leaders of public and private industry sectors serve on many tertiary education advisory boards.

Box 5.5. Southern Arizona's Leadership Council

The Southern Arizona Leadership Council's mission is to improve the greater Tucson area and the State of Arizona by bringing together resources and leadership to enhance the economic climate and the quality of life in the community and attract and retain high quality, high wage jobs. The Council works through its task forces and their respective members, and interacts with community organisations interested in its own objectives. A conscious effort is made by the Council to include in that process leaders representing the various segments of the community.

Started in 1997 as an organisation by senior business and community leaders committed to addressing public needs with balanced pragmatic policies and partnerships. SALC has attained a significant presence in Southern Arizona and state-wide at a time when national and state support has declined. SALC continues being a member-driven organisation focused on issues and initiatives of strategic importance for the region's future. SALC is or has been involved in many collaborative projects and task:

- The Tucson Regional Town Hall (TRTH), a mechanism for seeking collaborative regional partners to help address challenges important to Southern Arizona, engaging thousands of people and using these large meetings to kick off community-wide efforts led by sister organisations.

- Tucson Values Teachers (TVT), a major initiative that grew out of the 2007 TRTH to ensure that the Tucson region attracts, retains and supports the very best teachers. This was SALC's most ambitious education undertaking.

Box 5.5. Southern Arizona's Leadership Council (continued)

- The Arizona Science Foundation:
- The Bioscience agreement, reached in 2008 by the region's leaders in bioscience to co-operate and co-ordinate their efforts.
- Greater Phoenix Leadership and the Flagstaff Forty, striving to develop a statewide voice for Arizona's business leaders.

Source: *www.salc.org.*

5.4. A way forward

Arizona's tertiary education institutions are contributing to regional innovation and capacity building for regional co-operation through many institutional links, co-operation initiatives, and a variety of modes of interchange between these institutions and business, industry and governments, some of them articulated in multi-stakeholder, public-private structures or intermediary organisations. As a whole they have the common objective of transferring knowledge into business and society in order to build on regional innovation and support indigenous development of local and regional economies.

Many of the partnerships have evolved through a series of stages utilising public funding, but others are the result of the capacity for joint action between tertiary education institutions and regional interested parties. In order to move forward, the OECD review team suggests three areas worth receiving attention in the near future. These are co-ordination between tertiary education institutions, building critical mass and evaluation of outcomes.

Co-ordination

Strategic co-ordination between the tertiary education institutions can maximise the regional uptake and benefit of their activities. This inter-institutional co-ordination activity involves progressing towards managing the overall regional human capital system with tertiary education institutions, consolidating their strengths and collectively identifying and addressing regional challenges and system needs.

Different types of institutions play different roles in human capital formation, and together make a network that supports the production of the higher-order capacity necessary for development. Co-operation and co–ordination between the universities and the community colleges in the region should be viewed as a means to develop synergies and improve their regional offer of services.

Co-ordination can maximise the number of pathways, allowing progression between institutions, and focus on core objectives and missions without neglecting harder-to-reach regional groups, such as remote, distance, special or part-time students. Co-ordination allows specialisation between institutions, engagement in regional economic development, expertise in region-specific issues (border economy, desert environment, cross border collaboration), sharing of best practice and avoidance of harmful competition.

Critical mass

Co-ordination between tertiary education institutions can also contribute to critical mass, giving more capacity to respond to *ad hoc* needs for regional collaboration and develop more inter-institutional partnerships of a complementary nature.

In the current transformation process, in response to the cuts in the state funding, the University of Arizona has shifted its focus on research in areas of national importance in order to tap into external funding. It has also increased tuition fees with the risk of creating further barriers to education for the in-state students of low socio-economic backgrounds. To address these challenges, the university has launched a new model to increase its student enrolment by 10 000 by 2020. The impacts of this policy should be carefully implemented and monitored (Box 5.6).

Box 5.6. The University of Arizona seeks to enlarge its student enrolment

On March 2009, the Board of Regents of the University of Arizona (UA) adopted a new model designed to achieve an increase its student enrolment from 38 000 to 52 000 students by 2020, while at the same time reducing per-student programme costs.

They aim to serve 10 000 new students ("10K by 2020") through targeted hybrid delivery, specifically reducing cost via the following mechanisms:

1. Focusing on a narrow number of high-value, high-demand degrees and investing in those programmes to ensure that the UA will increase enrolment in its distributed programmes by 10 000 students before 2020.
2. Creating a competitively distinct, experience-rich distributed learning environment by leveraging its land grant assets across the state. Target programmes will include industry-driven internships, capstone projects, service learning opportunities, and distributed research activities.
3. Relying on and integrating the teaching and advising strengths of its community college partners across the state both to increase the rate of successful transfers between those colleges and the UA, and to significantly reduce the total cost-to-student for the undergraduate experience.
4. Maximising its teaching asset through an effective leverage of the instructional expertise of its main campus and distributed faculty, regardless whether those faculty are living in the communities they serve, are teaching from main campus, or are teaching between locations.
5. Shared community resources and investments, and creating business efficiencies across academic units.

Through this model, the University of Arizona expects to make a significant and sustainable contribution to Arizona's baccalaureate goals.

Source: Proctor, M. and G. Sander (2009), "10K by 2020: A New Model for Access to The University of Arizona Experience", paper presented at the March 2009 Meeting of the Arizona Board of Regents, University of Arizona, Tucson, 3 March, *www.azregents.edu/1_the_regents/meetings/board_book/2009-03-Mar/Item-01C1-2009-03.pdf.*

Mapping, monitoring and evaluation

There is a need for the region's tertiary education institutions to collectively construct an overall monitoring and evaluation system, covering all the regional development issues. This has to be supported by coherent and informative systems of indicators for the measurement of the regional contribution of institutions. The system should be able to gather information at the organisational, institutional and regional levels.

The collective working of tertiary education institutions for the region requires a systematic mapping and monitoring of their innovation and regional development activities as well as of the links and engagement practices used. The geography of the collaboration with the users and beneficiaries of research and the contribution of the tertiary education institutions involvement in regional policies and strategies should also be mapped. Documenting the present linkages and publicising them within the region and within the institutions itself will raise the profile of higher education as a region builder.

Monitoring and evaluation should follow this mapping. The template guiding the self-evaluation process of the current OECD study asked tertiary education institutions to critically evaluate with their regional partners and in the context of national tertiary education and regional policies under four major headings: *i)* contributions under research to regional innovation; *ii* the role of teaching and learning in the development of human capital; *iii)* contributions to social, cultural and environmental development; and *iv)* contributions to building regional capacity to act in an increasingly competitive global economy. This could serve as a start.

Notes

1. K-12 education refers to the primary and secondary education (Kindergarten through 12th Grade).

2. Founded by Andrew Carnegie in 1905 and chartered in 1906 by an Act of Congress, The Carnegie Foundation for the Advancement of Teaching is an independent policy and research centre dedicated to support needed transformations in American education through tighter connections between teaching practice, evidence of student learning, the communication and use of this evidence, and structured opportunities to build knowledge. Bringing together researchers, teachers, policymakers and members of organisations with common interests in education, the Foundation works to create knowledge and to develop tools and ideas to foster positive change and enhanced learning in US schools.

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Annex A. OECD review team

Jaana Puukka leads the OECD work on Higher Education and Regional and City Development. She joined the OECD Programme on International Management in Higher Education (IMHE) in 2005 to co-ordinate and manage the first round of OECD Reviews of Higher Education in Regional Development which took place in 2005-07 and embraced 14 regions in 12 countries. She led the second round of reviews in 2008-11 which reached out to 14 regions and city-regions in 11 countries and is also leading the third round of reviews. She is the co-author and editor of the OECD publication "Higher Education and Regions – Globally Competitive, Locally Engaged" (OECD, 2007). Before joining the OECD, Puukka had experience in tertiary education and regional development in Finland as a national and local government adviser, programme manager, practitioner and evaluator. She has management experience from both the university and polytechnic sector and has worked in university internationalisation, PR & communication and stakeholder management. In addition, she has experience in the corporate sector in the pharmaceutical industry.

Ernesto Flores is the planning co-ordinator at the Sonora Institute of Technology (*Instituto Tecnológico de Sonora*, ITSON), participating in projects that aim at improving economic and social performance in the region, such as the creation of the Technology Park, the Digital City initiatives and innovation-based regional development. He joined the OECD Programme on Institutional Management in Higher Education (IMHE) in Paris in 2009 for a 15-month secondment to support the OECD reviews in higher education in regional and city development. He holds a master's degree from Monterrey Institute of Technology and Advanced Studies, Mexico. He has worked as a Consultant in the Quality Center of Monterrey Tech, developing projects in several companies. In 2002, he was invited to collaborate to the Strategic Planning and Regional Development Office of the Executive Office of the President of Mexico where he served as planner and consultant in strategic planning for Federal Government offices.

Emiliano Duch is the founder of Competitiveness, a consulting company dedicated to cluster competitiveness reinforcement projects. He

was the founding chairman of The Competitiveness Institute (TCI). As CEO of Competitiveness he has lead more than 120 cluster initiatives in Europe and Latin-America. He has acted as advisor to Public Administration Institutions and Regional Governments, as well as for multilateral institutions like the European Union and the Inter-American Development Bank (IADB). He has given seminars on clusters to United States Agency for International Development (USAID), the IADB and many national organisations. He holds a MBA from Harvard Business School and a MPA from the Kennedy School of Government.

Madeleine Green is international consultant in the field of international education and a fellow of the International Association of Universities (IAU). Formerly, Vice President of the American Council on Education (ACE) she led the internationalisation efforts of ACE through its Center for International Initiatives (CII). CII offers programmes and services that support and enhance internationalisation on US campuses. It also works with international partners on tertiary education issues that have a global impact, conducts research on internationalisation, and advocates on international issues. Widely published on tertiary education issues, Green's areas of expertise also include tertiary education management, leadership and governance. She has authored numerous books and articles on leadership and management in tertiary education. Green served as interim president of Mount Vernon College (United States) from 1990-91. She also served as member of the board of trustees of Wilson College (United States) from 1988-93 and at Sweet Briar College (United States) from 1994-2002. She is currently a board member at Juniata College (United States) and the International Association of Universities. She holds a BA from Harvard University and a PhD from Columbia University.

Salvador Malo is Research Director at the Mexican Competitiveness Institute (IMCO). With a degree in physics from Universidad Nacional Autónoma de México (UNAM) and a doctorate in physics from Imperial College, London, he worked for three years at the International Atomic Energy Agency in Vienna, Austria. Malo conducted surface science research for several years at Mexico's Instituto Mexicano del Petroleo (an oil industry-related technical and research centre), where he held several positions, including Vice-President of Research. Before joining IMCO, he served as director general of CENEVAL, A.C., Mexico's National Centre for Quality Assessment in Higher Education. He has a long career in science and higher education, and was a member of the Mexican Task Force Group for Collaboration in Higher Education in North America. He later joined the Mexican Department of Education and initiated several programmes to promote development of the sciences in Mexican state universities, including the well-known "Sistema Nacional de Investigadores". His past

positions at UNAM include Vice-President for Planning, professor in the School of Sciences and UNAM's Centre for University Studies, as well as and Secretary General and Vice-President of Administration. In addition to his scholarly work in physics, he has published numerous articles, essays and chapters in books on topics related to educational development, research and technology in Mexico. He's author or co-author of several books.

Jamil Salmi, a Moroccan education economist, is the co-ordinator of the World Bank's network of tertiary education professionals. Salmi is the principal author of the Bank's new Tertiary Education Strategy entitled "Constructing Knowledge Societies: New Challenges for Tertiary Education." In the past thirteen years, he has provided policy and technical advice on tertiary education reform to the governments of over 35 countries around the world. Salmi has also guided the strategic planning efforts of several public and private universities in Colombia, Kenya, Mexico and Peru. Before moving to the Human Development Vice-Presidency in July 2001, Salmi worked for seven years in the Bank's Latin America and Caribbean region; in the Education and Social Policy Department of the World Bank and also prepared the World Bank's first Policy Paper on Higher Education. Prior to joining the World Bank, Salmi was a professor of education economics at the National Institute of Education Planning in Rabar, Morocco. He also worked as a consultant to various ministries, national professional associations, and international organisations. Salmi is a graduate of the French Grande Ecole, ESSEC. He also holds a Master's degree in Public and International Affairs from the University of Pittsburgh (United States) and a PhD in Development Studies from the University of Sussex (United Kingdom). He is the author of five books and numerous articles on education and development issues.

Annex B. Programme of the review visit

OECD Review Visit to Southern Arizona, 4-10 October 2009

Sunday 4 October

18:00-20:00 **OECD Review Team internal meeting**

Monday 5 October

09:30-10:45 **General Session about The University of Arizona (UA)**

- Leslie TOLBERT, Vice President for Research, Graduate Studies and Economic Development
- Ron MARX, Dean, College of Education
- Joaquin RUIZ, Dean, College of Science
- Joel VALDEZ, Senior Vice President for Business Affairs

11:00-13:00 **Lunch Meeting with Steering Committee**

- Roy FLORES, Chancellor, Pima Community College
- Jaime GUTIÉRREZ, Associate Vice President of Community Relations, University of Arizona
- John Paul JONES, Director, School of Geography and Development, UA
- Francisco MARMOLEJO, Assistant Vice President of Western Hemispheric Programs, UA
- Suzanne MILES, Provost and Executive Vice Chancellor, Pima Community College
- Vera PAVLAKOVICH, Senior Research Scientist, Economic and Business Research Center, UA
- Mike PROCTOR, Dean, Outreach College, UA
- Robert SHELTON, President, UA
- Ron SHOOPMAN, President, Southern Arizona Leadership Council
- Sarah SMALLHOUSE, Brown Family Foundations
- Joe SNELL, President and CEO, Tucson Regional Economic Opportunities
- Olivia VANEGAS-FUNCHEON, President, Tohono O'Odham Community College
- Mark VITALE, Director of Academic Affairs, University of Phoenix
- Alfredo VELÁSQUEZ, School Superintendent, Santa Cruz County
- Charlotte FUGETT, East Campus President, Pima Community College
- Louis ALBERT, West Campus President, Pima Community College

14:00-15:30 **General Session about Pima Community College (PCC)**

- Roy FLORES, Chancellor
- Suzanne MILES, Provost and Executive Vice Chancellor
- Louis ALBERT, West Campus President
- Charlotte FUGETT, East Campus President

- Brigid MURPHY, Vice Provost, Academic Services
- Donna GIFFORD, Assistant Vice Chancellor
- Johnson BIA, Campus President
- Rachelle HOWELL, AVC for Marketing
- Paul SCHWALBACH, Marketing and PR Coordinator
- Lorraine MORALES, Assistant Vice Chancellor, Student Services
- Terry SAWMA, VP Instruction/Adult Education
- Marty MAYHEW, Division Dean, West Campus

16:00-17:30 **Session on Occupational Education/Economic Development and Distance Education**

PCC Downtown campus

- Roy FLORES, Chancellor
- Johnson BIA, Campus President
- Charlotte FUGETT, East Campus President
- Donna GIFFORD, Assistant Vice Chancellor
- Terry SAWMA, VP Instruction/Adult Education
- Rachelle HOWELL, AVC for Marketing
- Kimlisa DUCHICELA, Faculty
- Tom TOMASKY, Faculty
- Ric ROSEN, Faculty

Articulation, Dual Enrolment and Health Education

PCC West Campus

- Suzanne MILES, Provost and Executive Vice Chancellor
- Louis ALBERT, West Campus President
- Brigid MURPHY, Vice Provost, Academic Services
- Paul SCHWALBACH, Marketing and PR Coordinator
- Jody KOSANKE, Faculty
- Anthony PITUCCO, Faculty

Tuesday 6 October

08:00-10:00 **University of Phoenix**

- Gregg JOHNSON, Director, University of Phoenix, Southern Arizona Campuses
- Mark VITALE, Director of Academic Affairs

12:00-14:00 **Cochise Community College**

- James Dale ROTTWEILER, President, Cochise College
- Representatives of the university's leadership and management

16:00-17:45 **Session on Clusters**

- Nina OSSANNA, Director of Business Development & Strategic Planning, BIO5, The University of Arizona

Wednesday 7 October

08:00-09:00 **University of Arizona Green Session**

- Glenn SCHRADER, Associate Dean for Research College of Engineering and Chair of the UA Campus Sustainability

09:00-09:30 **Tohono O'Odham Community College**

- Olivia VANEGAS-FUNCHEON, President

09:30-11:00 **Session on Community Outreach** **Tohono O'Odham Community College**

	• Marilyn ROBINSON, Community Outreach PartnershipCenter, Drachman Institute, UA • Gilberto OLIVAS, Program Manager, EDUCAMEXUS, UA • Sarah T. EVANS, Neighbourhood Relations Coordinator, UA • Sally STEVENS, Southwest Institute for Research on Women • Cecilia ROSALES, Professor, College of Public Health	• Olivia VANEGAS-FUNCHEON, President
11:00-12:00	**"Mujer Sana" Center**	
12:00-13:30	**Public Perception about Higher Education** • Paul ALLVIN, Associate Vice President for Communications	**Lunch with UA Students**
14:00-15:00	**Visit to the Office of the City Manager** • Mary Okoye, Director, Intergovernmental Relations • Other participants to be confirmed	
15:30-17:00	**Visit to the McGuire Center for Entrepreneurship** • Sherry HOSKINSON, Managing Director	**Session on Student Services** • Melissa VITO, Vice President for Student Affairs

Thursday 8 October

08:30-09:30	**From Research to Innovation: A dialogue with researchers** • Patrick JONES, Director, Office of Technology Transfer, The University of Arizona	**Breakfast meeting with Regent Fred BOICE**
10:30-12:00	**Session about the Science and Technology Park** • Bruce WRIGHT, Associate Vice President, University Research Parks, The University of Arizona	**Session about The University of Arizona South** • Dieter STEKLIS, Associate Dean, Academic Affairs, UA South
12:30-14:30	**Session with Southern Arizona Leadership Council** • Ron SHOOPMAN, President, Southern Arizona Leadership Council	
15:00-17:00	**Session with Tucson Regional Economic Opportunities (TREO)** • Joe SNELL, President and CEO, Tucson Regional Economic Opportunities	

Friday 9 October

08:00-09:00	**Breakfast Session on Community and Government Relations** • Jaime GUTIÉRREZ, Associate Vice President of Community Relations, UA • Greg FAHEY, Associate Vice President for Government Relations, UA
09:00-13:00	**OECD Review Team internal meeting**

13:30:14:30 **Wrap up session with Steering Committee**

- Roy FLORES, Chancellor, Pima Community College
- Jaime GUTIÉRREZ, Associate Vice President of Community Relations, University of Arizona
- John Paul JONES, Director, School of Geography and Development, UA
- Francisco MARMOLEJO, Assistant Vice President of Western Hemispheric Programs, UA
- Suzanne MILES, Provost and Executive Vice Chancellor, Pima Community College
- Vera PAVLAKOVICH, Senior Research Scientist, Economic and Business Research Center, UA
- Mike PROCTOR, Dean, Outreach College, UA
- Robert SHELTON, President, UA
- Ron SHOOPMAN, President, Southern Arizona Leadership Council
- Sarah SMALLHOUSE, Brown Family Foundations
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- Olivia VANEGAS-FUNCHEON, President, Tohono O'Odham Community College
- Mark VITALE, Director of Academic Affairs, University of Phoenix
- Alfredo VELÁSQUEZ, School Superintendent, Santa Cruz County
- Charlotte FUGETT, East Campus President, Pima Community College
- Louis ALBERT, West Campus President, Pima Community College

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where governments work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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Higher Education in Regional and City Development

Southern Arizona, United States

Southern Arizona is a major gateway for trade with Mexico. Its economic engine, the Tucson metropolitan area, has developed into a hub of light-based industries but ranks near the bottom third of US cities in per capita income. State funding for education is in decline, accentuated by the economic crisis, and the public good of tertiary education is under threat.

In a time of financial stringency, how can the University of Arizona and community colleges preserve their existing strengths and address the needs of the diverse population? How can the region and its tertiary education institutions fuel local growth and create high quality jobs and new businesses? How can the institutions prepare for the post-crisis economy and help diversify the economy?

This publication is part of the series of OECD reviews of Higher Education in Regional and City Development. These reviews help mobilise higher education institutions for economic, social and cultural development of cities and regions. They analyse how the higher education system impacts upon regional and local development and bring together universities, other higher education institutions and public and private agencies to identify strategic goals and to work towards them.

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