Higher Education in Regional and City Development

Sonora, Mexico

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Foreword

Universities and other tertiary education institutions can play a key role in human capital development and innovation systems in their cities and regions. Since 2005, the Reviews of Higher Education in Regional and City Development have been the OECD's tool to mobilise tertiary education for economic, social and cultural development of cities and regions. The reviews have analysed how the tertiary education system impacts local and regional development and helped improve this impact in more than 30 cities and regions in over 20 countries. They have examined universities' and tertiary education institution's contribution to human capital and skills development; technology transfer and business innovation; social, cultural and environmental development; and regional capacity building. The review process has facilitated partnership building in cities and regions by drawing together tertiary education institutions and public and private agencies to identify strategic goals and work together towards them.

The review of Sonora is the fourth review of its kind in Mexico, after the reviews higher education in regional and city development in Nuevo Leon (2006), Veracruz (2010) and Ciudad Juarez in Chihuahua (as part of the Paso del Norte review, 2010). It complements the reviews that have taken place in the strategically and economically important US-Mexico cross-border region, such as those of the Nuevo Leon, the Paso del Norte Region and most recently Southern Arizona (2011), right next to the state of Sonora.

The principal objective of the Sonora review is to examine the links between the region and the tertiary education institutions, and to strengthen these links to the benefit of both. In this respect the key questions for Sonora are: How can the state of Sonora benefit from a stronger tertiary education system? In what ways can universities and other tertiary education institutions individually and collectively contribute to the economic, social and cultural development of Sonora. It is our hope that Sonora's experience in this review will be an inspiration for the state governments and cities in Mexico as well as their universities and tertiary education institutions.

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List of acronyms

AARG	AIDS Action and Research Group, Universiti Sains Malaysia
ACSTI	Advisory Council for Science Technology and Innovation, Ireland
ADOC	Asia-Pacific Economic Cooperation Digital Opportunity Center, ITSON
AHELO	Assessment of Higher Education Learning Outcomes
AMC	Arizona-Mexico Commission
AMS	Association of Maquila Industries of Sonora
ANUIES	*Asociación Nacional de Universidades e Instituciones de Educación Superior* National Association of Universities and Higher Education Institutions
ASU	North American Center for Transborder Studies
BERD	Business Enterprise Research and Development
BPOE	Border Ports of Entry
BUAP	Benemérita Universidad Autónoma de Puebla
CAM	*Centro de Asistencia Meterológica* Center for Meteorological Assistance
CANAMEX	A corridor linking Canada to Mexico
CECA	Co-operative Education & Career Action, University of Waterloo, Canada
CEFRL	Common European Framework Reference of Languages
CEMADU	*Centro de estudios de marketing y desarrollo urbano* Centre for marketing and urban development
CENNI	*Certificación Nacional de Nivel de Idioma* National Certification for Language Level
CEPES	*Centro Panoramericano des estudios superiores* Pan-American center for higher education
CERM	Center for Environmental Resource Management

CESUES (See UES)	Centro de Estudios Superiores de Sonora
CETA	*Centro de Tecnología Avanzada* Centre for advanced technology
CeTIDE	*Centro Tecnológico para la Integración y Desarrollo Empresarial* Technological Centre for Enterprise Integration and Development
CIAD	*Centro de Investigación en Alimentación y Desarrollo* Centre for Research on Nutirition and Development
CIATEQ	*Centro de Techologia Avanzada* Advanced Technology Center
CIDESI	*Centro de Ingenieria y Desarrollo Industrial* The Centre for Engineering and Industrial Development
CINVESTAV	*Centro de Investigación y de Estudios Avanzados del IPN* Center for Research and Advanced Studies of the National Polytechnic Institute
CITAA	*Centro de Investigación en Tecnología del Agua y Ambient* Centre for research in water technology and environment
COEPES	*Comisiones Estatales para la Planeación de la Educación Superior* State Commission for Higher Education Planning
COLSON	Colegio de Sonora (HEI focusing on postgraduate studies and RDI)
CONACYT	*Consejo Nacional de Ciencia y Tecnología* National Council of Science and Technology
CONALEP	*Colegio Nacional de Educacion Profesional Tecnica* National College of Professional Technical Education
CONEVAL	*Consejo Nacional de Evaluacion de la Politica Desarrollo* National Center for the Evaluation of Social Development Policies
COPRESON	*Consejo para la Promoción Económica de Sonora* Economic Development Council of Sonora
COVES	*Consejo de Vinculacion del Estato de Sonora* State of Sonora Connection Council
CSA	*Comisión Sonora-Arizona* Sonora-Arizona Commission
CUDDEC	*Centro Universitario Para El Desarollo Communitario* Centre for Community development, ITSON
DIAPyME	*Distrito Internacional de Agronegocios para la Pequeña y*

	Mediana Empresa International agrobusiness park for SMEs, ITSON
EHEA	European Higher Education Area
ENFACE	*Modelo Educativo de la Universidad Estatal de Sonora ENFACE (Enfocado en el Aprendizaje y las Competencias del Estudiante* The UES educational model with focus on learning and student competencies
ENLACE	*Evaluación Nacional del Logro Académico en Centros Escolares* National Assessment of Academic Achievement in Schools
EPCC	El Paso Community College, Texas, US
EU	European Union
EUR	Euro
FAA	Federal Aviation Administration, United States
FDI	Foreign Direct Investment
FOMIX	Fondos Mixtos Mixed Funds
FORDECYT	*Fondo Institucional de Fomento Regional para el Desarrollo Científico, Tecnológico y de Innovación* Regional Institutional Fund for the Promotion of the Development of Science, Technology and Innovation
GATT	General Agreement on Tariffs and Trade
GBP	British Pounds
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GVA	Gross Value Added
HEBCIS	Higher Education and Business and the Community Interaction Survey
HEFCE	The Higher Education Funding Council for England
HEI	Higher Education Institution
HEIF	Higher Education Innovation Fund, England
HERD	Higher Education R&D
HSRC	Human Sciences Research Council, South Africa
ICATSON	*Instituto de Capacitación para el Trabajo de Sonora* Sonora Work Training Institute
ICEES	*Instituto de Credito del Estado de Sonora* State of Sonora Student Loan Institute

ICREA	The Catalan Institution for Research and Advanced Studies
ICT	Information and Communication Technology
IDEA	*Incubadora de Empresas ITSON IDEA (Imagina, Desarrolla, Emprende, Alcanza)* ITSON Business Incubator (Imagine, Develop, Launch, Reach)
IMCO	*Instituto Mexicano para la Competitividad* Mexican Institute for Competitiveness
IMHE	OECD Programme on Institutional Management in Higher Education
MMEX	Manufacturing, Maquila and Export Services Industry
INEE	*Instituto Nacional para la Evaluación de la Educación*
INEGI	*Instituto Nacional de Estadística y Geografía* National Statistics and Geography Institute
INNOVAPYME	*Programa de apoyo a la innovación tecnológica de alto valor agregado* Support Programme for High Value Added Tecnological Innovation
INNOVATEC	*Innovación en Tecnológica Educativa y Capacitación* Innovation in Educational Technology and Training
IT	Information Technology
ITAP	*Instituto Tecnologico de Agua Prieta* Technological Institute of Agua Prieta
ITESCA	*Instituto Tecnológico Superior de Cajeme* Higher Technological Institute of Cajema
ITESCAN	*Universidad Tecnologica de Nogales* Technological University of Nogales
ITESM	*Instituto de Estudios Superiores de Monterrey* Monterrey Tech
ITG	*Instituto Tecnológico de Guaymas* Technological Institute of Guaymas
ITH	*Instituto Tecnológico de Hermosillo* Technological Institute of Hermosillo
ITSC	*Instituto Tecnológico Superior de Cananea* Higher Technological Institute of Cananea
ITSON	*Instituto Tecnológico de Sonora* Sonora Institute of Technology
ITSPP	*Universidad Tecnologica del Sur de Sonora* Southern Sonora Technological University

ITSPP	*Instituto Tecnológico Superior de Puerto Peñasco* Higher Technical Institute of Puerto Peñasco
ITYV	*Instituto Tecnológico del Valle del Yaqui* Yaqui Valle Technological Institute
JDD	Joint and double degree
KEI	Knowledge Economy Index
KOF	*Konjunkturforschungsstelle* Swiss Economic Institute
LEED	Local Economic and Employment Development, OECD
MNC	Multinational corporation
MXN	Mexican Pesos
NAFTA	North American Free Trade Agreement
NHERI	National Higher Education Research Institute, Penang, Malaysia
NOVUTEK	Centre for Software Solutions
OECD	Organisation for Economic Cooperation and Development
PEE	*Programa Estatal de Educacion* State Education Programme
PIFI	*Programa Integral de Fortalecimiento Institucional* Programme for Institutional Quality Assurance
PISA	Programme for International Student Assessment
PND	*Plan Nacional de Desarollo* The National Development Plan
PROINNOVA	*Programa de Estímulo a la Investigación, Desarrollo Tecnológico e Innovación* Incentive Programme for Research, Technological Development and Innovation
PROMEP	*Programa de Mejoramiento del Profesorado* Teacher Improvement Programme
PROMESAN	Student Mobility Program for North America
PRONAE	*Programa Nacional de Educacion* National Programme for Education
PSDC	Penang Skills Development Centre, Malaysia
PV	Photovoltaics
R&D	Research and development
RENIECYT	National Registry of Science and Technology Institutions and Businesses
RIS	Regional innovation system
RVOE	*Reconocimiento de Validez Oficial de Estudios* Official Certification of Studies

SACS	Southern Association of Colleges and Schools
SE	*Secretaría de Economía* Ministry of Economy
SEC	*Secretaría de Educación y Cultura* Ministry of Education and Culture
SEP	*Secretaría de Educación Pública* Ministry of Public Education
SES	*Subsecretaría de Educación Superior* Sub-Secretariat of Higher Education
SIR	SCImago Institutions Rankings
SIROW	Southwest Institute for Research on Women, University of Arizona, US
SME	Small and medium-sized enterprise
SNI	*Sistema Nacional de Investigadores* National System of Researchers
STAADIS	Automotive and aerospace technology site for the development and research of Sonora
STI	Science, Technology and Innovation
TE	Tertiary education
TEA	Total entrepreneurship activity
TEI	Tertiary education institution
TOP	Temporary Entrepreneurship Position, University of Twente
TTO	Technology Transfer Office
UABC	*Universidad Autónoma de Baja California* Autonomous University of Baja California
UAEH	*Universidad Autónoma del Estado de Hidalgo* Autonomous State University of Hidalgo
UAEM	*Universidad Autónoma del Estado de Morelos Morelos* Autonomous State University of Morales
UANL	*Universidad Autónoma de Nuevo León* Autonomous State University of Nuevo León
UASLP	*Universidad Autónoma de San Luis Potosí* Autonomous University of San Luis Potosi
UCSC	*Universidad Católica de la Santísima Concepción* Catholic University of Santisima Concepción
UDG	*Universidad de Guadalajara* University of Guadalajara
UES	*Universidad Estatal de Sonora* Sonora State University, formerly known as CESUES

UFS	University of the Free State, South Africa
UGTO	*Universidad de Guanajuato* University of Guanajuato
UK	United Kingdom
UNAM	National Autonomous University of Mexico
UNDESA	United Nations Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISON	Universidad de Sonora University of Sonora
UNRISD	United Nations Research Institute for Social Development
US	United States
USD	United States Dollars
UTEP	University of Texas at El Paso
UTN	*Universidad Tecnológico de Nogales* Technological University of Nogales
UTPP	*Universidad Tecnológica de Puerto Peñasco* Technological University of Puerto Peñasco
UTSLRC	*Universidad Tecnológica de San Luis Rio Colorado* Technological University of San Luis Rio Colorado
UTSS	*Unversidad del Sur de Sonora*
UV	*University of Veracruz* Universidad Veracruzana
UVM	*Universidad del Valle de México* University of Valle de Mexico
WUF	World Universities Forum

Assessment and recommendations

Sonora – climbing the ladder of inclusive and sustainable development

Sonora is among Mexico's wealthier states with a GDP per capita about 15% higher than the Mexican average. Strategically situated next to the US markets and fuelled by foreign direct investment (FDI), Sonora's GDP growth generally outpaces the rest of the country, with a growth of 7% in 2011. Sonora's economy is more diversified than those of other Mexican states, with important sectors in agriculture, mining, animal husbandry, fisheries and tourism, as well as a large, diverse and growing manufacturing base. New emerging industries include software development, supply chain management and logistics, and medical tourism. All of these sectors require distinctive educational strategies that combine theory and practice.

After a period of stagnation produced by competition with China for FDI and a recession-induced slump, the FDI-based *maquila* sectors are once again growing throughout Sonora, with new business locations and increasing employment. A significant part of Sonora's public resources has been committed to meeting their demands, including the demand for a trained workforce. The FDI-driven expansion of jobs and production in Sonora attracts migrants from other states, who also find jobs in the growing service and construction sectors and require skills upgrading.

While Sonora, like other northern states, is wealthier than southern Mexico, a significant portion of its population that is now close to 2.7 million faces poverty, severe income inequality and limited access to education and jobs in the formal labour market. The spatial distribution of the population contributes to patterns of unequal access to services, including tertiary education, which particularly affects the rural population. Given Sonora's high level of poverty, relatively modest income performance and unemployment rate above the national average, the state is facing the need to improve its economic profile and move up the competitiveness ladder.

Sonora's outward development model has served the region well, but now faces many challenges. If Sonora wants to move up the competitiveness ladder it needs to have a highly skilled population and knowledge-based economy that can absorb these skills. Therefore, the ability to fuel local growth by cultivating relevant skills is the best guarantee that Sonora will thrive in future. Sonora's tertiary education system can play an important role in transforming the regional economy and society, but its full potential has not yet been mobilised for regional and local development. In this context, the key challenges for Sonora, its universities and other tertiary education institutions are:

- How to raise the overall education attainment levels and ensure that education provision is aligned with the long-term needs of Sonora's economy and population? How to improve the flexibility of the workforce to adapt to the changes in the global economy and to guarantee inclusiveness in education and the labour market?
- How to promote new business formation, indigenous innovation and the development of local industry? How to ensure that local firms are linked to the global value chains and that the region fully benefits from knowledge and technological spill-overs?
- How to address the problems of poverty, social inequality and environmental needs of the population?

To address these challenges, Sonora needs joint efforts in regional development, including a human capital, skills and innovation strategy with a vision, measurable goals, milestones, co-ordination measures and a robust evidence base. Tertiary education provision and research, development and innovation efforts need to be better aligned with Sonora's long-term needs by building stronger links between institutions and existing and emerging local industries. Joint efforts are needed to continue to raise the educational level of all, to strengthen skills for new and changing jobs and to focus on Lifelong Learning. Pathways between the technical education sector and universities need to be strengthened. To move up in the ladder, Sonora needs to strengthen its research trajectory and foster its contribution to Mexico's technological output. RDI in local SMEs and new business formation should be promoted, while transfer from informal to formal economy should be facilitated. Complementarities in economic and social goals for sustainable development should be pursued.

Human capital and skills development

Sonora has made great strides in building its human capital and skills and is today one of Mexico's top three states for highly educated young adults. One-third of Sonora's young adults have tertiary education qualifications. This progress is founded on Mexico's highest rates in literacy and upper-secondary school completion. It has also been based on tertiary education expansion and diversification driven by the increasing demand from industry and families that see the value of and invest in education.

Sonora's has the highest share of tertiary educated workforce in Mexico after the Federal District. In 2010, 30% of Sonora's young working age adults (25-34 years) had tertiary education qualifications, compared to 15% of the 55-64 year-olds, showing rapid progress in educating Sonora's population, far above the national average (24% and 15% respectively). Sonora's tertiary education enrolment rate has grown to 37%, reaching over 100 200 students in 2011-2012. These achievements have been built on the improvements made in earlier levels of education. At 95%, Sonora's literacy rate is the highest among Mexican states. Altogether, 96% of children aged 6-14 are attending school in Sonora. At 75%, Sonora's upper-secondary school completion rate is the best among Mexican states. One in three secondary school graduates in Sonora continue their studies in tertiary education, compared with one in four in Mexico. The expanding tertiary education sector serves the needs of the Sonora's young population: half of the regional population is 25 years or younger and 29% are under the age of 15.

The approach taken by the state of Sonora in order to broaden and deepen the impact of TEIs in the region has emphasised diversification of institutions and decentralisation of technical education opportunities throughout the state, including in historically under-served rural areas. Diversification also applies to subject matter, which now includes more applied scientific and technical programmes. Driven by continuing industrial demand for skills, the technological education sector has played a major role in widening participation. The state government-driven "common space" (*Espacio comun*) for technological institutions is a potentially strong tool for enhancing mobility and collaboration across the sector, but the

implementation process has been very slow. These institutes have some degree of flexibility in the composition of their programmes, which allows them to serve the needs of the local population not only in bigger cities but also in rural and indigenous communities. The expansion of tertiary education has also been driven by growing levels of wealth and the ability of Sonora's families to invest in education, while Sonora's Student Loan Institute (*Instituto de Credito del Estado de Sonora*, ICEES) puts the state as a leader in Mexico in providing assistance to needy students.

Sonora has built a significant comparative advantage by developing skilled labour for the foreign companies investing and building plants in the state. Yet narrow skills development will not serve Sonora's economy and population in the long run. Continuing efforts are needed to raise the overall education levels and general competencies that will allow people to adjust to rapid changes in the labour market and equip them with the capacity for lifelong learning.

The state of Sonora offers significant incentives to the *maquila* industries, or foreign companies investing and building plants in the state, including subsidies for workers' wages during the initial phase of employment, support for job training and custom-designed workforce assistance. This strategy has helped identify Sonora as a source of skilled labour available at approximately one-third the cost of similarly skilled labour in the United States and as a place where the public sector takes responsibility for the initial workforce preparation for industry. Although the *maquila* sector has an image of low-tech, routine manufacturing, the majority of FDI employers (57%) require workers with technical skills. The state of Sonora's technical expertise, especially in engineering, is attracting companies requiring higher value added skills. This workforce is particularly evident in the supply chains in aerospace and electronics in the Guaymas and Empalme industrial parks, and in the Hermosillo production complex built around Ford Motor company production.

While the focus on custom-designed workforce training is commendable, overly narrow skills development will not serve Sonora's population and economy in the long run. Despite significant progress, Sonora's overall educational attainment levels remain low by OECD standards and concentrated in few municipalities due to differentiated access to educational opportunities by age, skill and socio-economic background,

and a continued bifurcation in educational attainment, with a large portion of the state population having only completed primary school education. According to PISA (Programme for International Students Assessment), the learning outcomes of Mexican students are generally low and in Sonora they are even lower than national averages, which implies a problem with the quality of education. Due to school failure in Sonora, a large number of youth are outside of the labour market, education and training: around 33 000 12-29 year-olds neither study, nor work in Sonora. Sonora's unemployment levels (5.56%) are higher than the national average, whereas activity rates in the informal economy are close to the national average (13.5%).

Continuing emphasis needs to be placed on raising the overall education levels and general competencies that will allow Sonora's population to adjust to rapid changes in the labour market and have the capacity for lifelong learning. Long-term, comprehensive, multi-stakeholder efforts to enhance the quality of education could improve the completion and learning outcomes at schools and the preparation of both the youth and adult population for further education. Lifelong learning strategies should go beyond the current efforts that focus on the provision of direct skills development for *maquila* industries. Stronger efforts should be made to develop skills that can be generalised throughout the labour market so that a worker can carry them from one plant to another or move up in the hierarchy of employment responsibility and compensation. Tertiary education institutions need to develop their capacity to provide lifelong learning opportunities, including "second chances" and reskilling and upskilling opportunities, such as executive education, directed at the technically-skilled workforce that is growing in Sonora. Given Sonora's need to build a knowledge economy and infrastructure serving its diverse industrial base, changes to the tax regimes governing the *maquila* industries should be considered in view of the need to invest in long-term economic development.

There is considerable diversity among tertiary education institutions in terms of their productivity and labour market relevance of education. Productivity, retention and completion are a problem in many institutions: dropout rates in Sonora's TEIs have remained consistently above the national average. For example, the 2010/2011 dropout rate in Sonora was 11.6%, compared with 8.2% nationally. Greater academic, financial and social support would allow first generation students to access tertiary education and complete their studies. Currently, the lack of data on students' academic progress has limited the possibility of estimating the need for academic and social support. In most cases, curricula remain focused on narrow skills or qualifications rather than wider skills and competencies that

can be generalised across the labour market and enhance the ability for lifelong learning. Building on the existing examples at ITSON and UE (*Univerisdad Estatal de Sonora*, formerly CESUES), Sonora's TEIs could develop a stronger approach to competence-based curricula. In addition to student internships, a range of measures would improve the labour market relevance of education. These include mobility schemes where employees act as instructors while tertiary education staff members temporarily work in industry. Inclusion of labour market representatives in the curriculum and course design, and the governance of tertiary education institutions could also improve the relevance of tertiary education and strengthen the skills and competencies of students.

Sonora's universities are facing a potential crisis of supply for university teaching and research capacity. It is unclear where the next generation faculty will come.

Sonora's tertiary education sector suffers from a lack of long-term planning for university teaching and research capacity. Short-term appointments predominate in the university faculty ranks. Universities do not have sufficient programmes to support basic research across a range of fields, which places them in danger of losing talented postgraduates to universities in other countries. Faculty to supervise Masters and PhD students is shrinking. There is no evidence of strategies to develop and retain research talent or plans to replace an ageing teaching faculty in universities.

An education quality crisis may develop in Sonora due to increasing demand for education at all levels. Most significant to this potential crisis is evidence that support for faculty researchers/mentors and basic research has diminished as a proportion of total tertiary education expenditure. In some cases, educational programmes are admitting more students in order to fund their faculty, with the result that they are unable to supervise the admitted students, resulting in declining programme quality.

While Sonora's universities need to improve the quality, equity and relevance of their undergraduate education, they also need to continue their efforts to develop and expand postgraduate education. In designing postgraduate programmes, Sonora's universities could consider introducing joint doctoral schools and "structured doctoral programmes" that provide a framework for timely completion over four years and a framework for interdisciplinary modules, transferable skills and industry collaboration as a means of enhancing research career development in academia and industry.

Sonora needs a state-wide mechanism to articulate a long-term vision and an integrated development strategy for all educational institutions. Strengthening evidence-based decision making is necessary.

If Sonora wants to move up in the global value chain, it needs a co-ordinated, long-term strategy and a systemic approach ranging from secondary education to tertiary education and lifelong learning in order to continue to improve overall education levels, develop a highly skilled workforce and an economy that can absorb this workforce. The current technical education programmes that respond to the demands of individual companies need to be developed and evaluated within a long-term strategic plan for tertiary education in the region. The state education authorities need to be more proactive in setting the tertiary education agenda rather than leaving it to economic development actors who may do an excellent job for particular enterprises, but lack the broader educational picture of Sonora. Building a stronger strategy for human capital and skills development in Sonora requires four key elements: first, robust data on the status of the region's human capital; second, a policy audit to identify barriers to meeting needs; third, state/federal policies to foster tertiary education institutions with multiple, complementary missions aligned with regional needs; and fourth, a revision of student selection, finance policy (institutional, state and federal per-student funding as well as student support) and governance/regulation.

Sonora's tertiary education system requires more robust performance measurement, data collection and benchmarking so that the government and institutions can track their progress. At the state level, information on access to education and on institutional performance is limited and lacking authoritative status. There is a need for a state-wide, demographically-informed, data-based information system, grounded in a limited number of ambitious and measurable goals, such as improving educational attainment level by raising secondary, upper secondary and tertiary education attainment levels and reducing dropouts throughout the education system in order to provide the basis for planning, resource allocation or performance evaluation. Robust data and diagnostic analysis are also necessary to plan for longer term educational objectives and to meet broad labour force needs, such as those emerging in human services and tourism. These needs can be met through public sector needs analysis based on demographic data, an examination of the capacity of public sector service providers and their plans for service provision and improvement, and proactive efforts to contact and assess needs in SMEs. Additionally, tertiary education institutions need the common fact base provided by benchmarks to serve as

an external reference for their own performance. As part of the COVES (Sonora State Connection Council) agenda, the state of Sonora could agree with the tertiary education institutions on standard practices for recording and measuring productivity and publishing tertiary education productivity data. Without comprehensive and accessible data, institutions cannot be held accountable for their progress.

The following measures would promote human capital and skills development in Sonora:

Recommendations for the federal government

- Re-evaluate the numerous special business tax regimes that subsidise foreign direct investment and review incentives with the long-term workforce and economic development needs in view.
- Review funding arrangements for tertiary education, taking into consideration and reducing the wide differences in funding per student across the sector and within subsystems to ensure the growing demand for tertiary education in Sonora is met with adequate funding for the maintenance of quality programmes. If programmes are self-funded based on the number of students admitted and insufficient faculty are available to instruct those students, educational performance will suffer.
- Review universities' funding model to develop a plan to renew faculty who can supervise postsecondary and postgraduate students. Take steps to retain and attract junior faculty who can build careers in universities, doing research and teaching the researchers and faculty of the future.
- Develop an initiative to focus on training low-skilled people to move from the informal to the formal sector of the economy. Facilitate the move from the informal to the formal sector, for example by helping micro-entrepreneurs with outreach and training to "scale-up" their micro-enterprises in sectors such as hospitality.

Recommendations for the state government

- In collaboration with tertiary education institutions, other educational institutions and key stakeholders in the economy and society, develop a co-ordinating structure (or build on existing structures such as COVES) and appropriate mechanisms to articulate a long-term vision and strategy for human capital and skills development that stretches from primary education to tertiary education and lifelong learning (including

workforce development activities). Outline clear qualitative and quantitative goals, policies and priorities for human capital development from primary to tertiary education, and confirm the respective contribution of individual institutions (or types of institution). Build and co-ordinate relationships among the different components of the education sector to address pathways between universities and technological institutes, and between different levels of education.

- Develop an authoritative, data-driven infrastructure to inform evidence-based decision making, goal setting and evaluation for the secondary and tertiary education sectors. Monitor the performance of tertiary education in the region and benchmark its progress with appropriate comparators in the country and with OECD countries. This requires: i)robust data on the status of the region's human capital, ii) a policy audit to identify barriers to meeting needs, iii) state/federal policy to foster tertiary education institutions with multiple, complementary missions aligned with regional needs, and iv) revision of student selection, finance policy (institutional, regional and national student support) and governance/regulation. Develop data and information on: *i)* educational attainment rates benchmarked to country-level achievement, the OECD average and the best-performing OECD countries, *ii)* migration by educational level and age, iii) regional tertiary education participation rates (age groups including youth, adults; socio-economic status), *iv)* robust information on which institutions serve the region's population, *v)* long-term labour market needs, *vi)* degrees awarded by regional tertiary education institutions, vii) student labour market outcomes and *viii)* functioning pathways between and among tertiary education institutions, as well as other levels of education. Publish the comprehensive labour market intelligence online in a single place to improve students' ability to make rational choices about their studies and to help graduates and employers come together and increase the graduate employment. Use this data to identify regional priorities and facilitate the access of TEIs to the data to help develop relevant education and skills.

- In collaboration with the tertiary education institutions, continue to expand efforts to increase the enrolment and success of students from low social and economic backgrounds. Facilitate the removal of the remaining geographical barriers to education with the help of ICT, academic, social and financial support services for students and collaboration and pathways between universities and technological institutes, as well as between tertiary education and the primary and secondary education institutions. Focus attention on teacher training colleges and how secondary school teachers are prepared. Experiment

with approaches to increase the average years of school completed and to decrease desertion (drop-out) rates. These may include community development efforts that reach parents and opportunities to continue education while working.

- In collaboration with the tertiary education institutions, increase tertiary education opportunities for working age adults, ensuring that the workforce development for the maquila industries also provides general skills that enable mobility. Ensure that this training is available to workers outside the maquila industries as well. Lifelong learning measures should include transparent pathways to advanced education, the ability to attend multiple institutions, obtain short-term education and training that can later be applied to degrees, and re-skilling and up-skilling courses and programmes designed around the needs of working adults. For non-traditional learners who combine work and study and/or family obligations, develop flexible ways of education provision through work-based, e-learning and distance education and allow attendance on the basis of non-formal learning. This involves the development of a qualifications framework with strong credit recognition schemes, course and programme articulation agreements, clear and enforceable policies related to credit transfer and support for joint and collaborative programmes.

- Develop a long-term plan to meet broad labour force needs in the regional economy, based on a diagnostic analysis. Evaluate the technical education programmes that have been developed to meet the demands of individual companies. Develop these programmes within a long-term strategic plan for tertiary education in the region. Meeting the needs of the emerging sectors, such as human services and tourism, will require proactive efforts to contact and assess needs in small and medium-sized enterprises (SMEs) not represented by trade associations or economic development agencies or organisations. Public sector needs analysis should draw on demographic data as well as an examination of the capacity of public sector service providers and their plans for service provision and improvement.

- Provide micro-enterprise business training to move people from the informal to the formal sector. Expand programmes to train micro-enterprise entrepreneurs building businesses in industries such as tourism and waste management.

- Develop strategies to increase the supply of knowledge-intensive workers and to integrate them in the sectors in which the region has comparative advantages. This is beginning in the tourism sector (which engages historians and anthropologists in cultural heritage programmes,

as well as performing and visual artists), but connections could be strengthened.

Recommendations for tertiary education institutions

- Increase the proportion of longer-term appointments in the faculty in order to foster faculty research, improve quality of teaching and enhance contributions to university governance. In order to improve the quality of all tertiary education programmes, gradually reserve academic positions only for candidates with a Masters degree or higher and fix a period for those who wish to follow an academic career to complete their doctoral studies. Provide comprehensive professional development programmes for university teachers. Provide regular short courses to improve teaching skills, encourage assessment and feedback from students, and support and reward excellence in teaching.

- Develop policies, programmes and measures to improve, on a continuous basis, the quality and relevance of study programmes. First, review the curriculum content and pedagogical methods of study programmes to align them with the needs of the labour market and the local and regional economies. The opinion of employers and graduates should play an important role in the systematic and continuous revision of the education programmes of tertiary education institutions. Evaluate academic programmes and curricula that create bridges between skill levels, for example, from technician skills to post-graduate engineering programmes. Make it clear how students could move up the skills ladder, assessing, for example, opportunities to combine work and education and mentoring programmes. Second, evaluate generic skills such as critical thinking, problem solving, written output and interpersonal understanding in curriculum design, and the development of teaching and learning. Third, create robust methods to monitor student progress and achievement, labour market outcomes and mobility, as well as graduate destinations (out-migration). Monitor studies that analyse the entry of graduates into the labour market. Systematically monitor student progress, achievement and labour market outcomes. Use the data strategically to improve academic, financial and social support for students, course provision and the supply of skills.

- Construct flexible learning paths and institutional bridges that include tertiary-type B post-secondary education. Put in place measures to accommodate and encourage mobility within and between institutions by formal agreements to help students move from one institution to another.

- Address the need for lifelong learning and more flexible modes of delivery for those who combine work and study. Develop executive and lifelong education directed at the technically-skilled workforce, which will increase in the future thanks to the growing pool of technically-skilled workers in Sonora.
- Collaborate more actively with industry to ensure greater relevance of the educational provision and to build graduates' entrepreneurial skills. Engage employers in curriculum development, invite professors from industry to deliver courses, and develop experiential, problem-based, interdisciplinary and work-based learning methods to develop employability, entrepreneurial and transferable skills, management capacity and English language acquisition. Embed transferable skills in degree programmes across the academic and technical disciplines to boost the productivity base in Sonora and enhance its internationalisation efforts. Develop a stronger student-centred approach in teaching and learning, building on international best practice and the existing models in Sonora. Develop more interactive forms of education tailored to students' individual needs and capacities.
- In collaboration with other TEIs, develop a joint doctoral school and "structured doctoral programmes" that provide a framework for timely completion and a framework for industry collaboration. To enhance research training and research career development within academia and industry, incorporate in the doctoral training discipline/interdisciplinary courses, transferable skills and mobility, such as through internships in the public, private and the non-profit sector.

Research, development and innovation

Among Mexican states, Sonora ranks among the highest for its participation in the knowledge economy. In order to fully exploit its advantages, Sonora needs to strengthen its research trajectory and foster its contribution to Mexico's technological output. While universities and high- level technological institutes are numerous in the state, they are not yet actively engaged in technology transfer.

Sonora exhibits medium to high performance for regional competitiveness compared to the rest of Mexico. It comes in at 10th place in

the ranking of the Mexican Institute for Competitiveness (IMCO) and performs well for its share in the knowledge economy (4th place). At the same time, R&D spending is more modest (Sonora ranks in the middle of the list for state expenditure of national STI programmes) and patenting is marginal (18th place).

Research in Sonora's tertiary education sector is highly concentrated: four institutions – UNISON, CIAD, COLSON (Colegio de Sonora) and ITSON – account for 99% of Sonora's researchers in the National System of Researchers (SNI) and 83% of all public researchers. At the same time, Sonora's SNI researchers represent only 2.27% of the national total, and two-thirds of them are at UNISON. Universities' R&D spending remains fragmented and limited in volume for most research domains. R&D is mainly undertaken in the sectors of engineering, natural resources, basic sciences, agrofood and life sciences. Data from the National Council of Science and Technology (*Consejo Nacional de Ciencia y Tecnología,* CONACYT) demonstrates that Sonora has moved away from supporting basic research and the institutional programmes that support the development of young scholars. There is poor support for basic research outside of the fields of mineralogy and biotech, which are related to Sonora's key industries, mining and agriculture. This means that while existing industry needs continue to be served, basic research in other areas critical to the state's economy, including renewable energy or regional science and logistics, is not currently on the agenda.

Despite Sonora's relatively modest R&D performance, efforts have been made to transform universities' research results into innovation. Several tertiary education institutions are running incubators. About 22 incubators are in operation in Sonora, but only one can be classified as high-tech. Furthermore, Sonora's universities and other tertiary education institutions do not have specific mechanisms or tools to transfer technologies, only "connection offices" that have recently started to co-operate with other institutions in Mexico. UNISON's technology transfer office has not yet achieved the creation of a new business via technology transfer. Similarly, technology transfer units in the technological institutes are insufficiently professionalised. Most of the new strategic initiatives come from ITSON, which is running a software factory (NOVUTEK), an agribusiness park (DIAPyME), a technological centre for small business (CETIDE) and a range of social programmes such as CUDDEC. At the same time, ITSON faces difficulties generating sufficient R&D and reaching critical mass for its activities.

There is room for improvement in university-industry relations and making Sonora's Regional Innovation System stronger and more consistent.

Higher Education R&D (HERD) in Mexico remains very low, amounting to less than 0.04% of the national GDP. The share of HERD financed by the business sector is negligible (0.1 %) and limited progress has been made in university-industry interactions. Dialogue with business is often conducted through forums, which seem to be organised discretely and not as a continuous effort to create a link with small firms. Collaboration between firms and TEIs in Mexico only accounted for 0.5% of the products and 2.4% of the innovative processes involved in developing innovation projects in 2001. According to OECD Review of Innovation Policy: Mexico (2009) these figures increased slightly in 2006, reaching 1.8% and 2.8% respectively. No robust data for Sonora was available for these indicators, but there is no reason to believe that the situation would be much different. The lack of university-industry connections is manifest in the limited extent of applied research activity in Sonora and its TEIs. Programmes such as "Entrepreneurs and Enterprise Incubators" have been established at some TEIs, but faculty are rarely recognised for participating in these applied efforts so their participation has been limited. One exception is *Centro de Asistencia Metrológica* (CAM) at UNISON, which has worked consistently with Ford Motor Company and its suppliers in Sonora.

Because of the lack of policy efforts to link SMEs and TEIs, there are limited incentives for TEIs to build stronger relations with SMEs or help them connect with the multinational companies. CONACYT's programme for technological development and innovation addressed to companies emphasises linkages with the academic sector, but the scale of the programme remains modest; in 2010, EUR 8 million for 28 projects in Sonora. Stronger efforts backed up by funding mechanisms are needed to develop a "demand pull" for innovation in SMEs. Innovation voucher systems in many European countries and initiatives developed in other Mexican states, such as the Club of Innovators and the innovation networks promoted by Guanajuato Council for Science and Technology (CONCYTEG) could serve as a source of inspiration for Sonora.

The deficiencies in the business-science interface in Sonora constitute a major gap that state innovation policy needs to address. Other challenges include the weak absorption capacities of small firms and, consequently, the low share of business investment in process technological R&D (only 6%, below even the low 9% national average). Another issue is related to the relatively low participation of large international firms in Sonora's regional

innovation system. In Mexico, less than 2% of BERD (Business Expenditure on R&D) comes from abroad and Sonora is no exception. Large firms in the *maquila* industries tend to import technology and do not take part in local innovative networks. Moreover, the Mexican public sector provides only limited support. Public R&D spending is low according to international standards. Though Sonora received a relatively large amount of money from the federal funding scheme *Fondos Mixtos* compared to the average across Mexico, its total R&D assistance does not exceed EUR 15 million, whether from the state or from the federal government. This is insufficient to strengthen the clusterisation process and to consolidate the loose links between firms, public research organisations, TEIs and multinational companies in Sonora. The final problem is the weakness or inexistence of intermediate organisations or venture development organisations.

State policy should make stronger efforts to target Sonora's two key advantages: the broad spectrum of industrial activities and the region's location close to south-western states of the US. There is a need to develop a plan and policy initiatives to develop management and entrepreneurial capacity for indigenous business creation and to link Sonora's TEIs with US businesses and TEIs.

Sonora's economy has made strong progress, enjoying 7% growth in 2011, above the performance of most Mexican states. While its industrial structure remains balanced, Sonora seems to be moving up the technological ladder. In Sonora, the manufacturing gross value added is realised for 43.4% (percentage of manufacturing industries) in the low-tech segment, 23.5% in mid-low-tech, 18% in mid-high-tech and 15% in high-tech. The state has increased its degree of specialisation in clothing, plastics and automobiles, but has witnessed decreasing specialisation in ICT and pharma during 1980-2003. In the last part of the 2000s, however, Sonora has made great strides in several sectors, improving its competitiveness in a number of high-tech niches. For example, activity in the aerospace industry in Guaymas has increased, with the cluster employing 7 000 persons in the region. In addition to aerospace, other sectors have shown steady growth in the past year, including agriculture, automobile, mining and fisheries. The *maquiladoras* have regained their competitive edge in recent years because of the rising price of products coming from emerging countries and increasing transportation costs. This development has been supported by large, often multinational firms, but the spill-over to the small business

sector has been limited. Given the large number of SMEs in Sonora, many state programmes, including seven specific funds, target SME activities. These funds nonetheless give insufficient attention to small firms' innovation standing and none of them link SMEs to TEIs.

While Sonora has made significant progress in providing technical expertise to attract companies requiring higher value added skills, links to university research expertise and infrastructure that can enable entrepreneurs to develop new, domestically-based companies producing high value added products are less developed. Sonora's TEIs can contribute to the educational opportunities that will develop entrepreneurial and management capacity. This type of education is provided by ITSON in the tourism and agricultural sectors, which may offer more opportunities for business creation for locally-based companies. TEIs could be a source of more market-oriented R&D by providing firms with innovation inputs through consulting contracts, joint projects and the development of innovative SMEs. R&D by technological institutes could complement the more academically-oriented R&D.

Sonora could also develop stronger synergies with the neighbouring US state of Arizona by encouraging TEIs' RDI collaboration. Sonora's economic development is closely linked with Arizona. Knowledge spill-overs could be fostered by encouraging co-patenting and other forms of co-operation in R&D. Exchanges between Arizona and Mexico mainly take place at the two main ports of entry in Sonora: Nogales and Douglas/Aqua Prieta. As much as USD 16 billion worth of goods passes through Nogales each year and USD 1.1 billion passes through Douglas. A total of 235 000 jobs in Arizona rely on trade with Mexico and 25.8 million northbound visitors cross the US-Mexico border annually at the state level. To build a dynamic, bi-national regional economy, closer co-operation could be developed in a number of fields including tourism, water, renewable energy, copper mining and waste management. The leading TEIs in Hermosillo and elsewhere in Sonora have not yet played a major role in the Arizona-Sonora co-operation. This is reflected in the low number of joint research projects conducted with South Arizona TEIs and firms. A new breadth needs to be instilled in the Arizona-Sonora collaboration in order to unleash the full potential of tertiary education for cross-border development.

The following measures would promote regional innovation in Sonora:

Recommendations for the federal and state governments

- Articulate a state-level innovation plan and technological vision, and focus on implementation. Sonora's economic strategy has traditionally stressed the development of maquilas, recruitment policies and infrastructure building, rather than R&D and new product and process innovations. The state would nonetheless benefit from a clearer focus on technological perspectives. Drafting an innovation plan would help policy makers to develop a vision for Sonora's future and make clear technological choices. This requires the mapping of linkages between the state clusters and should lead to an assessment of the consequences of different technological assumptions and priorities. A state-level innovation plan would help policy makers focus on the merits of endogenous R&D policy for certain niche sectors (aerospace, alternative energy, desalinisation plant, logistics and measurement instruments) and to depart from the "technology-follower" model that has been prevalent in Sonora for the past decades. This framework will provide TEIs with a roadmap for the future and make their R&D programme more coherent and easier to evaluate. The process of designing the plan would be facilitated by referring to ITSON's Strategic Development Plan for Southern Sonora, which was developed at the end of the 2000s in collaboration with state and sub-state authorities. Given that Sonora underperforms in obtaining federal research funding compared to other states like Nuevo Leon and Baja California, an innovation plan would significantly help the state obtain more funding for innovation and R&D development from the federal ministries and CONACYT.

- Improve the alignment of universities' and technological institutes' education and research policies with the state's comparative advantages, bearing in mind the dominate role that low technologies continue to play in Sonora. The availability of skilled and semi-skilled personnel is a key factor in the choice of location for multinational companies. At the same time, MNCs target areas of strength within the state in order to foster their competitive edge. Even if the search for low-cost labour is playing an important role in FDI strategies, investors also look for skills. Sonora and Mexico are in competition with many other emerging countries trying to attract companies and talents. The higher education sector therefore needs to engage in regional development through a stronger focus on training in skills and technologies in Sonora's areas of comparative advantage. If TEIs want to become engines of economic

growth in Sonora, they must align their teaching and education policies with the appropriate segments of the market. HE research policies should also echo these concerns. Thus far, the distribution of nationally certified SNI researchers does not favour industrial research topics (only 11% of SNI researchers work in engineering and only 10% work in chemistry and biology). The technological institutes are also very weak in engineering R&D. A better balance of research that is more closely aligned to Sonora's specialisation assets must be achieved.

- Continue to build on good practices in technology transfer, such as focused parks like SonoraSoft Technology Park, and impose a rigorous cost-benefit and environmental analysis of large-scale programmes such as Knowledge City in Hermosillo. Thus far, Sonora has made moderate use of technology transfer instruments such as parks and incubators, but there are now ambitious plans to transform Hermosillo into a knowledge city. Many studies have shown that while university-based science parks perform better than non-university-based parks, they are not a panacea. There is limited evidence that networking with science parks has positive effects for SMEs. Various studies that compare firms located on and off science parks have shown limited evidence of significantly enhanced performance by the science park enterprises. Incubators, often located in science parks, are another mechanism for transferring academic research to start-up firms. The increasing development of incubators in Sonora is a welcome trend. There is, however, a risk of fragmentation, particularly for incubators linked with the new technological institutes. Focusing on the formation of sector-specific incubators, e.g. in the biotechnology or engineering sector, and state-wide networks may increase the chances of achieving the necessary critical mass to ensure the sustainability of these activities.

- Define frameworks and increase incentives for inter-university co-operation and joint programmes between higher technological institutes and universities. This process should involve the federal government (SEP, SES, and CONACYT) working together with the state authorities (State Secretary for Education and Culture). Many research and innovation opportunities are lost due to insufficient collaboration between different higher education institutions. Research in engineering (UNISON, ITESM-Monterrey Tech, ITSON, ITH, ITN, ITESCA, ITSC, ITSPP) and in agribusiness and fisheries (UNISON, ITSON, Instituto Technologico del Mar, CIAD, Centro de Estudio Superiore del Estado de Sonora) is particularly fragmented. The technological institutes have often forged relationships with SMEs, providing them with technical assistance and co-operation in incremental innovation. They have also embarked on the process of

building a common space (Espacio comun). This space needs to prioritise academic collaboration and the implementation of joint R&D and innovation projects. Collaboration between universities and technological institutes should receive special attention, as it could help large institutions such as UNISON to improve their interaction with SMEs. This could be further reinforced by the creation of joint one-stop-shops that offer an integrated range of supply services to firms, emphasising the relationship between market-based and less-applied research. Mapping out the strengths and knowledge fields of different TEIs would be useful. Synergies could be developed through common projects and graduate theses.

- Promote an evaluation culture based on robust data at an institutional level. A more efficient tertiary education sector can act as a springboard for achieving a more innovative and robust Sonoran economy. Monitoring the outcomes and assessing the impact of engagement policies would help secure a greater innovation-based trajectory for Sonora's economy. State authorities should embark on a comprehensive evaluation programme of their tertiary education policy and its outcomes. This would imply regular strategic meetings between agency directors and university rectors with the goal of regularly assessing progress. This would require the establishment of a data collection methodology, the use of indicators and the definition of the assessment's objective. With regard to policy support for technology transfer or network creation, Sonora's authorities should build an evaluation platform that uses indicators such as the number of business ideas screened and the number of development products generated. In the case of university start-ups, incubators and science parks, indicators should include the capacity of these organisations to establish large scale partnerships and to obtain private funds. The number of universities involved and the number of firms and jobs created are often quoted as indicators of success. More sophisticated analysis, such as using questionnaires addressed to customers or cost benefit analysis of programmes, would be welcome.

Recommendations tertiary education institutions

- Forge stronger links with the SME sector and relevant industry clusters (this is especially important for UNISON). Align institutional education policies and research programmes with the demands of the state economy. Give more attention to internship policies and long-term collaboration with the private sector.

- Streamline institutional internationalisation policies and diversify areas of research collaboration. Some TEIs have signed a great number of agreements that often remain umbrella frameworks that do not lead to concrete projects. While EU co-operation is excessively focused on the agribusiness sector, there is strong potential for collaboration in Sonora's other areas of strength such as engineering, solar energy and water technologies.
- Clearly articulate institutional technology transfer policies and increase networking with other institutions. Focus on specialising the incubators and increasing the professionalization of technology transfer offices in areas where a sufficient critical mass of researchers can be achieved.
- Make efforts to ensure a broad diffusion of entrepreneurship programmes in education institutions, notably technological institutes. Give these programmes an important role in the education strategy of the institutions.
- Despite the recent increase in the number of entrepreneurship support programmes at the federal level, e.g. within the framework of PeCiTi (a federal programme for STI) and national efforts to diffuse a culture of entrepreneurship among researchers (Programme Mexico Emprende), Sonora's universities and technological institutes are not fully mobilised to develop a comprehensive approach to entrepreneurship teaching. While UNISON has implemented a programme to diffuse enterprise culture (Programma institutional de Fomento a la Cultura Emprendedora) that is based on lectures, focus groups and product displays and ITSON has hosted a 2012 event called Caravan of the Entrepreneur, which aims to raise awareness and drive society towards more entrepreneurial and innovation-oriented attitudes, entrepreneurship is in most cases not part of the core curricula. Scaling up the effort made by ITSON, steps need to be taken to create comprehensive entrepreneurship modules and to integrate them into the curricula.

Contribution to social, cultural and environmental development

Sonora is one of the wealthiest states in Mexico, but faces many challenges. These challenges can provide an opportunity to develop a more resilient and sustainable economy by up-scaling TEIs' RDI effort, learning programmes and community outreach, and seeking

complementarities of social and economic goals.

Sonora is one of Mexico's wealthier states, but it continues to face many challenges such as poverty and large income inequalities, intra-regional disparities, inter-ethnic and gender inequality, and environmental challenges. The geographic distribution of the population across the state results in unequal access to services, such as tertiary education, which particularly affects people in rural areas. The rural population in Sonora is poorer than the urban population, and includes a higher proportion of the indigenous population, among which the poverty rate is higher. Environmental challenges include the severe drought that Sonora has experienced since the mid-1990s. The demand for water in the urbanising northern portion of the state and the continued demand for water by agricultural water users in the southern part have produced water disputes, but no long-term solutions to the water shortage. Sonora's water situation is likely to deteriorate due to in-migration, land and real estate development, and inefficient use of water resources. All of these challenges provide an opportunity to develop a more resilient and sustainable economy through up-scaling TEIs' research, development and innovation efforts, learning programmes and community outreach, and by seeking complementarities between social and economic goals. For example, focusing efforts on environmental sustainability could bring improvements to the quality of life in low-income neighbourhoods, but also help develop endogenous business development in Sonora, as many examples of frugal innovations in India show.

The ongoing growth-enhancing and equity-seeking initiatives should be better co-ordinated, institutionalised, rewarded and profiled within institutions, local and regional communities, and state and federal governments.

The various efforts by Sonora's TEIs indicate recognition of the key challenges in Sonora, but due to the lack of a long-term vision and strategy, co-ordination, investment and technical challenges remain to be addressed. Despite significant efforts, resources are often spread thinly, and the scope and impact of the activities remain limited. There are many fragmented, sector-specific, uncoordinated initiatives, none of which have the critical mass to generate projects that could have a significant impact at the local and regional level and generate multiplier effects. There is limited evidence of collaboration across the tertiary education sector, and in most cases

(although not all), a lack of focus on the implementation and monitoring of results, which could help evaluate the outcomes of the outreach activities and scale up good practice examples into a system. There is also a lack of co-ordination among activities, programmes and plans between the state government, municipalities and TEIs.

The opportunities for sustainable and extended third mission activities in Sonora's tertiary education institutions lie in building on and scaling up current good practice models that take an integrated, demand-led approach to local economic and social development. Examples include ITSON's community development centre CUDDEC, tourism trails and other initiatives that help widen access to education and address critical environmental challenges. These growth-enhancing and equity-seeking policies and practices should be recognised by the public and private stakeholders as important to Sonora's future. Without public acknowledgement and funding, university-led community programmes are vulnerable to cuts and downsizing when governments and institutional leadership change. Sustainable engagement in these areas will require prioritisation and building critical mass. It will also require closer collaboration and co-ordination, mobilising both private and public sources, and aligning the projects more closely with the federal and state initiatives.

The following measures would promote social, cultural and environmental development in Sonora:

Recommendations for the state and local authorities

- Create a forum for the systematic exchange of information and experience among tertiary education institutions with regard to social, cultural and environmental matters. This forum could organise thematic events with regular information retrieval and exchange facilitated by a dedicated website. The forum would permit the tracking and monitoring of different initiatives and their outcomes, along with the identification of best practices for publication and policy fine-tuning. As a first step, all the social initiatives and projects of tertiary education institutions should be mapped and published in a shared platform. Build on existing examples of good collaboration between universities and local government, most notably ITSON's work in southern Sonora, which could be used as a model for collaborative and joint intervention in other areas.
- Provide incentives in the form of competitive funds (with public and private support) dedicated to supporting "challenge-driven" research to

connect university research to community development. Incentivise "translational research" and frugal innovation to address the critical issues in Sonora.

- Collaborate with the public and private sector to support sustainable environmental and economic development through a comprehensive regional approach, where tertiary education institutions can contribute to the diagnosis of regional environmental conditions and sustainability, the ecological education for the community at large and research solutions to existing environmental problems.
- Mobilise TEIs to contribute to environmental sustainability by encouraging the Commission of Ecology and Sustainable Development of the State of Sonora (Comision de Ecologia y Desarrollo Sustentable del Estado de Sonora, CEDES) to identify and directly engage with TEI researchers with the capacity to contribute to approaches to environmental issues in a multi-disciplinary framework.

Recommendations and other tertiary education institutions

- Improve the monitoring and follow-up of the success and results of the community engagement initiatives, projects and programmes to provide evidence of their impact and to show the return on public investment, building on the example of CUDDEC. The lack of robust and comparable data constrains the visibility and impact of universities' activities. It also makes it difficult to measure the real success or failure of programmes.
- Align initiatives for social, cultural and environmental development with the plans designed by the federal and state authorities in order to have a stronger impact at the local and community level. Collaborate with other tertiary education institutions in the design and implementation of extension activities.
- Engage in long-term community development through collaborative projects between the community and TEIs for developing research and innovation, as well as involving students in community service and experiential learning. These partnerships should empower communities to find their own solutions to the economic, social, cultural and environmental challenges they face, which are local, national and global in nature. Learn from and scale up successful models such as the CUDDEC facility and programmes to enhace TEIs' impact on economic and educational opportunities in low-income communities.

- Mobilise networks for international co-operation on issues related to the social, cultural and environmental development of the region. Engage in projects with other regions in the world that are experiencing similar problems, for example between Mexico, Malaysia, Chile and the US, with an emphasis on South-South collaboration.
- Contribute to the development of the local/regional tourism economy by developing and expanding programmes in entrepreneurship and non-profit management, both in formal degree programmes and through outreach efforts.
- Mobilise and build on existing cross-border collaborations between US universities and colleges and Sonora's TE campuses across the border for urban, energy and environmental planning. For example, develop Geographic Information Systems collaboration focused on environmental/hydrologic conditions in Sonora through bi-national research programmes.
- Develop a co-ordinated, multidisciplinary, cross-institutional research effort to address water access and water quality in the state.
- Develop a process for evaluating the environmental footprint of TEIs' expansion in the state of Sonora. Support both individual and collaborative initiatives to foster university demonstrations of green building practices, including retrofitting old buildings.

Globalisation and internationalisation

To maximise its opportunities in the global economy and to shift towards more inclusive development, Mexico needs to move up the value chain by continuing the process of structural reforms and improving the quality of its education. Sonora, like other Mexican states bordering the United States, is part of the global value chain, but now needs to mobilise its tertiary education to move up the ladder.

In the past few years, Sonora's tertiary education system has made considerable progress in advancing the internationalisation process. Its results and impacts remain modest, however, considering the size of the tertiary education system, Sonora's economic strengths, its proximity to the US and the overall needs of the region. While the internationalisation of

tertiary education institutions embraces student mobility, faculty mobility and curricular development, the only existing mechanism of internationalisation in Sonora's universities and tertiary education institutions is traditional student mobility, which remains limited in number and scope: on average less than 0.1% of the total enrolment. International activities stem from individual initiatives and students' and scholars' interests. This piecemeal strategy is not enough to transform the tertiary education system into an internationally competitive system. In the absence of adequate strategies, Sonora's TEIs are developing international activities that remain marginal to institutional policies and disconnected from institutional plans and priorities. The main challenge is the *ad hoc* nature of institutional policies, which limit the scope of present activities and their synergy within the community, and prevent TEIs from reaping the benefits from globalisation, international co-operation and mobility flows.

Internationalisation strategies and activities can support the transformation of Sonora's tertiary education system only if a systematic approach to the process is implemented by the institutions. For this to happen, TEIs need to develop a comprehensive internationalisation strategy at the institutional level, embracing all the sectors and functions of the university. To overcome the fragmentation, they will need to update their organisational structures, equipping their international relations offices with responsibilities in the overall institutional strategy. In addition to South-North co-operation, Sonora's TEIs should focus on South-South co-operation.

The following measures would help widen and deepen the internationalisation process of Sonora's tertiary education system:

Recommendations for the state government

- In collaboration with the TEIs, design and implement a strategy to promote the state tertiary education system as an international destination for students and actively participate towards this end in different TE international events (see Box 5.4). Take full advantage of the opportunities provided by the Sonora-Arizona and Sonora-New Mexico Commissions to support this goal by developing adequate mechanisms and structures that will foster student and faculty mobility, innovative joint-degree programmes and RDI collaboration.

Recommendations other tertiary education institutions

Restructure organisational strategies for the further advancement and viability of the institutional internationalisation process. To do so, the following steps are recommended:

- Restructure and update procedures in respect to planning, management, budgeting and assessment.
- Develop a comprehensive institutional plan for internationalisation based on the prior assessment of institutional strengths and areas for improvement, and establish institutional priorities for internationalisation activities.
- Create wider awareness within the TE and wider community on the importance and benefits of internationalisation for students, faculty and staff.
- Link internationalisation strategies to policies for innovation, quality improvement and staff development.
- Create the necessary budget conditions for the implementation of the internationalisation programmes.
- Create a supportive academic and administrative culture through the establishment of institutional policies with respect to human resources, legal regulations and management structures.
- Enlarge the functions of the international office in order to co-ordinate the overall institutional strategy under the direction of an internationalisation committee. The office functions should include: the co-ordination of all international activities and programmes including student, faculty and researcher mobility; the internationalisation of the curriculum and research; the recruitment of international students and their interaction with local students and the community; institutional participation in international networks and associations for TE collaboration; the promotion and communication of internationalisation process strategies; the establishment of an institutional database on internationalisation and internationally-experienced faculty; the co-ordination of special programmes of international demand, such as Spanish language programmes.
- Assess and continually enhance the quality and impact of the different aspects of the internationalisation process.

- Encourage staff and faculty internationalisation through the establishment of a reward and recognition scheme for their involvement in international projects.
- Link government policy and institutional initiatives for internationalisation.
- Take advantage of support structures for internationalisation at national, regional and supranational levels such as databases, exchange of experiences and information.

Develop comprehensive programmatic strategies:

- Link internationalisation strategies to innovation, teaching, research and curriculum policies.
- Design and implement the different programmes related to the comprehensive internationalisation strategy that is linked to institutional priorities.
- Integrate an internationalised curriculum into the general curriculum and academic offering, linking this process to the quality assurance system.
- Promote the establishment of international joint-degree programmes as a means of internationalisation of the curriculum, academic model and offering; use international academic models like Tuning to aid curricular design; set up academic offerings in area studies or internationalised general education courses available for all academic programmes in order to develop students' global awareness, or establish a common curriculum cutting across all programmes including international general education; establish research centres or programmes on different regional world areas (North American, Asian and European studies).
- Design strategies to integrate foreign and domestic students in the classroom and in extracurricular activities.
- Promote the use of ICTs for virtual international student mobility.
- Broaden the offering of Spanish courses or special courses for international students; establish a unit in charge of designing, co-ordinating and monitoring the institutional strategy for the teaching of foreign languages across the curriculum to implement a unified teaching methodology, course contents, standardised exams and recruitment of faculty specialised in the teaching of foreign languages.
- Promote internationalisation of research through a better organisational strategy and enhanced availability of financial resources.

- Design a dedicated strategy for international accreditation of programmes.

Capacity building for regional development

Federal and state policies encourage government-university-industry collaboration. Sonora has established "connection councils" at the state, regional and institutional levels. While the machinery is in place, there is now a need to identify regional needs and development trajectories, and establish adequate incentives and monitoring systems.

The Federal Government and the state government of Sonora have both acknowledged the key role that the tertiary education institutions can play in economic and social development. Federal and state policies such as the National Development Plan 2007-2012 (PND), the Sectoral Plan for Education (PRONAE) and Sonora's State Education Programme 2010-2015 (PEE) have emphasised the importance of TEIs' third mission and have encouraged the formation of "connection councils" as a mechanism to build capacity for TEIs' engagement activities. In Sonora, connection councils have been established at the state, regional and institutional levels to promote education-government-business links. Sonora was one of the first states in Mexico to establish a state-level connection council, COVES (*Consejo de Vinculación del Estado de Sonora*), in 2011. Connection councils have been replicated in eight regions and most of Sonora's TEIs.

While machinery is now in place for long-term collaboration, it remains necessary to develop detailed knowledge of the needs and opportunities of Sonora and the TEIs' research and education portfolio so that when opportunities arise, the development agencies can identify the appropriate institution or part of an institution to be engaged in the negotiation process. Building on the existing expertise, such as ITSON's Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*), could facilitate assessing regional needs and development trajectories.

Federal government and state government could also consider introducing a funding and monitoring mechanism to support university/TEI business and community engagement. Internationally, such mechanisms include the Higher Education and Innovation Fund for England (HEIF) and

the associated monitoring system the Higher Education and Business and the Community Interaction Survey (HEBCIS). In the US, the Kentucky Regional Stewardship Program provides an example of a programme promoting regional or state-wide economic and social development through university engagement. This programme offers infrastructure funds to support the development and maintenance of engagement, regional grant funds for comprehensive university efforts to build intellectual capacity in priority areas and the stewardship initiatives pool for strategic initiatives.

The issue of incentives is also important at the individual level. Currently, the criteria for staff recruitment and promotion in Sonora's TEIs do not sufficiently encourage activities related to local engagement and few incentives exist to encourage regional engagement of tertiary education staff. TEIs in Sonora could find inspiration from the University Rovira i Virgili in Spain and the Universiti Sains Malaysia that have introduced a "Research and Academic Staff Agreement" and a "3-track promotion exercise" respectively to acknowledge research, teaching, and community engagement or industry collaboration to reward and incentivise staff.

The following measures would enhance capacity building for regional development:

Recommendations for the federal government

- Strengthen institutional capacity of TEIs to ensure relevance of education and application of knowledge to economic and social needs.
- Allocate a special budget of the federal government to promote specific linkages in addition to existing initiatives. The UK HEIF funding could provide inspiration.
- Promote a model of facilitators or managers and other personnel of connection councils and units responsible for translating business issues to the academic agenda and generating specific collaboration projects.
- Analyse existing regulations and propose improvements in legal and institutional framework that facilitate connection between academia and industry.
- Evaluate the National System of Connection continuously; establish indicators to measure performance and impact to ensure that the system functions properly.
- Establish and promote incentive schemes that give priority to research that serves the needs of the regional/local domestic industry.

Recommendations for the state government

- Strengthen the co-ordination function of the state-wide COVES in order to better identify regional priorities and more efficiently apply the resources and expertise of regional connection councils.
- Develop incentives for TEIs to engage in regional development via regional connection councils. The Kentucky Stewardship Program could provide an inspiration.
- Conduct surveys of TEIs to assess their experiences and challenges participating in regional councils in order to improve collaboration and co-ordination with the productive, service and social sectors.
- Incentivise TEIs to develop a common set of measures to assess outputs and outcomes of their regional engagement.
- Provide incentives to TEIs to improve the connection council's professional capacity for regional engagement.
- Strengthen the engagement of TEIs as institutional partners in developing and implementing state plans and strategies.
- Encourage companies to work collaboratively with TEIs in areas of mid- and long-term labour needs planning, technology development and application.
- Building on the existing successful models, develop capacity in regional data gathering and sharing regional data repositories as a basis for identifying regional priorities.

Recommendations tertiary education institutions

- Develop internal incentives for faculty/researchers to engage in specific committees established under connection councils.
- Document the present linkages and publicise them within the region and within the institutions to raise the profile of tertiary education as a region builder.
- Assess needs for professional capacity building within the connection council and invest in strengthening its professional capacity building.
- Use regional connection councils as a platform to strengthen co-ordination among local and regional TEIs and to promote a "common tertiary education vision" to policy makers.

- Utilise the experience of individuals and groups within TEIs who are actively involved in providing advice to regional agencies to assist the academic leadership in guiding the institution's policy and practice as it pertains to regional engagement.
- Review existing efforts in developing methodology for evaluation of the TEIs-industry sector linkage, modify and adopt common measures.
- Design and implement tangible rewards and incentives, including new employment and human resources management practices, in support of individual and institutional regional engagement. Review staff recruitment, hiring and reward systems so as to include the regional development agenda. 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.
- Through feedback to COVES and regional councils, contribute to the improvement of co-ordination and management of regional links.
- Educate faculty/staff about the benefits of regional engagement, and maintain pressure for mainstreaming of regional engagement into research, teaching and service functions
- Utilise existing expertise in regional economic analysis and modelling (e.g. ITSON's Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación)) as a basis for collaboration with government, productive and social sectors in assessing regional needs and development trajectories.

Chapter 1.
Human capital development, labour market and skills

This chapter examines how universities and other tertiary education institutions in the state of Sonora contribute to opportunities for study and the achievement of educational credentials. The chapter also addresses whether the skills and competencies offered in tertiary education institutions are relevant to the needs in the regional economy and identifies the strengths and areas for improvement in the tertiary education system. The chapter concludes with a series of recommendations to support sustainable local and regional development, and to enhance the role that the state government, together with the tertiary education institutions and local and regional stakeholders, can play in improving human capital and skills development in Sonora.

Introduction

Many analyses of the global division of work in the knowledge economy assume that some economies will continue to play a role carrying out routine tasks in manufacturing and services while others will emphasise creativity, research and innovation. One of Mexico's wealthier states, Sonora is moving against this stereotype, developing a strong base in middle-level technical skills, particularly in advanced manufacturing. The question is whether Sonora, through its tertiary education institutions (TEIs), will be able to expand on this strength in two directions to: *i)* improve the life chances of the substantial portion of the Mexican population by raising average educational attainment; and *ii)* enable Mexican workers and Mexican enterprises to move up the value chain, benefitting from the opportunities for process and product innovation afforded by the presence of companies using advanced technologies.

The approach to human capital and skills development taken by the state of Sonora in order to broaden and deepen the impact of tertiary education in the region has emphasised diversification of institutions and decentralisation of technical education opportunities throughout the state, including in historically under-served rural areas. Diversification also applies to subject matter, which now includes more applied scientific and technical programmes.

The state of Sonora has committed significant public resources to meeting the skills demands of the firms in the FDI-based manufacturing industries (the *maquila* industries) by increasing and expanding technical institutes. After a period of stagnation produced by competition with China for FDI and a recession-induced slump, the *maquila* sectors are once again growing throughout Sonora, with new business locations and increasing employment. In the state capital of Hermosillo, for example, 330 *maquiladoras* employ over 100 000 workers. The need to fill employer demands for more sophisticated workforce skills for the *maquila* industry is largely responsible for the differentiation of Sonora's tertiary education sector: a wide range of technical institutes have emerged in Sonora to train the workforce to fill *maquila* jobs. While 43% of *maquila* enterprises are in low tech sectors, the majority of FDI employers require workers with some – and sometimes, advanced – skills. So, although the *maquila* sector has an image of low-tech, routine manufacturing, many firms located in Sonora, such as those in the auto and aerospace industries, require considerable technical skills from their workforce.

While the state efforts to provide for the direct skills needs of the FDI-based industries are commendable, a too narrow skills focus does not serve

Sonora's population and economy in the long run. To move up in the value chain Sonora needs to continue its efforts to raise the overall education attainment levels of its population and to enhance the flexibility of population to adjust to the changes in the labour market. Other critical issues include the need to invest in the new generation of university faculty and to offer advanced technical training for employees. Moving up the value chain will require investment in the next generation of tertiary education faculty and researchers, as the current generation is ageing and will retire. Although there is evidence in Sonora of capabilities in research and development, and in areas related to advanced production, such as logistics and supply chain management, there is little systematic strategic educational planning to build these capacities. For example, among the most critical issues facing Sonora's universities is a shrinking cadre of postgraduate research and teaching faculty working full time at the university level. Without investment in faculty researchers and supervisors of Masters and PhD students, the possibilities for building higher level knowledge economy capacities will be constrained. There is also a need to provide advanced technical training for Mexican employees not employed in companies taking advantage of foreign direct investment incentives, whose employees already receive this training. Here the goal should be to devise a curriculum to train Mexican business executives and encourage the skill development and capacity that can build the role of Mexican enterprises in global supply chains in advanced technology sectors.

Within this context Sonora's universities and other tertiary education institutions can contribute to the human capital and skills development in Sonora by:

- Widening access to and success in education for the youth and adult population of the region, thus increasing the more generally-skilled workforce (and demand for more sophisticated products).
- Attracting talent to and retaining talent in the region, including students and highly-qualified faculty and researchers. This includes talent across a wide range of fields.
- Producing graduates with knowledge and skills relevant to the region's economy. This may occur through academic programmes, internships and other programmes that link work experience with formal study.
- Contributing to the development of an economy that will employ graduates and retain and attract an educated population. This includes entrepreneurial and executive education, strategic co-operation to foster business development and provision of critical information on economic trends in order to inform public and private investment.

With these objectives in mind, this chapter examines the following questions:

- Do the universities and other tertiary education providers in Sonora offer adequate learning and training opportunities to the local population? How can educational access be widened to include a broader segment of the regional population?
- Are universities and educational programmes adequately aligned with the skill needs of the local economy? Do they support entrepreneurship in the region?
- What lessons can be learned from experience in other regions of Mexico and internationally that can advance the higher education goals in the region?

1.1. Tertiary education expansion

This section outlines the tertiary education expansion in Sonora, by first providing a brief overview of the two key reasons for the growing demand for tertiary education: continuing industrial demand for skills and the increasing ability of Sonora's families to see the value of and invest in tertiary education. It then highlights the progress that Sonora has made in tertiary education sector by improving the outcomes in pre-university education, diversifying the system and reducing some of the geographical barriers to education. It identifies some challenges for further expansion, such as the quality of school education and the pathways between school and tertiary education and between technology institutes and universities. Finally, it provides an example of a long term collaborative effort to widen access and improve success in education in Texas. The key message is that Sonora needs to continue its efforts to widen access and increase education attainment of its population to make improvements in the local and regional economy and to enhance the flexibility of the population to adjust to changes in the labour market.

Growing demand for tertiary education

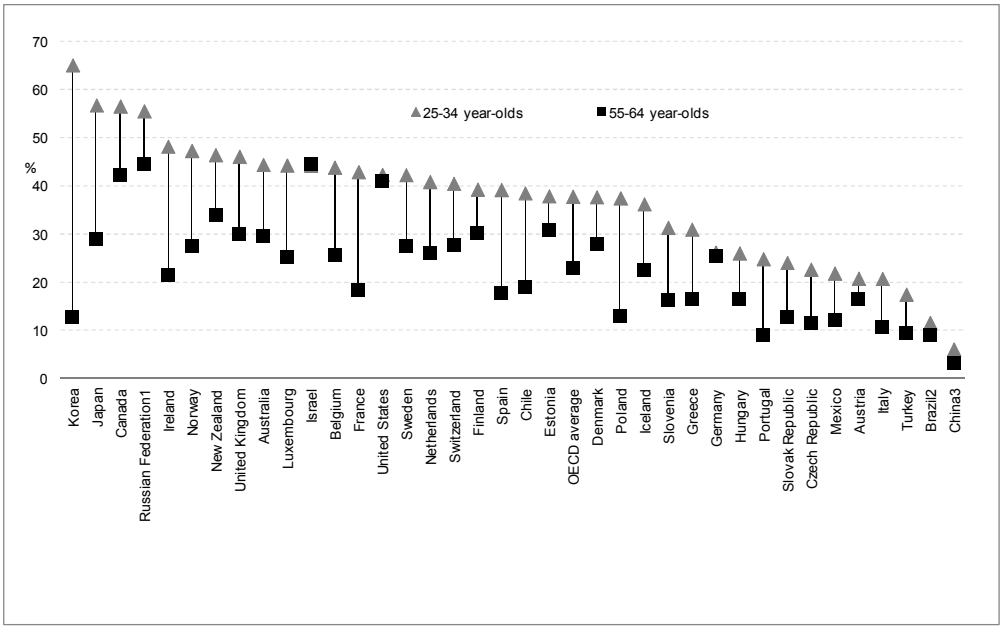
Sonora stands out in Mexico as a state with an increasing demand for tertiary education emerging from the continuing industrial demand for skills and the increasing ability of families to see the value of increased education and finance educational opportunities. To a large extent the positive educational trends are related to employment opportunities for workers with some educational credentials because of Sonora's high concentration of *maquila* industries. The FDI-driven expansion of jobs and production in

Sonora as well as a growing number of jobs in service and construction sectors also attract migrants from other states in Mexico.

The long term demographic transition in Mexico and Sonora caused by the slower population growth will have implications for the labour supply, dependency patterns and tertiary education expansion. Sonora's population will continue to grow since its population is young – half the regional population is 25 years old or younger and 29% under the age of 15 – (Sonora's Regional Steering Committee, 2012), but the pace of the growth is slowing down because of the declining fertility rates.[1] The slowing pace of population growth has been manifested in decreasing migration into the US, gradually increasing wages for many Mexican households, and in the increased ability of Mexican families to invest in children's education. These patterns are particularly visible in Northern Mexico, including Sonora.

Figures for Mexico's tertiary education participation and attainment rates show that, despite progress over the past decades, there is still much room for improvement. In 2010, 22% of the Mexican population aged 25-34 had a tertiary education degree, compared to 12% among the 55-64 year-olds, showing the overall progress that Mexico has made in educating its young populations (compared to OECD averages 38% and 23% respectively) (OECD, 2012a) (see Figure 1.5). The net entry to tertiary education in Mexico remains below the OECD average (33% vs. 62%). In addition, the 2010 graduation rate for Mexico's undergraduate degree programmes, based on the same year's entry rate, was 20%[2], compared to the OECD average of 39% (OECD, 2012a).

Figure 1.1. Percentage of population, by age group, that has attained at least tertiary education in selected countries (2010)



1. Countries are ranked in descending order of the percentage of 23-34 year-olds who have attained at least tertiary education. The year of reference for the Russian Federation is 2002, Brazil 2009 and China 2000.

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.

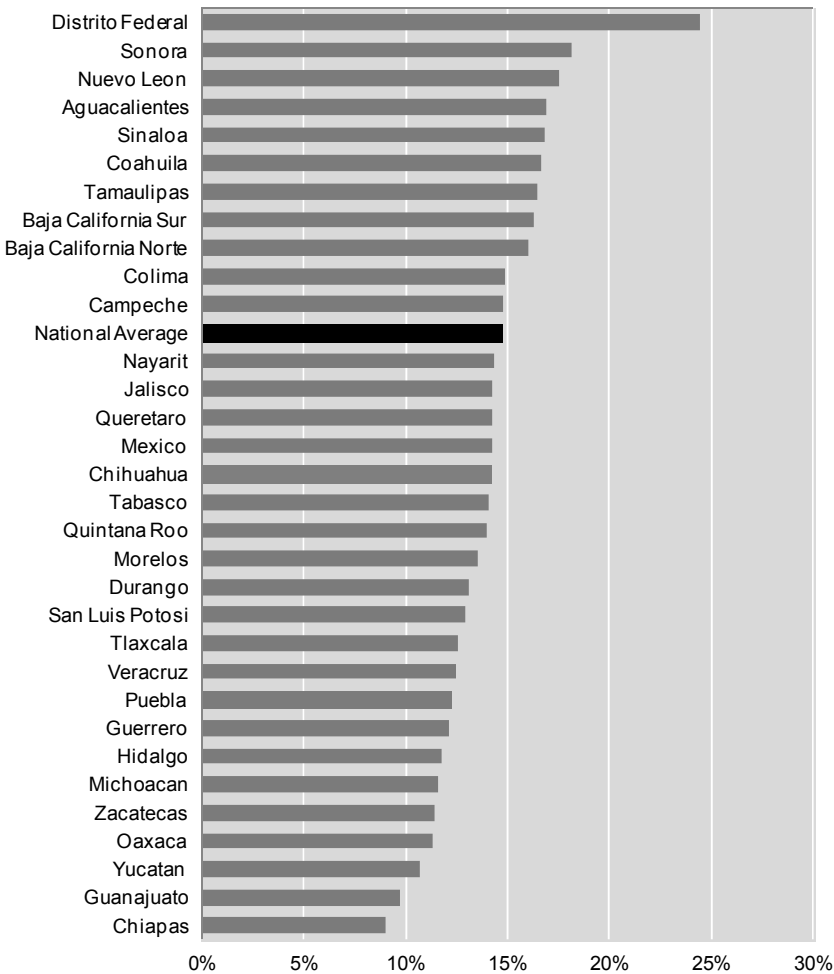
Source: OECD (2012a), *Education at a Glance 2012: OECD Indicators*, OECD Publishing, *http://dx.doi.org/doi: 10.1787/eag-2012-en.*

Progress in tertiary education through improvements in pre-tertiary education and sector diversification

Sonora has made great strides in tertiary education in recent years. It is the leading state in Mexico with the highest proportion of work force with tertiary education after the Federal District (see Figure 1.2). In 2010, 30% of population aged 25-34 years and 15% among 55-64 year olds had tertiary education qualifications, showing the progress Sonora has made in educating its population, far above the national average and right after the Federal District (37%) and the state of Sinaloa (33%) (see Figure 1.3). Also Sonora's tertiary education enrolment rate is higher than the national

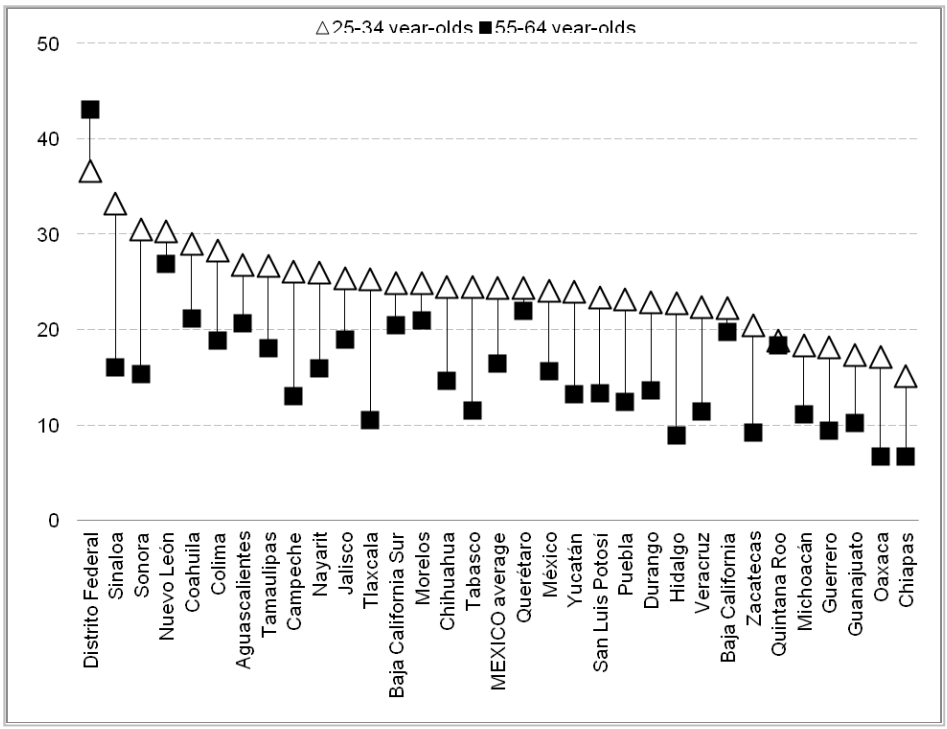
average (37% vs. 34.6% in 2009-2010), (Gobierno Federal, 2011; OECD, 2012a).

Figure 1.2. Tertiary education attainment rate as a percentage of the labour force in Mexican states (2007)



Source: OECD (2012b), *OECD Territorial Reviews: Chihuahua, Mexico 2012*, OECD Publishing, : *http://dx.dio.org/10.1787/9789264168985-en*, based on OECD (2011), Regional Database, OECD.Stat, *http://stats.oecd.org/*, accessed 22 June 2011.

Figure 1.3. Population with tertiary education, Mexican states (2010)

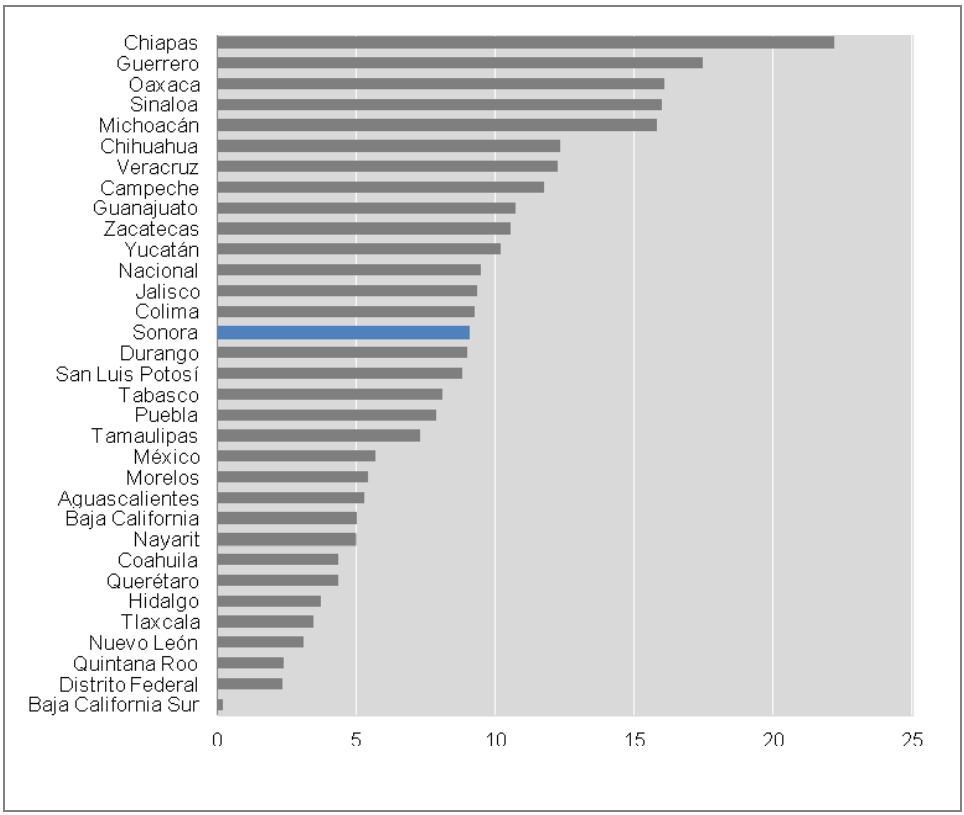


Source: Based on INEGI (Instituto Nacional de Estadística y Geografía) (National Institute of Statistics and Geography) (2011b), Censo de Población y Vivienda de 2010 (2010 Population and Housing Census), *www.censo2010.org.mx*.

The progress in tertiary education is associated with the expanding access to education at all levels in Sonora. At 5%, Sonora's illiteracy rate is the lowest among Mexican states. 96% of the population aged 6-14 was attending school in 2010, an increase of 4% from 1990. Among students who go on to secondary and then to postsecondary education, completion rates are good in the Mexican context and improving. Upper secondary school completion in Sonora is ranked 1st among Mexican states at 75% and is higher than the national average rate of 63%. Every third secondary school graduate in Sonora goes on to a postsecondary educational programme (compared with every fourth in Mexico) (INEGI, 2011a). While these statistics should be treated with caution because of the lack of a regional information system on educational attainment and because migration into Sonora from other regions in Mexico may include a

population that has had limited access to education, they provide a positive picture of Sonora's education system.

Figure 1.4. Completion of basic education in Mexican states (2006/2007)



Source: OECD (2012b), *OECD Territorial Reviews: Chihuahua, Mexico 2012*, OECD Publishing, *http://dx.doi.org/10.1787/9789264168985-en*, based on INEE (Instituto Nacional para la Evaluación de la Educación) (National Institute for Education Assessment) (2008), *Estadísticas Continuas del Formato 9111*, Secretaría de Educación Pública and Instituto Nacional para la Educación Educativa, Mexico.

Sonora has widened participation in tertiary education through sector diversification and reducing geographical and financial barriers, which allow it to cater to the needs of an increasingly diversified student population. Over the past ten years, tertiary education enrolment in Sonora has increased by 31%, reaching over 100 200 students in the 2011-2012 academic year (SEC, 2012). The state of Sonora has been a leader in Mexico

in providing assistance to needy students through a public sector loan programme, the Sonora Student Loan Institute (*Instituto de Credito del Estado de Sonora*, ICEES). Table 1.1 shows the differing shares of the population with tertiary education between municipalities in Sonora. (For more on widening participation, see chapter on Social, Cultural and Environmental Development.)

As elsewhere in Mexico, the technological education sector in Sonora has gone through a process of expansion and is becoming an important actor in Sonora's skills development system (see Annex 1.B.1). The expansion of technological institutes has been driven by the continuing industrial demand for skills. There has been a 16% increase in students trained in the technological institutes in the last four years, indicating a growing market for practice-oriented degree programmes. While the technological institutes are often centrally-administered, they have some degree of flexibility in the composition of the programmes, which allows them to serve the needs of the local population. Technological institutes also play an important role in widening access because they mainly serve first generation students.

The expansion of technological education has also been driven by a commitment to widening participation and to reaching rural and indigenous populations with historically poor access to tertiary education. A key factor in the enrolment for many students in remote and rural areas has been the availability of a technological institute close to their home. Many of these institutes are embedded in their local communities. Locally-oriented tertiary education institutions, such as the Yaqui Valley Technological Institute (see Box 1.1) , are serving Sonora's indigenous population, which accounts for about 6% of the population and is mainly concentrated outside of urban areas where higher education has historically been provided.

Table 1.1. Percentage of population with tertiary education, municipalities of Sonora by age group (2010)

Municipality	25-34 (%)	55-64 (%)	Municipality (cont.)	25-34 (%)	55-64 (%)
Aconchi	11	2	Magdalena	25	14
Agua Prieta	14	9	Mazatán	11	4
Alamos	10	3	Moctezuma	27	9
Altar	9	3	Naco	11	7
Arivechi	12	2	Nácori Chico	3	2
Arizpe	10	3	Nacozari de García	19	11
Atil	16	2	Navojoa	26	10
Bacadéhuachi	8	2	Nogales	20	14
Bacanora	4	6	Onavas	6	0
Bacerac	10	4	Opodepe	6	4
Bacoachi	9	5	Oquitoa	10	0
Bácum	14	3	P.E. Calles	10	7
Banámichi	14	7	Pitiquito	20	6
Baviácora	10	4	Puerto Peñasco	20	14
Bavispe	4	2	Quiriego	2	3
Benito Juárez	14	5	Rayón	15	1
Benjamín Hill	13	5	Rosario	9	3
Caborca	19	11	Sahuaripa	12	3
Cajeme	31	18	San Felipe de Jesús	16	19
Cananea	21	19	San Ignacio Río Muerto	12	2
Carbó	8	5	San Javier	14	3
Cucurpe	7	2	San Luis Río Colorado	17	10
Cumpas	20	3	San Miguel de Horcasitas	2	1
Divisaderos	16	0	San Pedro de la Cueva	9	4
Empalme	21	7	Santa Ana	23	7
Etchojoa	16	6	Santa Cruz	4	2
Fronteras	14	10	Sáric	5	1
Granados	14	3	Soyopa	9	3
Guaymas	25	12	Suaqui Grande	12	0
Hermosillo	36	30	Tepache	6	0
Huachinera	8	0	Trincheras	8	1
Huásabas	14	4	Tubutama	6	1
Huatabampo	19	7	Ures	19	6
Huépac	19	4	Villa Hidalgo	8	3
Imuris	12	7	Villa Pesqueira	10	3
La Colorada	11	1	Yécora	6	1

Note: These numbers may present discrepancies with those provided by the Ministry of Public Education of México, given that for a census is not mandatory to provide evidence of the degree achieved.

Source: INEGI (Instituto Nacional de Estadística y Geografia) (National Institute of Statistics and Geography of Mexico) (2011b), Censo de Población y Vivienda de 2010 (2010 Population and Housing Census), *www.censo2010.org.mx*.

Box 1.1. Yaqui Valley Technological Institute

Established in 1975, the present name of *Instituto Tecnológico del Valle del Yaqui* was adopted in 2005. The Yaqui Valley Technological Insitute is located in Bacúm at the lower basin on the Yaqui River in the Southern part of Sonora. The Yaqui Valley Technological Institute's mission is to train high level professionals that meet the national and international standards in scientific and technological fields in order to contribute to the economic, social and productive development of its surroundings. The Yaqui Valley Institute's vision is to become a top quality tertiary education institution that strengthens the Yaqui Valley's position and performance. Its education and training provision is closely aligned with the needs of the Yaqui Valley, by developing human capital and developing new technologies relating to environmental preservation. The institution serves young people in the area and graduated 1 187 students in 2011. Some 30% of the student population is native Mexicans.

Source: Garcia Martinez, R. (2012), "Instituto Tecnológico del Valle del Yaqui", presentation to the OECD Review visit, Hermosillo, 13 March 2012; Garcia Martinez, R. (2011), *Instituto Tecnológico del Valle del Yaqui*, Secretaria de Educación Pública, *www.dgest.gob.mx/archivos/irc/informerendicion2010/Sonora/Valle%20del%20Yaqui%20IRC%202010.pdf.*

The UES (*Universidad Estatal de Sonora*) serves the special higher education needs of students coming from culturally-distinct or low-income communities and provides academic, social and financial support to encourage access to and success in tertiary education. UES has campuses in five municipalities including Navojoa and Benito Juarez, where 70% of the population is made up of Indian Mayo people, and provides a range of financial support mechanisms for students. UES has developed a competency-based learning model that provides employability skills and focuses on fields relevant to local communities. UES plays an important role in providing educational opportunities to the local population, but faces significant challenges due to its low per-student funding (for more on UES, see Box 4.4).

Challenges for further expansion

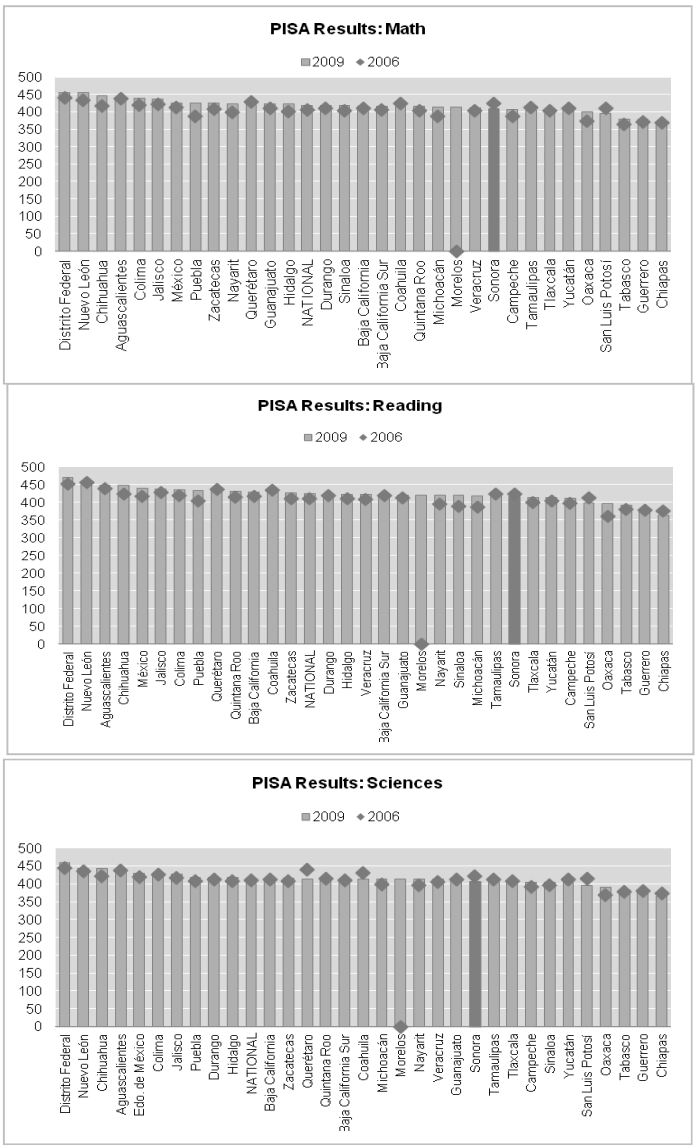
While Sonora's tertiary education system has made progress in expanding opportunity, challenges remain both in consolidating the gains that have been made, continuing and accelerating the progress and improving the quality and efficiency of education. In view of international competitiveness, Sonora's tertiary education enrolment rate is above the national average (37% vs. 34.6%), but still lagging behind the OECD average (62%) (Gobierno Federal, 2011; OECD, 2012a). Also the overall

educational attainment levels remain low, because of differentiated access to educational opportunities by age, skills and socio-economic status and a continued bifurcation in educational attainment, with a large portion of the state population only attaining a primary school education and because of the limited access of adult population to education. Partly because of school failure a large number of youth are outside of the labour market, education and training. According to some media reports, in Sonora around 33 000 12-29-year-olds neither study, nor work. Sonora's unemployment rates remain consistently higher than the national average, while activity in the informal sector is close to the high national rates.

Access to and progress in tertiary education is largely determined by outcomes in preceding levels of education. A major weakness in the Mexican system is the low completion rate in upper secondary education. In 2010, Mexico had a 47% rate of upper secondary attainment, one of the lowest attainment rates in the OECD and below the OECD average of 84% (OECD, 2012a). In Sonora, the secondary attainment level is higher than the national average, but still low by international comparison. In addition, Sonora continues to feature drop-off between primary school (grades 1-9) and secondary school INEGI, 2011b) that impacts subsequent educational participation. In order to improve access at the secondary school level, opportunities for secondary school students to combine work and education should be created. For the very-low-income population, family support may take precedence at an early age. While young people may want to continue their education, full-time schooling may not be an option. Innovative programmes to combine work and school may increase the level of educational attainment in the broader community.

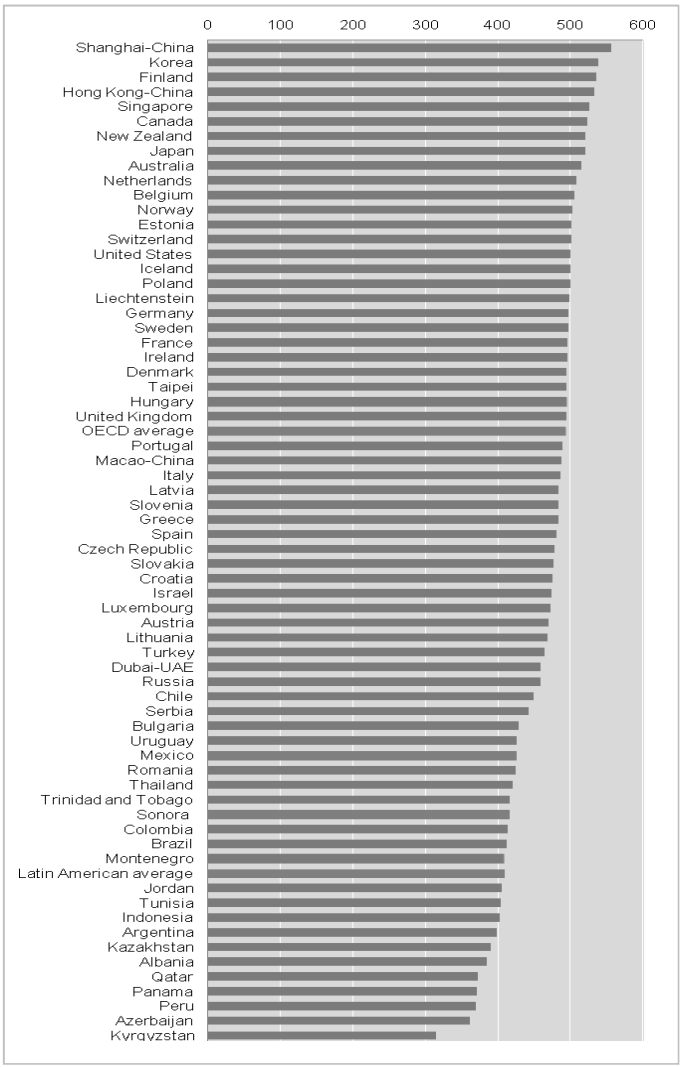
Weak learning outcomes at Sonora's schools are a cause of concern and call for sustained efforts to improve the quality of education. While Sonora is one of the best performers – No 3 in primary education and No 1 in secondary education in 2010 – in the national ENLACE examinations (*Evaluación Nacional del Logro Académico en Centros Escolares*) which test students' aptitudes in Spanish, geography and mathematics, the PISA results for Sonora show that there is much room for improvement: the learning results for Sonora's students are below those of the national average, which in turn in international comparison remain very low. In the 2009 PISA results, Sonora scored 410 in mathematics, 407 in science and 415 in reading compared with the national averages of 419, 416 and 425 respectively (Compara tu Escuela, 2012 and INEE, 2010).

Figure 1.5. PISA results in Mexican States (2009)



Source: OECD (2012b), *OECD Territorial Reviews: Chihuahua, Mexico 2012*, OECD Publishing. doi: 10.1787/9789264168985-en, based on INEE (Instituto Nacional para la Evaluación de la Educación) (National Institute for Education Assessment) (2010), *México en PISA 2009* (Mexico in PISA 2009), INEE, México, D.F., *www.inee.edu.mx/index.php/component/content/article/4834*.

Figure 1.6. PISA 2009 mean scores for participating countries



Source: OECD (2012b), *OECD Territorial Reviews: Chihuahua, Mexico 2012*, OECD Publishing, *http://dx.doi.org/doi: 10.1787/9789264168985-en,* based on INEE (Instituto Nacional para la Evaluación de la Educación) (National Institute for Education Assessment) (2010), *México en PISA 2009* (Mexico in PISA 2009), INEE, México, D.F., *www.inee.edu.mx/index.php/component/content/article/4834*.

In Sonora, the problem of insufficient preparation is recognised by most tertiary education institutions, which as a sector has consistently higher dropout rates than the national average. A recurrent concern among faculty and administrators was the inadequate preparation of students. Interviews with faculty and administration at UES, an institution that particularly focuses on the educational needs of students who must work to support themselves while attending college, indicate that approximately 25% of the incoming students are not prepared for tertiary education. This places an additional burden on tertiary education institutions to provide remedial education, decreases overall graduate performance and leads to high dropout rates in tertiary education.

The state education authorities in Sonora need to continue to work on improving the quality of education in Sonora and to reduce the equity gaps in basic and secondary education. Continuous efforts are necessary to establish programmes to improve the preparation of teachers in the schools and to ensure that all primary and secondary students (and their families) get the information they need to prepare for tertiary education. Teacher and curricular evaluation at the state level, with incentives for superior performance, may begin the difficult process of improving educational performance at the primary and secondary levels and thus creating the potential for higher performance at the postsecondary level. At the same time, universities and other tertiary education institutions can reach out to local schools to help improve the quality of teaching as well as to raise aspirations and academic performance of students.

Improving access, retention and completion in Sonora's tertiary education also requires better functioning pathways between schools and tertiary education institutions, and between technology institutes and universities. The effectiveness of Sonora's education system would benefit from universities recognising courses completed by students in technological institutes as fulfilling some of the requirements for a university degree. This action would significantly help widen tertiary education access, as a substantial number of students at technological institutes are from low socio-economic backgrounds. In Sonora, pathways and bridges have been developed between training in technical institutes and universities with opportunities for students to utilise technical degrees from the technological institutes as the basis to move to universities to receive bachelors and masters degrees. However, there appears to be no systematic evaluation of how these pathways and bridges are used and how they could be made more effective. More functional pathways would require greater transparency and the development of credit recognition schemes, course and programme articulation agreements, increased support for joint and collaborative study programmes and clear and enforceable policies related to

credit transfer between the technological institutes and universities. Access to education should also be inclusive of experiential learning gained in enterprise settings and for-profit training institutions.

Benchmarking with international experience: widening access in Texas, United States

International examples underscore the need for long-term collaborative efforts to widen access and improve success in education. In El Paso, Texas over 80% of the population is self-identified as Hispanic compared to about 25% for the state of Texas. Almost three-quarters of the population speak a language other than English at home. There is a high concentration of low-income people, many with low educational attainment. When children from these households enter school they face significant challenges including: *i)* remaining in school; *ii)* learning the skills necessary to increase their employability and productivity and *iii)* obtaining a college degree. The El Paso's tertiary education institutions, under the leadership of the University of Texas at El Paso, have taken concrete measures to widen access to tertiary education. In collaboration with the public and private sector, stakeholders they have formed the El Paso Collaborative for Academic Excellence and made notable progress in raising educational attainment. Underlying individual institutional efforts is the College Readiness Consortium, which connects efforts in primary and secondary education institutions in all school districts to tertiary education programmes (see Box 1.2).

Box 1.2. El Paso: widening access through broad-based, long-term co-operation

The ability of the HEIs to widen access and increase educational attainment in the region depends on preparation in primary and secondary education. The El Paso Collaborative for Academic Excellence (est. 1991) is a multi-stakeholder public-private effort to improve educational attainment and retention from the first year in school through college or university programmes. The collaborative has members from the business community, all levels of educational institutions, the public sector and NGOs. The goal is to make systematic changes in educational policy and curriculum in all of the 12 El Paso County School Districts to produce measurable results in performance and bridge the gap between ethnic and socio-economic groups.

Box 1.2. El Paso: widening access through broad-based, long-term co-operation (continued)

The approach has been successful in improving the performance of Hispanic students, who make up the largest proportion of low-income students and for whom English is usually a second language. Test results for Hispanic students in the 11th grade (a year before college entry) show improvement from the 33rd percentile in 1993 to the 72nd percentile in 2008. Hispanic students show increases in enrolment in science, technology, engineering and mathematics, and a graduation rate of 76.7%, the highest among school districts in the State of Texas. Hispanic students make up 89% of the student population in the El Paso school district. Improvement in their achievement has a significant effect on the overall performance at schools.

HEIs benefit from this collaboration. El Paso Community College (EPCC) is the primary entry point to tertiary education for low-income students. As a result of efforts to widen access and increase educational attainment (*e.g.* through grants to improve remedial education), enrolment rates increased by 35% and graduation rates by 92% (2002-08). Programmes to increase college readiness and success in a four-year degree programme have resulted in improvements in mathematics, reading and writing measures. The percentage of students assessed as college-ready improved from 35% in 2003 to 74% in 2008. EPCC's Early College High School Programme enables high school students to obtain credit for college level courses reducing the time and money needed to complete a college degree.

The University of Texas at El Paso (UTEP) benefits from better preparation for tertiary education and has undertaken its own programmes to widen access and improve completion rates. 70% of the UTEP students come from the region. UTEP has increased its enrolment by 40% since the late 1990s. The majority of the increase has been in Hispanic students (from below 40% of the student body to 75%). Degrees awarded have risen from about 2 000 in the late 1990s to 3 500 in 2008. About 10% of students are Mexican citizens who cross the border to attend classes at UTEP.

UTEP has made tertiary education more affordable and accessible to students who have to work to attend college, by changing course scheduling, enabling students to borrow books and paying for their education. This support is important given the low-income levels of the college age population and their households, their lack of familial experience with tertiary education, their need to combine work and study and propensity to avoid borrowing to invest in tertiary education.

Source: OECD (2010), Higher Education in Regional and City Development: The Paso del Norte Region, Mexico and the United States, OECD Publishing.
http://dx.doi.org/10.1787/9789264088887-en.

1.2. Quality and relevance of tertiary education

This section provides and overview of the quality and relevance of Sonora's tertiary education, by briefly outlining the key issues: lack of capacity to identify long term needs, lack of robust data, gaps in curricula and difficulties in retention and completion. It highlights the general lack of labour market relevance of tertiary education programmes, despite the widespread use of student internships. Finally, it highlights Waterloo University's Co-operative Education Programme that can inform Sonora's tertiary education institutions when they are building closer, more systematic links with the world of work.

Key challenges in tertiary education

The inter-dependence between regional economies and tertiary education systems means that their alignment is an issue of increasing importance. This issue has received increasing attention in Sonora, which can be seen in the growth of the technological education sector and the examples of workforce training schemes serving the *maquila* industry. The following conclusions can be made about the alignment of tertiary education in Sonora to regional labour markets:

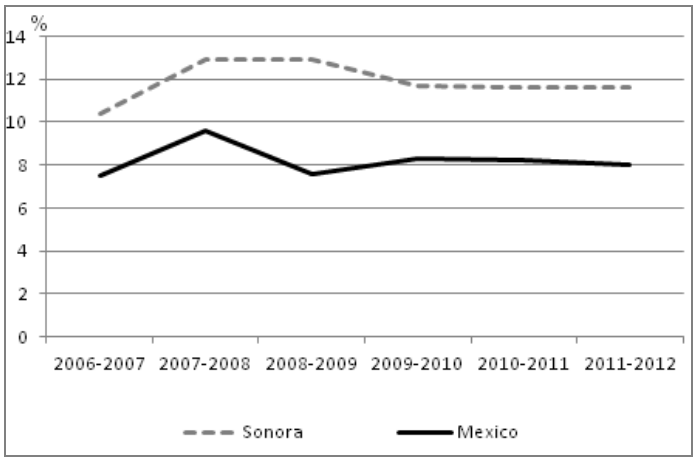
- There is limited capacity to identify long term labour market needs and trends on a regional basis. Most evidence about labour markets addresses tightly focused industry sectors (automotive, aerospace, agriculture) and short term skills demands of the *maquila* industries.
- There is a lack of robust data about student progress and achievement, as well as their labour market outcomes (*e.g.* employment and mobility after graduation, salary and career paths) and graduate destinations (where graduates find jobs).
- In general, tertiary education curricula remain oriented either in narrow skills or qualifications rather than based on wider skills and competencies that can be generalised. In universities a traditional academic model dominates, with a strong teacher-centred focus. There is limited participation of employers in curriculum and course design, with the exception of some technological institutes. In recent years, institutions like ITSON and UES have adopted competence-based curricula but there is little information on how this has been implemented across different fields and what impact the change has had on the learning outcomes of students.

The general conclusion that can be drawn is that not enough robust data is available about state-level and regional labour markets in Sonora to better

align tertiary education programmes with the long term regional needs. Part of the problem stems from the large number of institutions and the decentralised nature of the tertiary education system in Sonora as well as the strong focus of the state government to address the immediate skills needs of the FDI-driven industries. These characteristics provide benefits and strengths for Sonora, but may have a negative impact on the ability of tertiary education institutions to address the needs of Sonora's population and labour market in the long run.

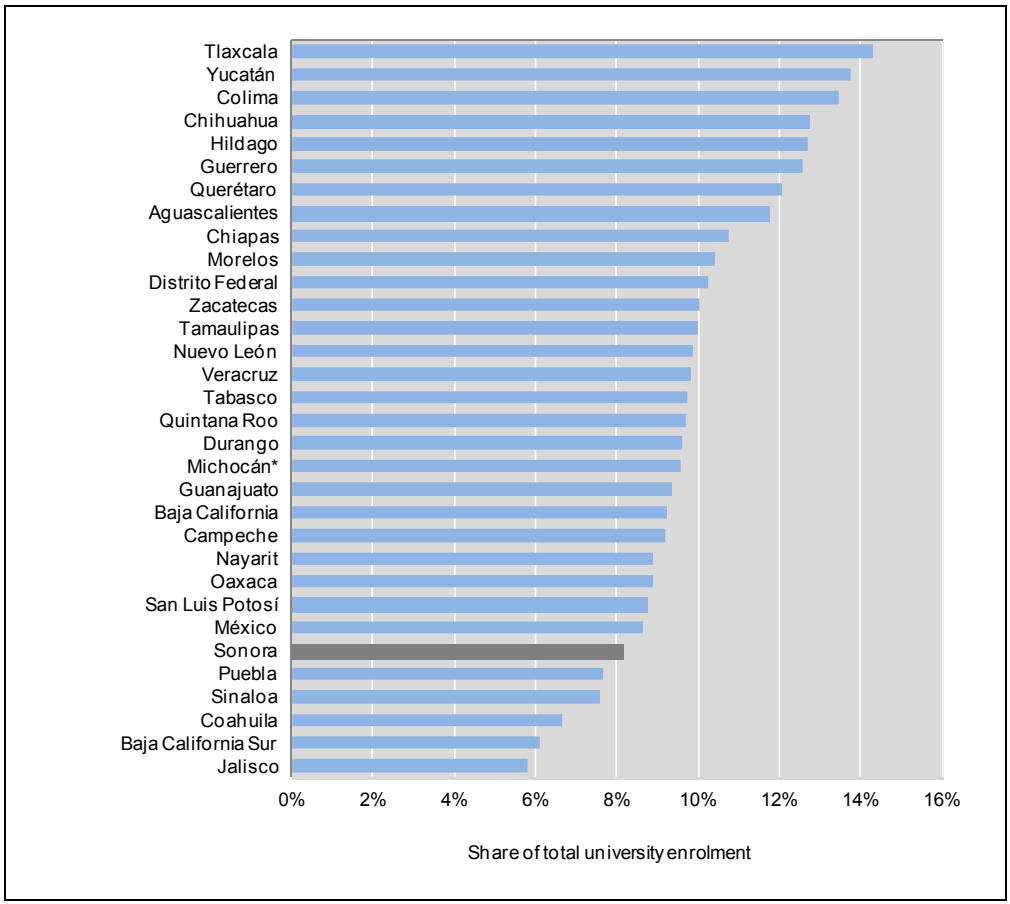
The expanding tertiary education system also faces continuing difficulties in efficiency, retention and completion. Sonora's tertiary education dropout rates have consistently kept above the national average (Figure 1.7). For example in the 2010-2011 academic year, the dropout rate was 11.6% compared to the national average of 8.2%). According to Sonora's Secretariat of Education of Culture in Sonora, the average dropout rate for Sonora's tertiary education sector is 11.6% in the 2011-2012, but no robust data were available for different institutions. The reasons for dropouts can be manifold. In addition to insufficient preparation of incoming students and their financial and social problems, there can also be problems related to the quality and relevance of education provision, inflexible curricula and teacher-centred learning models. Figure 1.8 gives an overview of the productivity of the tertiary education systems in the Mexican state.

Figure 1.7. Dropout rates for the state of Sonora and Mexico



Source: SEP (Secretaría de Educación Pública) (Ministry of Public Education) (2011b), *Sistema Educativo de los Estados Unidos Mexicanos: Principales Cifras Ciclo Escolar 2010-2011*, Dirección General de Planeación y Programación, SEP, D.F., México, *www.sep.gob.mx/work/models/sep1/Resource/1899/2/images/principales_cifras_2010_2011.pdf*.

Figure 1.8. Degrees awarded by as a percentage of total enrolment by Mexican state (2007-2008)



Source: OECD (2012b), *OECD Territorial Reviews: Chihuahua, Mexico 2012*, OECD Publishing. doi: 10.1787/9789264168985-en, based on ANUIES (Asociación Nacional de Universidades e Instituciones de Educación Superior) (National Assocation of Universities and Higher Education Institutions) (2010), *Estadísticas de Educación Superior*, Asociación Nacional de Universidades e Instituciones de Educación Superior, *http://www.anuies.mx/servicios/e_educacion/index2.php*.

Improving retention and completion in tertiary education would require stronger student monitoring systems as well as academic, social and financial support for students. Data about dropout rates and academic progress of students is lacking at the state and institutional level. Collecting and analysing robust data could help better understand and address the dropout problem. The lack of data on students' academic progress has

limited the possibility of estimating the need for academic and social support. While some institutions, such as UES, are devoting considerable efforts to this end, in general it is unclear to what extent tertiary education institutions have invested in support services to facilitate success in education.

Enhancing labour market relevance

Tertiary education institutions particularly universities in Mexico have, generally, limited ties with the productive sector and with industry. The weak engagement of tertiary education institutions with the private sector is an important issue, which negatively affects industry-university relationships, knowledge transfer and university entrepreneurship activities and relevance of learning outcomes.

Tertiary education institutions in Sonora have focussed their labour market links in developing student internship opportunities. Virtually all Sonora's tertiary education institutions offer students the opportunity to obtain work experience and connect with potential employers as a facet of their educational programme. These internship programmes are proactively managed by the tertiary education institutions. For example, UNISON requires students to spend 255 hours in external work (either social or in a work internship) during the last three semesters of their bachelor's degree programme. UES has internship co-ordinators on each of its campuses and a range of long term agreements with companies. ITSON has taken steps to develop market-oriented, competencies-based curricula with professional practice, social service, problem-solving skills and project-oriented learning as part of a bigger cultural change to transform the university into a change agent for Southern Sonora (see Box 1.3). The federal government could help institutions develop more relevant education and R&D programmes by aligning its funding streams with regional priorities.

Box 1.3. ITSON and demand-led education and research

In 1993, faced with a deteriorating labour market prospects in local companies that were struggling to survive, ITSON made a strategic decision to transform itself into a vehicle to improve the Southern Sonoran society. The university took the responsibility to transfer and exchange knowledge through education and research. The change process was implemented in three stages that involved embarking on a cultural change, introducing a market-oriented and demand-led education provision, and making a strong commitment to transformation in the society.

In order to change the institutional culture, ITSON launched a redesigned curricula taking a holistic approach to student development, by introducing three values or areas of skills in addition to professional competencies: i) a good citizen, ii) an honest and reliable professional and iii) an entrepreneur, All students were required to take part in cultural, technological and sports activity and take up to three courses of English language as compulsory requirements for graduation.

In 2002, ITSON introduced the market-oriented competencies-based curricula. This included: integration of professional practices into the curricula, organisation of courses by competencies blocks, and improving problem-solving skills and project-oriented learning. ITSON also launched strategic initiatives to increase university's links with the labour market and society in general, such as the business incubator, the software-development company, the centre for community development (CUDDEC), the agriculture experimental field and a centre for biotechnology and environment research. These centres and units provide work-based learning opportunities to students.

In 2008, ITSON moved from transactional towards transformational focus in its competencies-based curricula. ITSON developed a Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*) in partnership with four local governments. The plan aims to create innovation eco-systems, based on local capabilities. ITSON also took the lead in business incubation and acceleration of companies in key technological sectors.

Source: Rodriguez-Villanueva, G. (2012), "The University working the region: Lessons learned in Sonora, Mexico," oral intervention presented at the OECD Roundtable on Higher Education in Regional and City Development: Universities for skills, entrepreneurship, innovation and growth," OECD, Paris, 19-20 September 2012.

Technological institutes that offer practice-oriented programmes in engineering-related fields have developed close ties with the local labour market. Employers participate as external members in the governing body of

the institutes. They take part in the design of programmes and curricula and provide internships in local firms are part of course requirements.

International experience in embedding labour market relevance in study programmes

International examples can inform Sonora's tertiary education institutions when they are building closer, more systematic links with the world of work. Many universities have taken steps to embed employability and transferable skills in their core curriculum. In Canada, the University of Waterloo is running the world's largest co-op programme of its kind with more than 16 500 students and 3 500 employers (see Box 1.4).

Box 1.4. The Co-operative Education Programme at the University of Waterloo, Canada

The Waterloo Region in Ontario, located about 100 km west of Toronto, has a strong factor advantage of a rich local labour pool largely as a result of a strategic decision made at the inception of the University of Waterloo. The university's founding document in the 1950s (the Waterloo Plan) envisaged a new type of education to be offered on a co-operative basis with industry. The rotation of students to industry and back to the classroom solidified the university's relations with local industry. Today, the University of Waterloo operates the largest post secondary school co-op programme of its kind in the world with more than 16 500 students enrolled over three semesters (60% of the student body) and 3 500 employers involved in the programme each year. It is a model of co-operative education which has spread to more than 100 colleges and universities across Canada.

Extensive co-op programme offerings are available in all university faculties and departments and in over 100 different programmes. Many local and global firms have strong links with the co-op programme. Sybase, an enterprise software company that spun-off from the original WATCOM Corporation, has over 250 employees in its Waterloo campus alone. 15% of its current employees are Waterloo co-op students and more than half of their Waterloo staff is former co-op students.

The co-op programme brings a number of benefits to the local economy. It provides a steady source of new hires, because firms know that the students have work experience; and they get an opportunity to evaluate their performance in the work place before hiring them. Students transfer tacit knowledge and know-how to firms; they also act as a critical source of knowledge circulation within the local high-technology cluster, between different firms as they undertake placements over the course of their integrated work-study programme.

Box 1.4. The Co-operative Education Programme at the University of Waterloo, Canada (continued)

The relationship between the university and local industry allows the curriculum to keep up-to-date with the changing technological frontiers of industry while industry support of the programme funds the acquisition of technology to enhance classroom learning. Finally, the Enterprise Co-op Programme enables students to start their own venture instead of doing a co-op placement with an established firm, and focuses on creating a local network of contacts and mentors to support it.

Co-operative Education & Career Action (CECA) administers the co-operative education system and career-related services for the University of Waterloo. CECA staff function as a liaison between students, employers, alumni, and the different faculties and departments within the University of Waterloo to help determine and facilitate employment opportunities. Employees have access to a complete service team including an account manager that will be the main contact for short- and long-term hiring plans (co-op, full-time, part-time or summer opportunities)

The principal obstacle to the success of the Co-op Programme is the high cost of finding and maintaining the work term positions for the student body. The university invests a considerable amount of its own resources in financing and managing the programme. However, it now benefits from the high reputation that both the programme and the university's students enjoy, which makes it easier to find firms willing to take the students on co-op employment. The key lesson to be drawn from this experience is that the investment of resources in a programme such as this can pay dividends to the local economy over a long period of time.

Source : Marchese, M. and J. Potter (2011), "Entrepreneurship, SMEs and Local Development in Andalusia, Spain", *OECD Local Economic and Employment Development (LEED) Working Papers*, No. 2011/03, OECD Publishing. doi: 10.1787/5kgdt917nvs5-en.; University of Waterloo (2012), Hire Waterloo, *http://uwaterloo.ca/hire*

1.3. Lifelong learning and reskilling and upskilling

This section provides an overview of Sonora's strategies for lifelong learning, highlighting the provision of direct personnel training for firms through co-operative firm-TEI programmes as well as the linkages between education and training programmes and industry labour demand. The key message is that apart from Sonora's considerable state-driven efforts to provide workforce development for the *maquila* industries, strategies for promoting lifelong learning are in need of enhancement. Finally, it

highlights the example of the Penang Skills Development Centre in Malaysia that could provide inspiration for Sonora when it crafts strategies for industry skills development with a stronger focus on skills that can be generalised across the manufacturing sector.

Lifelong learning strategies in Sonora

Ensuring that an increasing portion of the population is educated and able to meet the new needs for skills and competencies is especially important for Sonora given its location in the dynamic border region and its qualifications disparity according to age. Only 15% of the population aged 55-64 years have tertiary education qualifications. The overall educational attainment levels among Sonora's population remain low because of differentiated access to educational opportunities and a continued bifurcation in educational attainment, with a large portion of the state population having only completed primary school education. Sonora's largest city, Hermosillo, exemplifies the bifurcated access to education attainment in the state, with a low average rate of educational attainment (nine years of education) at the same time that postsecondary participation is increasing and TEIs are improving their educational credentials and programmes. About 88% of the workforce in Hermosillo has completed elementary school and 8% have high school degrees or have attended a technical school.

Apart from Sonora's considerable state-driven efforts to provide workforce development for *maquila* industries, strategies for promoting lifelong learning are embryonic. Sonora's tertiary education institutions remain more geared to catering for traditional young age student population than providing opportunities for "second chances" or upskilling and reskilling. Educational opportunities for mature students to facilitate career advancement or change through upskilling or reskilling remain limited. While some innovative initiatives have been launched by Sonora's tertiary education institutions to reach out to the region's low skilled adult population such as the long term, large scale commitment of ITSON to provide adult learners in Southern Sonora with ICT skills (see Box 1.5), these types of initiatives remain exceptional in the TEIs' portfolio.

Box 1.5. ITSON and Asia-Pacific Economic Co-operation Digital Opportunity Center ADOC 2.0

Digital divide is a reality in Mexico, where 68 million people out of a population of over 103 million have no Internet access, including 30 million adults. This population is excluded from communication, personal improvement, social life and information. In Sonora, over 760 000 out of 800 000 people have no access to Internet.

Since 2007, ITSON has worked to narrow the digital divide in Sonora to ensure that everyone, irrespective of individual, social or economic disadvantage, can participate in the information society. Digital literacy programmes are provided in ADOC centres for the local population. Attendees are mainly adults with no previous access to internet or digital learning tools. The programme provides them with training and access to these tools through a permanent education programme. ADOC provides basic training in computers, use of the Internet, email and chat, office suite and Facebook.

Since November 2007, eight generations have participated in the training. Roughly 8 800 people between 12 and 81 years of age have attended the training in over 600 workshops. More than 3 000 hours of training have been provided by ITSON students and staff. Adult learners have gained self-confidence and the feeling of belonging to a university. At the same time, 150 students from ITSON have completed their social service requirements though this programme. The programme has also improved social inclusion and has helped bridge the generation gap and maintain contacts with Sonoran emigrants in the US.

ITSON has developed a public-private partnership to support the training. In addition to ITSON's own funds, the training has been supported by the Ministry of Economy, the government of Taiwan, ADOC, Coca Cola and local governments (Cajeme).

Source : ITSON (Instituto Tecnológico de Sonora) (2012), "Asia-Pacific Economic Cooperation Digital Opportunity Center ADOC 2.0," PowerPoint presented at OECD Review Visit, Ciudad Obregón, 15 March 2012.

Programmes aimed at non-traditional learners need to be expanded and scaled up to enhance the flexibility of the population to adjust to the rapid changes in the labour market and to improve productivity in Sonora. The state could also consider developing an initiative to focus on training low skilled people to move from the informal to the formal sector. In order to reduce inequalities in education and training participation by age and skill, the state of Sonora could consider a two-pronged approach: First, state could increase investment in lifelong learning by supporting more generalised skills development. Second, the state could also ensure that advanced

technical training is available also to employees who are not employed in FDI-based industries whose employees already receive this training. Third, the attractiveness of training and its returns for older learners should be improved by adapting teaching methods and content to their needs, by the provision of short, modular courses and through the recognition of prior learning and experience (see also OECD, 2006).

Specific lifelong learning needs include the demand for executive and lifelong education directed at the technically-skilled workforce which will increase in the future because of the growing pool of technically-skilled workers in Sonora. In the international context, engineers tend to take two career routes, technical or managerial. Those engineers who are limited to a technical career face limited opportunities for promotion, particularly if an enterprise becomes more specialised, whereas engineers who obtain management skills are capable of mobility in the enterprise and potentially in the industry. This indicates a need and potential demand for lifelong and executive education directed at the technically skilled workforce that is emerging in Sonora. ITSON and Sonora's technological universities and higher technological institutes are well placed to address this demand for lifelong learning for technically skilled workforce.

More knowledge is needed regarding mobility within the skilled workforce and their ability to acquire managerial and entrepreneurial skills. In a study by Lizarraga *et al.* (2006): "… of 158 engineers interviewed, 45% of them had had one job before entering the actual plant, 30% had had two or more jobs, and the rest (25%) hold their actual job as their first one. As for mobility intra-enterprise, 65% of the interviewed had experienced a promotion in the last two years within his/her working area. Another 30% had had the same job for four years but have had promotion since entering the plant."

Direct training of personnel in firms through co-operative firm-TEI programmes

One of the most prominent features of Sonora's tertiary education approach is the provision of training to *maquila* industries as an economic development strategy. This strategy has helped identify Sonora as a source of skilled labour available at approximately one-third the cost of similarly skilled labour in the United States. The most important model for the upgrading of labour skills and its significance is the Ford Motor Company in Hermosillo. In 2012, The Ford Motor Company announced investments of USD 1.3 billion in its Hermosillo stamping and assembly plant, which is internationally recognised for the quality of its production (Sarmiento, 2012). The plant, which currently employs 2 700 workers, will add another

1 000 jobs with this investment. Through co-operation with the State of Sonora and the federal government of Mexico, the Ford Motor company has been able to ensure a skilled workforce, including technicians and engineers. The *Instituto Technologico de Hermosillo* is located directly adjacent to the Ford Motor facilities in Hermosillo.

Other technological institutes in Sonora have similar connections with foreign direct investment manufacturing plants or the *maquila* industry. One particularly valuable model is that in the aerospace industry, which has locations in industrial parks in Hermosillo/Ciudad Obregón, Guaymas and Nogales in the state of Sonora. This model (see Box 1.6) is particularly notable because it provides a hierarchy of training related to the skill needs identified by the aerospace companies. The provision of this type of skill-specific information is more likely under conditions where a few large enterprises dominate production in a region. They are more likely to co-operate in identifying and coordinating skill requirements both in their own operations and in affiliated supply chains in order to efficiently transfer initial workforce preparation to the public educational sector.

Box 1.6. Human capital development in the aerospace industry in Sonora

The aerospace industry is prominent in four Mexican states – Baja California, Chihuahua, Queretaro and Sonora. In a bid for more investment in this industry, Sonora won by having more qualified human capital which is crucial to the industry. Sonora's vast experience in the electronics industry led to the initial capabilities in aerospace manufacturing, in particular connectors and harnesses. The aerospace industry is one of the five emerging industries in Sonora state and is one which the State's Ministry of Economy is keen to grow.

Sonora houses the most integrated machinery processing cluster in Mexico with casting, precision machining and special processes. Sonora is the centre of excellence in the manufacturing of turbine components for the aerospace industry with installations in Guaymas, Hermosillo/Ciudad Obregón and Nogales. In March 2012, 41 companies including those in high precision machining, manufacture of electronic components, casting, manufacturing of composite based components and special processes were established in Sonora creating over 7 500 jobs. 17 companies are located in Guaymas, which is an area of special interest for the aerospace industry because of its proximity to the port and its particular ecosystem. Trac co UK is one of the foreign companies that invested in Sonora, which accounts for their largest investment outside of the UK. Other smaller companies like Pinnacle Aerospace, which works for the CESNA navigation system, are located in Ciudad Obregon's new Technology Park and also contribute to the local economy and job creation.

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Box 1.6. Human capital development in the aerospace industry in Sonora (continued)

Currently, Sonora's aerospace companies produce specific parts for the industry. The state hopes to increase the production of more parts. The ultimate goal is to manufacture entire airbus planes by 2015. To do this, Sonora will have to overcome challenges having to do with the state's human capital.

Key challenges in workforce development for the aeronautics industry

At each stage of the production process, the skill set of a worker changes and the level of specialised skills increases. To reach its ultimate goal, Sonora will have to ensure that*: i)* a training platform focused on high-precision machining, aerostructure and composite materials is created and *ii)* the capabilities in research and R&D in this industry is developed and accelerated.

The aerospace industry also requires more skilled workers at the level of machine operators, technicians, professionals, and postgraduates specialised in testing and design. Prioritised sectors in the aerospace industry need to find machine operators and technicians for different segments such as machining, aerostructures, polymers and composites.

The State Ministry of Economy is working with several tertiary education institutions in order to train these future professionals and to introduce the key competencies in to the education programme. The training centres are located in Nogales, Hermosillo and Guaymas within existing institutions. The government has also plans to invest in the state training centres (*Centro Estatal de Capacitacion*) for TE students while further specific training is provided at CONALEP (*Colegio Nacional de Educacion Profesional Tecnica*), Mexico's National College for Professional Technical Education.

Recent initiatives that promote and cater to the aerospace industry

- Launch of the Advanced Manufacturing and Aerospacial Institute of Sonora (June 2011). Initial disciplines include aeronautics and CNC Machining using internationally-recognised standards and competency-based training.
- Projects with ITSON including a specialisation in aerospace, a feasibility study for industry installations in Guaymas, training programmes in manufacturing and special processes and work training.

Box 1.6. Human capital development in the aerospace industry in Sonora (continued)

- Attracting CONACYT research centres (CIDESI, CIATEQ) highlighting skills such as: characterisation of materials and alloys; structural design and optimisation of the manufacturing process; vibration, heat, pressure and electrical tests; special thermic treatments of special alloys; development and certification according to aerospace standard AS9100, the National Aerospace and Defence Contractors Accreditation Program (Nadcap) and Federal Aviation Administration (FAA).

Source: SE (Secretaría de Economía) (Ministry of the Economy) (2012), "Capital Humano en Sonora: El Sector Aeroespacial," PowerPoint presentation for OECD Review Visit, Hermosillo, 12 March 2012

Linkages between education and training programmes and industry labour demand

The state of Sonora offers significant incentives to foreign companies investing and building plants in the state, including incentives for job training and custom-designed workforce assistance that are useful in attracting enterprises and providing a workforce that has necessary skills. In addition to "shelter" services, the state provides considerable incentives to support job training. For example, the state government offers to pay the minimum wage for workers in training for up to eight weeks; additionally, local tertiary education institutions have implemented training programmes to accommodate the needs of a particular company. Furthermore, the state economic development agency assists with custom-designed labour force assistance including: i) analysis of the labour market with respect to the enterprise needs; ii) financial and management assistance in job training and iii) assistance in the search for and vetting of potential employees.

While the custom-designed workforce assistance is useful in attracting enterprises to Sonora, stronger efforts should be made to ensure that the skills provided can be generalised throughout the labour market. This would involve development of skills that a worker can carry from one plant to another or move up in the hierarchy of employment responsibility and compensation. What little evidence there is of employment mobility indicates that employees generally rise within a career in one company.

Sonora has built and is building considerable regional comparative advantage through its educational initiatives providing skilled labour to the

maquila industries. While the focus of the state of Sonora on continuous skills development for the benefit of the *maquila* industry is commendable, too narrow skills development will not serve Sonora's population and economy in the long run. Stronger emphasis needs to be placed on general competencies that will allow people to adjust to rapid changes in the labour market and have the capacity for lifelong learning. Also, given the needs of the state to build a knowledge economy and infrastructure serving its diverse industrial base, changes to the tax regimes governing the *maquila* industries should be considered in view of the need to invest in long-term economic development. As pointed out in the OECD report on the Mexican economy (OECD, 2012b), a re-evaluation of the numerous special business tax regimes that subsidise foreign direct investment in Sonora should be undertaken.

International experience in skills development: Penang Skills Development Centre

When designing a new approach for industry skills development with stronger focus on skills that can be generalised across the manufacturing sector, the state of Sonora could find inspiration from the Penang Skills Development Centre which for over two decades has been a central element of the regional human resource capacity development in the state of Penang in Malaysia. While this centre has developed into Malaysia's leading skills learning institution that meets the immediate human resource needs of the business community, it is also a one-stop human resource development entity geared towards the promotion of shared learning among the manufacturing and service industries (NHERI, 2010). The centre plays a critical role as a broker between the needs of employers and higher education institutions and other sources of training capacity.

When established in 1989, the Penang Skills Development Centre concentrated on technical and vocational training programmes for employees of multinational corporations (MNCs). Over a 20 year period, the centre has improved the knowledge and skills of every level: operators, technicians, supervisors, engineers and managers.

In addition to its traditional training functions, the Penang Skills Development Centre offers initiatives such as "School 2 Work," and "FasTrack" that address the gaps in the current education system by providing school leavers with a complete education-to-employment pathway and university graduates with the skills they need for employment.

Box 1.7. Penang Skills Development Centre

The Penang Skills Development centre (PSDC) supports the building of the knowledge infrastructure in the state of Penang in Malaysia. PSDC is dedicated to providing quality programmes to serve the needs of SMEs and operates with an SME cradle fund. PSDC is a training institution, but it is also in charge of reskilling. It aims at promoting linkages between multinational companies (MNCs) and local companies and to promote fast track for radio-frequency, computer-embedded and green technologies.

To improve its efficiency and diversify its offerings, the centre has recently set up five commissions that focus on the following tasks: i) sustainable education and learning (led by Motorola), ii) mentoring young scientific entrepreneurs, iii) establishing a science tech park, iv) encouraging innovation and research (led by INTEL) and v) life sciences and medicine. PSDC is 80% financed by the private sector with 149 member firms representing 60% of the Penang workforce. 32% of these members are electronic companies, 22% engineering and 19% manufacturing. Initially, there were 589 participants in the programme (1989/90). In 2008, the number of participants had increased to 12 108.

"School2work" provides a complete pathway from education to employment. Students are admitted from secondary school on the basis of their performance on the Malaysian examinations (SPM and STPM). They can earn a Penang Skills Development Centre Diploma in Engineering in three years in electronic engineering, mechatronic engineering, computer engineering, and telecommunication engineering. The programme includes extensive field experience, including factory visits, talks with external examiners, professors and CEOs. After earning a diploma, students may enter a programme of skills enhancement ("FasTrack" programme) to equip them for employment or enter a bachelor's degree programme through an affiliated university. One option is to earn a degree locally in two to three years at a local private university. The other option is to earn a degree through one of several affiliated foreign universities, most of which are British. Students completing a degree programme are then given intensive skills enhancement training ("FasTrack") to prepare them for employment. The "FasTrack" programme is a government-funded initiative designed in collaboration with multinational corporations to accelerate learning and hands-on experience of new and existing engineers to support industry's competitiveness in design and development. (PSDC, 2010).

Source: OECD (2011), *Higher Education in Regional and City Development: State of Penang, Malaysia 2011*, OECD Publishing. doi:10.1787/9789264089457-en.

1.4. Strategic co-ordination: Creating linkages between foreign direct investors and local industry entrepreneurs

One of the major economic development problems facing the state of Sonora is the limited linkage between companies created by foreign direct investment and Mexican companies (Ornelas, 2011). For effective domestic creation of knowledge-based companies, several components must be in

place: i) companies, whether domestically owned or the result of foreign direct investment, must employ a workforce with specialised technical knowledge. The knowledge base is created first through the tertiary education system and then in the enterprise itself; ii) the technically-skilled workforce must have connections with the TE faculty creating new ideas and inventions. It must have access to and be able to recognise the potential for new products and process innovations; iii) the technically-skilled workforce must be able to move among enterprises in an industry cluster both to acquire new skills and to move up in a job responsibility and management hierarchy; and iv) the capital and governance infrastructure must be established to enable the establishment of new, domestically-owned companies to play a role in global production networks.

The state of Sonora has made significant progress in providing technical and scientific expertise, especially in engineering, to attract companies requiring higher value added skills to Sonora. This workforce is particularly in evidence in the supply chains in aerospace and electronics in the Guaymas and Empalme industrial parks, and in the Hermosillo production complex built around Ford Motor company production.

However, what appears to be less developed in Sonora are the links to university research expertise and the infrastructure that can enable entrepreneurs, especially among the engineering workforce, to develop new businesses that could create domestically-based companies producing high value added products. The lack of university-industry connections are manifested in the limited extent of applied research activity in Sonora and its TEIs. The number of patents registered in the state has been slowly increasing, with one per year being registered in first decade of the 2000s (Ornelas, 2011). Furthermore, "the state (of Sonora) still faces problems of limited applied research and a weak linkage with the productive sector, in spite of the consolidation process of top-level researcher groups and their outstanding scientific production. A vestige of the above is that, despite the high number of specialised publications produced in the state, until 2002 only two patents had been registered. The application of scientific knowledge to the needs of the state's productive sector is still scarce and embryonic."

In the important auto manufacturing and services industry in and around Hermosillo, a recent study showed that 40 enterprises carry out complex processes beyond straightforward assembly, but only three firms are specifically engaged in designing and manufacturing moulds and dyes, indicating a high level of technical capacity that is potentially transferable among industries.

Since many of Sonora's local enterprises are integrated into already established supply networks, enterprise goals are oriented toward meeting performance goals rather than, for example, entering new markets through export. Firms are moving toward international certification goals. Their learning occurs via joint projects with clients and suppliers. Enterprise relationships with TEIs are limited and when they do exist, they primarily focus on internships (Ornelas, 2011). Thus, training has been the primary focus of the TEI-enterprise relationship, even in these potentially advanced manufacturing areas. Programmes such as "Entrepreneurs and Enterprise Incubators" have been established at some TEIs, but faculty are rarely recognised for participating in these applied efforts so their participation has been limited. One exceptional example is *Centro de Asistencia Metrológica* (CAM) at UNISON, which has worked consistently with Ford Motor Company and its suppliers in Sonora.

In terms of the presence of capital and governance infrastructure to develop the entrepreneurial businesses that can build on the technical and scientific skills emerging in Sonora, it is clear that entrepreneurial businesses, including in established industries such as automobile production, face daunting odds. According to the Milken Institute's 2006 Capital Access Index, Mexico ranks 43rd out of 122 countries examined in capital access by enterprises (Barth *et al.*, 2006). Although this deficiency cannot be addressed directly by Sonora's TEIs, they can contribute to the types of educational opportunities that will develop entrepreneurial and management capacity. This type of education is provided by ITSON in tourism and agricultural sectors, which may offer more opportunities for business creation for locally-based companies.

Currently, the majority of technical education programmes are responses to the demands of individual companies and represent a significant accomplishment in responding to actual labour force needs. These programmes need to be developed and evaluated within a long-term strategic plan for tertiary education in the region.

In addition, a diagnostic analysis is necessary to plan for longer-term educational objectives and to meet broad labour force needs in the economy, such as those emerging in human services and tourism. Meeting these needs will require a different process than that used to determine *maquiladora* enterprise training needs. Much tourism activity is carried out by SMEs not represented by trade associations or economic development agencies or organisations. Determining labour force needs in this field will require proactive efforts to contact and assess needs in SMEs. Public sector needs analysis should draw on demographic data, as well as an examination of the capacity of public sector service providers and their plans for service provision and improvement. Micro-enterprise business training could move

people from the informal to the formal sector, but currently falls outside the education sphere.

1.5. A potential crisis of supply for university research and teaching capacity

Sonora's tertiary education sector suffers from a lack of long term planning for university research and teaching capacity. Short term appointments predominate in the university faculty ranks. Universities do not have sufficient programmes to support basic research across a range of fields. This places them in danger of losing talented postgraduates to universities in other countries. Faculty to supervise work of Master's and PhD students is shrinking. There is no evidence of strategies to develop and retain research talent or plans to replace an aging teaching faculty in universities. It is unclear where the next generation of faculty will come from.

A quality crisis in education may develop in Sonora because demand for education is increasing at all levels. Most significant to this potential crisis is evidence that support for faculty researcher/mentors and basic research has diminished as a proportion of total higher education expenditure. In some cases, educational programmes are admitting more students in order to fund their faculty. If they over-admit, they are not able to sufficiently supervise the admitted students, resulting in declining programme quality.

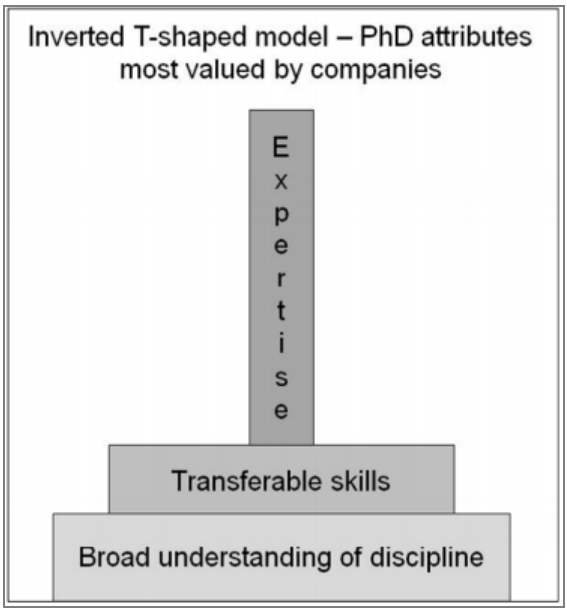
National Council of Science and Technology (*Consejo Nacional de Ciencia y Tecnología,* CONACYT) data demonstrates that the state of Sonora has moved away from supporting basic research and the institutional programmes that support the development of young scholars. There is poor support for TE programmes in basic research, outside the two areas on mineralogy and bio-tech, which are related to key industries in the state, mining and agriculture. What this means is that while existing industry needs continue to be served, basic research in other areas critical to the state's economy, including renewable energy or regional science and logistics is not currently on the agenda.

Federal research grant programmes appear to favour applied work tied to the agendas of individual foreign direct investors in Sonora. For example, *Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM) is more successful in creating linkages with firms and gets more grants. These grants are primarily pragmatic and enterprise-oriented and may not address broader industrial research issues. In addition, the programmes run on what is an unpredictable out-sourcing model. For example, ITESM does the original planning and design for the application and then identifies a

technician to do the work. This model should be evaluated with respect to its ability to develop broad and sophisticated research capacity in the state of Sonora. The paucity of patents and evidence of prioritising a technical over a research orientation may undermine long-run capacity to attract cutting-edge researchers and build a sophisticated research capacity in Sonora's TEIs.

Because of the considerable demand Sonora's universities have a strong focus on undergraduate education, but they also need to develop the quality and efficiency of postgraduate education. Sonora's universities could consider introducing joint doctoral schools among the TEIs as well as "structured doctoral programmes" that provide a framework for timely completion over four years and a framework for industry collaboration. A structured PhD model incorporates discipline/interdisciplinary courses or modules and transferable skills as a means of enhancing research training and research career development within academia and industry. Mobility can be embedded in the programme, for example through internships in the public, private and the non-profit sector. The Figure 1.9 provides a useful illustration.

Figure 1.9. Structured PhD Model



Source: ACSTI (Advisory Council for Science Technology and Innovation) (2009), *The Role of PhDs in the Smart Economy*, Forfas, Ireland, *www.forfas.ie/media/asc091215_role_of_phds.pdf*.

Conclusions and recommendations

Sonora has made considerable strides in improving access to educational opportunities as well education attainment levels. Positive signs include the strengthening vocational tertiary education sector and higher-than-average literacy rate among Mexican states. The establishment of institutions in many locales in Sonora has reduced the total cost of education for students who are able to live at home and commute to the campus. Among the notable strengths of Sonora's tertiary education sector are:

- Strong human capital in the Mexican context: Improved achievement in basic education and in the proportion of secondary school graduates who receive postsecondary education. At 30%, Sonora's tertiary education attainment rate among young population in working age is among the highest in the country.
- An effective multi-location model for TEI-enterprise co-operation in training in mid-level technical skills as demonstrated particularly in the aerospace industry.
- A diversified human capital base serving agriculture, mining, manufacture, livestock and tourism.
- Expansion of mid-level skill education institutions, particularly technological institutes, to meet labour force needs that are directly related to economic development and job creation in Sonora.

At the same time Sonora faces serious challenges in widening access to educational opportunities and ensuring that the educational system meets the needs of the regional economy. Most notably, there is a continuing gap in educational access at the secondary school level; many secondary school graduates appear to be unprepared to enter tertiary education. The challenges faced by Sonora and its educational institutions include:

- Improving educational access at the secondary and tertiary education level. There is a particular need to focus on opportunities for secondary school students to combine work and education, for example, through apprenticeship programmes that are fully incorporated into the secondary school curriculum.
- Responding to the full range of postsecondary educational needs. The majority of current technical education programmes are responses to the demands of individual companies, but do not necessarily respond to the wider needs of the society.

- Improving long term planning for university teaching and research capacity. Short term appointments predominate in the university faculty ranks. Universities do not have sufficient programmes to support basic research across a range of fields. Faculty to supervise work of Master's and PhD students is shrinking. There are no obvious strategies to develop and retain research talent or plans to replace an aging teaching faculty in universities.

- Strengthening evidence-based decision making. At the state level, information on access to education and on institutional performance or student progress is limited and lacking authoritative status. Individual institutions provide some useful data on enrolment and achievement rates but there is no state-wide demographically-informed data-based information system, grounded in goals, such as improving secondary school preparation, which could provide the basis for planning, resource allocation or performance evaluation.

- Developing a state-wide mechanism to articulate a long term vision and implement an integrated development strategy for all educational institutions.

Sonora's state education authorities need to become more proactive in setting the tertiary education agenda rather than leaving the agenda setting to economic development actors who may do an excellent job for particular enterprises, but do not have the broader educational picture of Sonora in view. Within this context, the OECD review team recommends that the following measures be taken to improve the human capital and skills development outcomes:

Recommendations for the federal government

- Re-evaluate the numerous special business tax regimes that subsidise foreign direct investment and review incentives with the long term workforce and economic development needs in view.

- Review funding arrangements for tertiary education, taking into consideration and reducing the wide differences in funding per student across the sector and also within subsystems to ensure the growing demand for tertiary education in Sonora is met with adequate funding for the maintenance of quality programmes. If programmes are self-funded based on the number of students admitted and insufficient faculty are available to instruct those students, educational performance will suffer.

- Review the funding model of universities to develop a plan to renew faculty who can supervise postsecondary and postgraduate students. Take steps to retain and attract junior faculty who can build careers in universities, doing research and teaching the researchers and faculty of the future.
- Develop an initiative to focus on training low skilled people to move from the informal to the formal sector of the economy. Facilitate the move from the informal to the formal sector, for example by helping micro-entrepreneurs with outreach and training to "scale-up" their micro-enterprises in sectors such as hospitality.

Recommendations for the state government

- In collaboration with tertiary education institutions, other educational institutions and key stakeholders of the economy and society, develop a co-ordinating structure (or build on existing structures such as COVES) and appropriate mechanisms to articulate a long-term vision and strategy for human capital and skills development stretching from primary education to tertiary education and lifelong learning (including workforce development activities). Outline clear qualitative and quantitative goals, policies and priorities for human capital development from primary to tertiary education, and confirm the respective contribution of individual institutions (or types of institution), building and co-ordinating relationships among the different components of the education sector to address pathways between universities and technological institutes and different levels of education.
- Develop an authoritative data-driven infrastructure to inform evidence-based decision making, goal setting and evaluation for the secondary and tertiary education sectors. In tertiary education monitor the performance of tertiary education in the region and benchmark its progress with appropriate comparators in the country and with OECD countries. This requires: *i)* robust data on the status of the region's human capital, *ii)* a policy audit to identify barriers to meeting needs, *iii)* state/federal policy to foster tertiary education institutions with multiple, complementary missions aligned with regional needs, and *iv)* revision of student selection, finance policy (institutional, regional and national student support) and governance/regulation. Develop data and information on: *i)* educational attainment rates benchmarked to country-level achievement, the OECD average and the best-performing OECD countries, *ii)* migration by educational level and age, iii) regional tertiary education participation rates (age groups including youth, adults; socio-economic status), *iv)* robust information on which institutions serve the

region's population, v) long term labour market needs, *vi)* degrees awarded by regional tertiary education institutions, *vii)* the data on student labour market outcomes and *viii)* functioning pathways between and among tertiary education institutions, as well as other levels of education. Publish the comprehensive labour market intelligence on line in a single place to improve students' ability to make rational choices about their studies and to help graduates and employers come together and increase the graduate employment. Use this data to identify regional priorities and facilitate the access of TEIs to the date to help develop relevant education and skills.

- In collaboration with the tertiary education institutions continue to expand efforts to increase the enrolment and success of students from low social and economic background. Facilitate the removal of the remaining geographical barriers to education with the help of ICT, academic, social and financial support services for students and collaboration ad pathways between universities and technological institutes as well the tertiary education and the primary and secondary education institutions. Focus attention on teacher training colleges and how secondary school teachers are prepared. Experiment with approaches to increase average years of school completion and to decrease desertion (drop-out) rates. These may include community development efforts that reach parents and opportunities to continue education while working.

- In collaboration with the tertiary education institutions increase tertiary education opportunities for working age adults, ensuring that the workforce development for the maquila industries provides also general skills that enable mobility and that this training is also available to other workers. The lifelong learning measures should include transparent pathways to advanced education, the ability to attend multiple institutions, obtain short term education and training that can later be applied to degrees, and re-skilling and up-skilling courses and programmes designed around the needs of working adults. For non-traditional learners who combine work and study and/or family obligations develop flexible ways of provision through work-based, e-learning and distance education and allow attendance on the basis of non-formal and informal learning. This involves the development of a qualifications framework with strong credit recognition schemes, course and programme articulation agreements, clear and enforceable policies related to credit transfer and support for joint and collaborative programmes.

- Develop a longer term plan to meet broad labour force needs in the regional economy, based on a diagnostic analysis. Evaluate the technical education programmes that have been developed to meet the demands of individual companies. Develop these programmes within a long-term strategic plan for tertiary education in the region. Meeting the needs of the emerging sectors, such as human services and tourism, will require proactive efforts to contact and assess needs in small and medium-sized enterprises (SMEs) not represented by trade associations or economic development agencies or organisations. Public sector needs analysis should draw on demographic data as well as an examination of the capacity of public sector service providers and their plans for service provision and improvement.
- Provide micro-enterprise business training to move people from the informal to the formal sector. Expand programmes to train micro-enterprise entrepreneurs building businesses in industries such as tourism and waste management.
- Develop strategies to increase the supply of knowledge-intensive workers and to integrate them in the sectors in which the region has comparative advantages. This is beginning in the tourism sector (which engages historians and anthropologists in cultural heritage programmes, as well as performing and visual artists) but connections could be strengthened.

Recommendations for tertiary education institutions

- Increase the proportion of longer term appointments in the faculty in order to foster faculty research, improve quality of teaching and enhance contributions to university governance. In order to improve the quality of all tertiary education programmes, gradually reserve academic positions only for candidates with a Masters degree or higher and fix a period for those who wish to follow an academic career to complete their doctoral studies. Provide comprehensive professional development programmes for university teachers. Provide regular short courses to improve teaching skills encourage assessment and feedback from students, and support and reward excellence in teaching.
- Develop policies, programmes and measures to improve, on a continuous basis, the quality and relevance of study programmes. First, review the curriculum content and pedagogical methods of study programmes to align them with the needs of the labour market and the local and regional economies. The opinion of employers and graduates should play an important role in the systematic and continuous revision

of the education programmes of tertiary education institutions. Evaluate academic programmes and curricula that create bridges among skill levels, for example, from technician skills to post-graduate engineering programmes. Make it clear how students could move up the skills ladder, assessing, for example, opportunities to combine work and education and mentoring programmes. Second, evaluate generic skills such as critical thinking, problem solving, written output and interpersonal understanding in curriculum design and the development of teaching and learning. Third, create robust methods to monitor the student progress and achievement, labour market outcomes and mobility as well as graduate destinations (out-migration). Monitor studies that analyse the entry of graduates into the labour market. Systematically monitor student progress and achievement, labour market outcomes. Use the data strategically to improve academic, financial and social support for students, course provision and the supply of skills.

- Construct flexible learning paths and clear institutional bridges that include tertiary-type B post-secondary education. Put in place measures to accommodate and encourage mobility within and between institutions by formal agreements to help students move from one institution to another.

- Address the need for lifelong learning and more flexible modes of delivery for those who combine work and study. Develop executive and lifelong education directed at the technically-skilled workforce which will increase in the future because of the growing pool of technically-skilled workers in Sonora.

- Collaborate more actively with industry to ensure greater relevance of the educational provision and to build entrepreneurial skills of graduates. Engage employers in the curriculum development, invite professors from industry to deliver courses, and develop experiential, problem-based, interdisciplinary and work-based learning methods to develop employability, entrepreneurial and transferable skills, management capacity and English language acquisition. Embed transferable skills in degree programmes across the academic and technical disciplines to boost the productivity base in Sonora and enhance its internationalisation efforts. Develop a stronger student-centred approach in teaching and learning, building on the international best practice and the existing models in Sonora. Develop more interactive forms of education tailored to the individual needs and capacities of students.

- In collaboration with other TEIs, develop a joint doctoral school and "structured doctoral programmes" that provide a framework for timely

completion and a framework for industry collaboration. To enhance research training and research career development within academia and industry, incorporate in the doctoral training discipline/interdisciplinary courses, transferable skills and mobility, for example through internships in the public, private and the non-profit sector.

Annex 1.A1 Tertiary education institutions in Sonora, 2011-2012

Institution		Total enrolment
State	**Acronym**	**25 676**
Universidad Estatal de Sonora	UES	7 723
Instituto de Formación Docente del Estado de Sonora	IFODES	5 328
Instituto Tecnológico Superior de Cajeme	ITESCA	3 644
Instituto Tecnológico Superior de Cananea	ITESCAN	691
Instituto Tecnológico Superior de Puerto Peñasco	ITSPP	532
Universidad de la Sierra	UNISIERRA	690
Universidad Tecnológica de Etchojoa	UTE	371
Universidad Tecnológica de Hermosillo	UTH	3 700
Universidad Tecnológica de Nogales	UTN	1 425
Universidad Tecnológica de Puerto Peñasco	UTPP	197
Universidad Tecnológica del Sur	UTS	1 134
Universidad Tecnológica de San Luis Río Colorado	UTSLRC	241
Universidad Tecnológica de Guaymas*	UTG	0
Federal		9 813
Instituto Tecnológico de Hermosillo	ITH	3 577
Instituto Tecnológico de Nogales	ITN	2 162
Instituto Tecnológico de Huatabampo	ITHUA	1 091
Instituto Tecnológico del Valle del Yaqui	ITVY	1 187
Instituto Tecnológico de Agua Prieta	ITAP	985
Instituto Tecnológico de Guaymas	ITGUAYMAS	703
Centro de Investigación en Alimentación y Desarrollo	CIAD	108
Autonomous		45 364
Colegio de Sonora	COLSON	74
Instituto Tecnológico de Sonora	ITSON	16 698
Universidad de Sonora	UNISON	27 998
IMSS Enfermería	IMSS	594
Private		19 369
Centro de Recursos Especializados en Cultura y Educación	CRECYE	
Centro de Enseñanza Técnica y Superior	CETYS	
Centro de Comercio Global del Noroeste	CCGN	

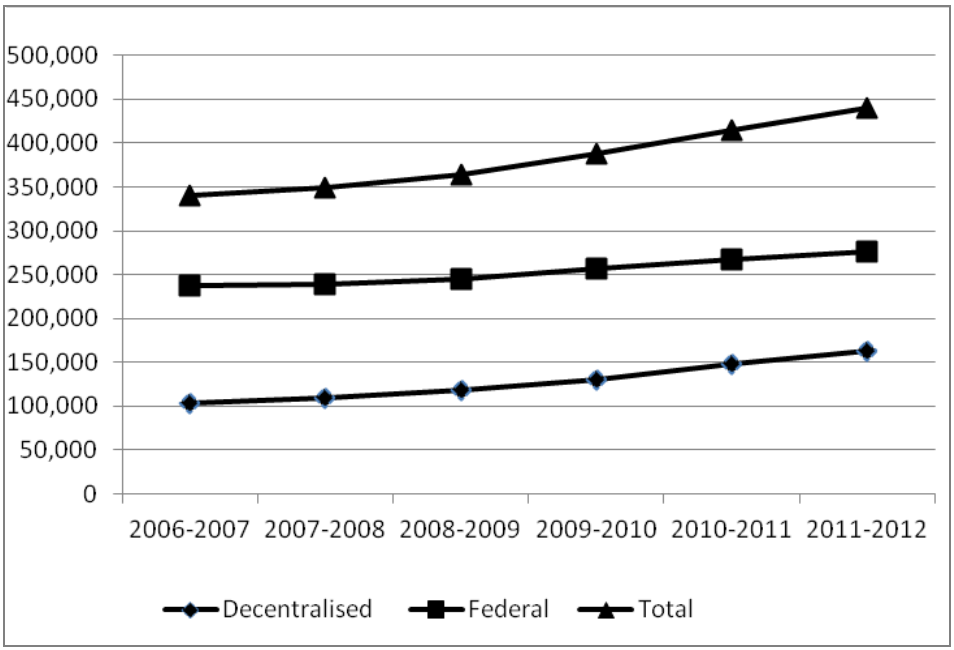
Annex 1.A1 Tertiary education institutions in Sonora, 2011-2012 (continued)

Institution		Total enrolment
Private (continued)	**Acronym**	
Centro de Estudios Educativos y Sindicales de la Sección 54 del SNTE	54SNTE	65
Centro de Investigación en Educación Virtual	CIEV	47
Centro Universitario de Sonora	CUSON	310
Instituto Sonorense de Seguridad Pública del Estado	I S S P E	0
Instituto Superior y de Desarrollo Empresarial	ISYDE	0
Instituto de Ciencias y Educación Superior	ICES	813
Instituto del Desierto de Santa Ana	IDESA	2 504
Instituto de Mediación de México	IM	
Instituto Vanguardia	IV	
Instituto del Sistema Empresa Inteligente ABA	ISEI	105
Instituto Pedagógico de Posgrado de Sonora	IPPSON	1 204
Instituto Sonorense de Administración Pública	ISAP	34
Instituto Tecnológico y de Estudios Superiores de Monterrey	ITESM	913
Instituto Educativo Hermosillo	IEH	162
Universidad Lasalle	ULASALLE	1 196
Multiversidad Mundo Real Edgar Morin	MMREM	0
Universidad Durango Santander	SANTANDER	757
Universidad de Hermosillo	UDEH	13
Universidad de Navojoa	UNAV	301
Universidad del Desarrollo Profesional	UNIDEP	5 828
Universidad Kino	UNIKINO	669
Universidad Unilider	UNILIDER	166
Universidad Contemporánea	UC	85
Universidad Interamericana de Desarrollo	UID	402
Universidad Interamericana de Guaymas	UIG	195
Universidad Tecmilenio	TECMILENIO	245
Universidad del Valle de México	UVM	3 355
Universidad del Valle de México Nogales	UVMN	
Universidad Vizcaya de las Américas	Vizcaya	
Universidad del Desierto	Desierto	
Total	**56 TEIs**	**100 222**

Source: Subsecretaría de Educación Media Superior y Superior, Dirección General de Educación Media Superior y Superior .

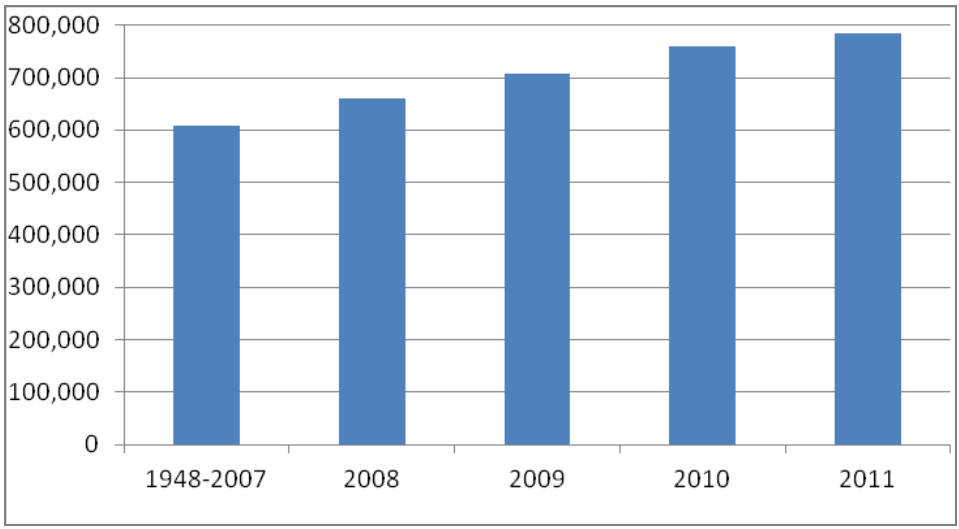
Annex 1.A2. Technical institutes' enrolment and graduation figures in Mexico

Figure 1.A1. Enrolment in technological institutions, 2006-2012



Source: SEP (Secretaria de Educacion Publica) (Ministry of Higher Education) (2012), "Sistema Nacional de Educación Superior Tecnológica", PowerPoint presented at OECD Review Visit, Hemosillo, Mexico, 13, March 2012.

Figure 1.A.2. Graduates of technological institutes: aggregate numbers, 1948-2011



Source: SEP (Secretaria de Educacion Publica) (Ministry of Public Education) (2012), "Sistema Nacional de Educación Superior Tecnológica", PowerPoint presented at OECD Review Vist, Hemosillo, Mexico, 13, March 2012.

Notes

1. Between 1965 and 2000 the birth rate in Mexico dropped from 7 children per woman to 2.5; in 2010 it was 2.3.The dependency rate in Mexico was 5.6 in 2010, and projected to decrease, with slowly rising old age dependency rate and a rapidly declining child dependency rate. In 2010, one in ten Mexicans was aged 60 or over; within three decades, the figure will be approximately one in four.
2. The entry rate to tertiary education for 2010 in Mexico was 33%. Of these students, 20% are expected to graduate. In comparison, the average OECD entry rate to tertiary education is 62% of which 39% graduated.

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Chapter 2.
Research, development and innovation

The local and regional dimension of innovation is crucial to promote long-term economic growth and competitiveness. All cities and regions can improve their capacity to adapt and transfer knowledge to local and regional needs. This chapter examines the effectiveness of current innovation policies and practices in Sonora and Mexico, and the role of research and knowledge transfer conducted by the universities and technological institutes. It considers the efforts made by the federal and state governments, universities, and technological institutes. It examines the current knowledge transfer and exchange mechanisms and highlights good practices from other regions. Finally, the chapter concludes with specific recommendations to improve regional innovation in Sonora.

Introduction

Mexico has improved its competitiveness in recent years, but continues to lag behind in its research, development and innovation investment. No progress has been registered over the last decade and Mexico's R&D spending has remained stable in relative terms. Mexico's R&D expenditure rate to GDP (0.5%) compares unfavourably with other OECD countries, which invest on average close to 2.5% of GDP in R&D. Mexico also lags behind in the knowledge economy, even if it has developed some niche sectors associated with multinationals. Because of its relatively low GDP per capita, Mexico remains a middle income country.

In the Mexican context, Sonora present above average economic performance, but needs to improve its efforts in research, development and innovation. Sonora has performed well in the recent period with a growth rate of 2.7% for the period 2004-2007, which is the fifth highest growth performance among Mexican states. Despite its low population density, Sonora exhibits a medium to high performance for regional competitiveness with regard to the rest of Mexico. Sonora is the 10th region for state ranking that measures competitiveness (IMCO)[1] and the 4th for the knowledge economy. Sonora ranks just after the Federal District for its export achievements that account for 30% of GDP. Sonora benefits from the development of the *maquila* industry and from its proximity and common border with the US. It has a large spectrum of robust industries including automotive aerospace, agribusiness, biotech, mining, tourism, ICT, logistics, and water management. At the same time, research spending and outcomes are more modest: Sonora ranks in the middle of the Mexican states list for regional expenditures of national STI programmes or patenting (18th position).

This chapter examines the following three dimensions to assess the effectiveness and coherence of innovation and R&D policies and practices in Sonora and the role that the universities' play in the local and regional innovation system:

- What is the potential of Sonora in terms of research and tertiary education and to what extent the region is able to convert this potential into new products and processes and other kind of innovations?
- What are the main strategic issues the universities face? Do they support the local and regional innovation system in an optimal way? Are there gaps in delivery where performance could be improved?

- What should be done at universities and other tertiary education institutions to improve the innovation performance of the state and what are the lessons that can be learnt from international experience?

2.1 Sonora's tertiary education potential

This section briefly outlines the progress that Sonora has made in education by expanding and diversifying its tertiary education sector, highlighting moderate learning outcomes at schools as a cause for concern. It then analyses the international competitiveness of the leading universities in Sonora, highlighting the high quality but limited volume of ITSON research. It identifies the key fields of research in Sonora which tend to focus on technological activities in line with the industrial basis, and notes the concentration of research in a small number of universities. Finally it identifies research in agriculture and fishing as an emerging field of strength.

Sonora's progress in education

Sonora has made considerable progress in tertiary education in recent years. The tertiary education sector in Sonora has diversified and now consists of 56 tertiary education institutions (TEIs), of which 60% are public. These TEIs include Federal TEIs[2] (financially and administratively dependent on the central government), autonomous TEIs (legislatively and academically self regulated), private universities, and state universities and institutes. The state of Sonora is home to 100 222 tertiary education students, including about 26 000[3] students in UNISON and 17 000 in ITSON (SEC, 2012). In Sonora, 30% of the 25-34 year old population compared to 15% of the 55-64 population have attained tertiary education. These figures show the rapid progress that Sonora has made in upskilling its population, far above the national average (24% and 15% respectively).

At the same time, learning outcomes and the efficiency of the education system remains a concern, While Sonora ranks high in national ENLACE tests on primary and secondary education in Spanish, mathematics and science (3rd for primary education and 1st in secondary education) (Compara tu Escuela, 2012), for PISA results, Sonora stands at the 23rd rank for mathematics with a deteriorating trend from 2006-2009. Sonora ranks 22nd for science and 24th for reading, losing ground in comparison to 2006. In 2009, Sonora scored 410 in mathematics, 407 in science and 415 in reading, compared with the national averages of 419, 416 and 425 respectively (INEE, 2010). Total dropout rates as a percentage of total enrolment (9% in primary education) are not much better, with an average

ranking among states (15th place). In 2007, the number of TE degrees awarded was 8% of total enrolment in Sonora thus putting the state in the 27th place among 32 Mexican states.

Competitiveness of Sonora's leading universities

UNISON and ITSON are relatively well-placed in national rankings for research output, but by international comparison their performance is modest. UNISON is 15th for the number of articles in published journals and ITSON is at 4th place for the number of citations – UNISON coming in at 14th place for citations. According to the Scimago classification (an international ranking of research institutions (*i.e*. TEIs as well as public research organisations (PROs), UNISON is at 2 750th place after UNAM (115), the National Polytechnic Institute (668), the University of Guadalajara (1 518), ITESM - Tech de Monterrey (1 797), the University of Guanajuato (1 843), and close to University of Veracruz (2 773) (see Table 2.1).

Table 2.1. Scimago ranking of selected universities in Mexico and Arizona (2012)

Ranking	Higher Education Institution	Output (O)	International Collaboration (IC)	High Quality Publications (Q1)	Normalised Impact (NI)	Specialisation (Spec)	Excellence (Exc)	Leadership
81	University of Arizona	21 720	32.5%	66.2%	1.7	0.5	19.6%	11 818
115	National Autonomous University of Mexico (UNAM)	18 568	39.1%	45.9%	0.8	0.6	7.4%	11 139
152	Arizona State University	16 437	24.6%	58.3%	1.7	0.5	20.1%	10 001
325	University of New Mexico	9 866	27.9%	63.1%	1.7	0.5	19.9%	5 252
668	Instituto Politechnico Nacional	4 962	29%	31.9%	0.6	0.6	5.1%	2 799
987	New Mexico State University	3 222	28%	47.4%	1.2	0.6	13.4%	1 846
1 518	University of Guadalajara	1 847	32.4%	34.3%	0.5	0.7	3.7%	965
1 797	ITESM - Tech de Monterrey	1 465	36.5%	29.2%	0.8	0.8	8.5%	907
1 843	University of Guanajuato	1 418	43.7%	36.9%	0.7	0.7	7.1%	783
2 750	UNISON	729	34%	39.1%	0.5	0.8	4%	375
2 773	University Veracruz	720	32.4%	36%	0.6	0.7	5%	344

Note: Universities are ranked according to their publication output (O) *i.e.* the total number of documents published in scholarly journals indexed in Scopus (see column 3). IC (International collaboration) in column 4 is the institution's output ratio produced in collaboration with foreign institutions. Q1 (Column 5) stands for high quality publication. It is the ratio of publication that an institution published in the most influential scholarly journals of the world. For NI *i.e.* normalised impact, the value shows the relationship between an institution average scientific impact and the world average (Column 6). A NI score of 0.8 means that the institution is cited 20% below world average. Spec (column 7) is a specialisation index. This index indicates the extent of thematic concentration/dispersion of an institution's scientific output (1 for the most concentrated, 0 for the most dispersed). Exc (column 8) index measures the amount in % of an institution's scientific output that is included in the set of the 10% of the most cited papers in their respective scientific field. It is a measure of the high quality output of a research institution. The last column indicates an institution's output as the main contributor, that is the number of papers in which corresponding authors belongs to the institution.

Source: SCImago Institutions Rankings (2012), *SIR World Report 2012: Global Ranking, www.scimagoir.com/pdf/sir_2012_world_report.pdf.*

UNISON's modest performance in the Scimago ranking is due to its relatively weak scientific productivity despite strong quality. UNISON's output in terms of number of articles signed and/or co-signed is significantly lower than the universities in Arizona and most of the Mexican universities in Northern Mexico. The quality of UNISON's published research (measured by the number of citation) is higher than those of its Mexican neighbours (*e.g. Universidad de Guadalajara*, *Universidad de Guanajuato*, *Tech de Monterrey*), but lower than its counterparts in Arizona. For international co-operation, however, UNISON is less internationalised than the other northern Mexican universities, but scores higher than Arizona's universities.

ITSON's national competitiveness is remarkable in research quality, but research volume low. It ranks first in Mexico for the relative number of citations per documents (FCCyT, 2011) and second for the degree of international collaboration. ITSON's strong performance is attributed to the well-focused nature of its research and its strong emphasis on applied technologies. At the same time, the volume of its publication activities and R&D remains limited. Moreover, there is no data that permits the comparison of its performance with other TEIs in the world.

TEI research in Sonora

HE research in Sonora is strongly biased towards technological activities that are in line with Sonora's main activities: ICT, computer system, mechatronics, electrical engineering, agriculture, and biotech. This specialisation reflects not only the structure of R&D in UNISON and ITSON (see Box 2.1), but also the distribution of training and research activities in technological universities and technological institutes (IT, according to its Spanish acronym), whether decentralised or not.

Technological universities and institutes, such as ITH (Hermosillo), ITN (Nogales), ITESCA (Cajeme), ITSC (Cananea), and ITSPP (Puerto Peñasco) focus on mechanical engineering, electronic, and ICT while the ITYV (Yaqui Valley) and the ITG (Guaymas) emphasise agriculture, sustainable fishing and maritime industries. Among these institutions, ITH stands out as it hosts five nationally certified researchers (SNI), ITN has a business incubator with 18 start-ups and ITESCA has a Technology Transfer Office (TTO). Their contribution to Sonora R&D is nonetheless limited.

Box 2.1. UNISON and ITSON: Two engines of TE and R&D in Sonora

UNISON (*Universidad de Sonora*) is a public university based in Hermosillo, which welcomes 80% of the student population of the university. The remaining 20% are located in two other campuses: Nogales (*Unidad Regional Norte*) and Navojoa (*Unidad Regional Sur*). The main research activities are carried out in the engineering (ICT, Mecatronic, Chemistry and Mining), basic sciences (Mathematics, Geology, Physics, Electronic), and biological departments (Agronomy, Food, Medicine). Over the period from 2006 to 2011, the number of UNISON's nationally certified SNI researchers has increased 85%, accounting for 62% of all Sonora's SNI researchers. UNISON is a member of numerous research networks, notably in basic physics, food processing (cereals), mathematic learning, literature investigation, optical phenomenon, sustainability, and agricultural products. It collaborates with other Mexican universities and, in some cases, with foreign TEIs within the PROMEP framework. It is also part of CONACYT networks. Some 122 agreements have been signed with the private sector and 17 with research centres.

ITSON (*Instituto Tecnológico de Sonora*) focuses its research and education activities in four areas: natural resources, engineering, social and administrative sciences, and humanities. It has launched a number of strategic initiatives including NOVUTEK (a software factory that offers IT solutions to local, national and international companies), CIIBA (a programme for the development of agricultural, cattle and water related activities) and CUDDEC (an initiative to help communities achieve self sufficiency and better quality of life in impoverished neighbourhoods). It runs the CETIDE, a food processing technology centre for integration and business development, in which, together with state and federal ministries of economy, it invested USD 3.2 million. It has also created DIAPYME, an agrobusiness park promoting business model and pilot projects for agricultural activities. ITSON is located in Ciudad Obregón, but also runs five other campuses in Empalme, Guaymas, Náinari, Navojoa Sur and Navojoa Centrol.

Source : ITSON (Instituto Tecnológico de Sonora) (2012), Instituto Tecnológico de Sonora, *www.itson.mx/Paginas/index.aspx.;* UNISON (Universidad de Sonora) (2012), Universidad de Sonora, *www.uson.mx*.

HE research in Sonora is highly concentrated. Four TEIs – UNISON, CIAD (*Centro de Investigación en Alimentación y Desarrollo*), COLSON (*Colegio de Sonora*) and ITSON – account for 99% of state SNI researchers (and 83% of all public researchers). Two- thirds of researchers belong to UNISON. Sonora also hosts public centres of technical research (conducting 248 R&D projects).

Research in agriculture and fishing is an emerging area of strength in Northern Mexico and Sonora. Altogether 13.5% of researchers in Mexico are located in the northwest part of Mexico: Baja California Norte, Baja California Sur, Sonora and Sinaloa. Agriculture R&D amounted to USD 517 million in 2010. Fishing and aquaculture are also important; 95% of Mexico's shrimp aquaculture takes place in Sonora, Sinaloa and Nayarit, and 25% of the area covered by aqua farms is in Sonora. CIAD, the Research Centre for Food and Development conducts R&D projects on production, preservation and commercialisation of food; health and biological development of human beings; and the socio-economic development in different Sonora locations. CIAD employs 75 nationally certified SNI researchers. For key research fields in Sonora's TEI's see Table 2.2.

Table 2.2. Specialty areas of principle TEIs in Sonora

Institution	Governance	Specialty area
CIAD (*Centro de Investigación en Alimentación y Desarrollo)*	Federal	Food
COLSON (*Colegio Sonora*)	Autonomous	Humanities; health and social studies
Instituto Tecnológico de Hermosillo	Federal	Engineering
Instituto Tecnológico de Guaymas	Federal technological insitute	Marine science and technology
ITESM (*Tecnológico de Monterrey*), Campus Obregon	Private	Administration; engineering
ITESM (*Tecnológico de Monterrey*), Campus Sonora Norte	Private	Knowledge economy; technological entrepreneurship; electric technology and aerospace development and research
ITSON (*Instituto Tecnológico de Sonora*)	Autonomous	Agro-business; science; information technology; psychology
UES *(Universidad Estatal de Sonora)*	State	Ecology; aquaculture
Universidad de la Salle Noroeste	Private	Institutional research; education
UNISON (*Universidad de Sonora*)	Autonomous	Physics research; graduate studies in food; technology science; polymers and materials research
Universidad Tecnológica de Hermosillo	State	Engineering
UVM (*Universidad del Valle de México*), Campus Hermosillo	Private	Administration; engineering; health sciences

Source: Sonora's Regional Steering Committee (2012), *Self-Evaluation Report*, Gobierno del Estado de Sonora, Sonora.

2.2 Challenges

This section outlines Sonora's key challenges in improving its RDI performance. It first discusses the need for a robust vision and strategy for Sonora's future, which could be crafted on the basis on the Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*). It then identifies the need to strike a balance between inward investment and local firm development, by enhancing the TEIs' focus on entrepreneurship and technology transfer activities. It recommends consolidation of the regional innovation system and strengthening the collaboration between TEIs and university, especially SMEs. Finally, it argues for the need to translate cross-border collaboration with Arizona into university R&D projects.

Lack of a state-wide innovation plan

Given Sonora's relatively modest income performance, its unemployment rate that is above the national average (around 5% at the end of the 2000s) and the large share of poor people in the population, the state is facing the need to improve its economic profile and to move up the competitiveness ladder. Among Mexican states, Sonora ranks among the highest for its participation in the knowledge economy. In order to fully exploit its advantages, Sonora needs to strengthen its research trajectory and foster its contribution to Mexico's technological output.

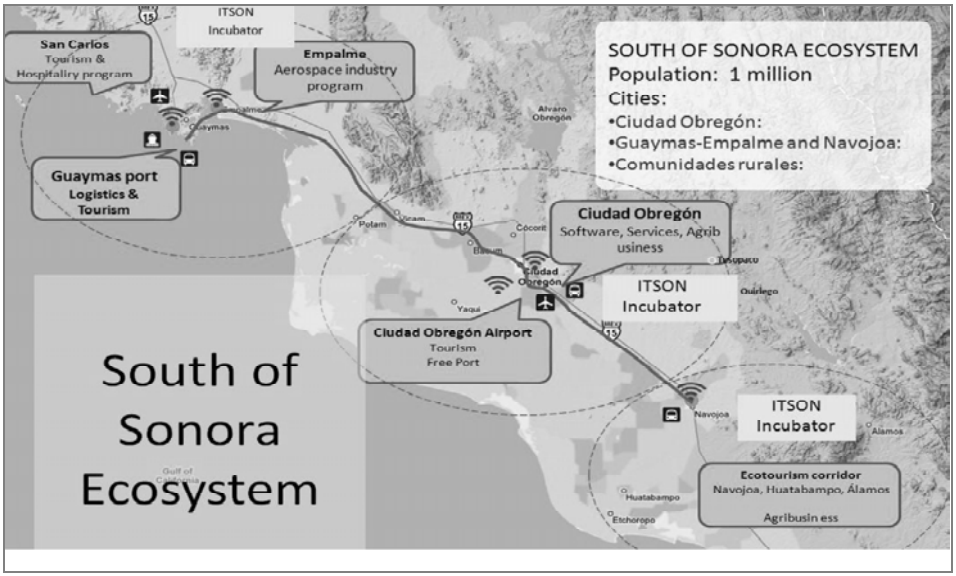
Thus far, the state of Sonora lacks a robust vision and strategy for its future. It is still engaged in a strategy that gives the priority to foreign direct investment and to the acquisition of imported technologies. There is limited concern for local development of RDI and generating locally-embedded innovations.

Sonora has made progress in setting up the machinery for science, technology and innovation, but more efforts are needed in this domain. Sonora has recently set up a State Council for Science and Technology (COECYT). It has also adopted a science and technology law. Since May 2009, the state has participated in an inter-state workshop that aims at building homogenous account registers of science and technology activities. It has nevertheless no science and technology committee in the legislative bodies and no midterm science and technology programme in force.

In 2008, ITSON designed a Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*) in co-ordination

with several municipalities, the State Secretary of Education and Culture (*Secretaría de Educación y Cultura,* SEC), and the State Secretary of Economy (*Secretaría de Economía*, SE). The long term plan for this area was based on the analysis of four ecosystems: biotechnology and agribusiness, software and logistics, eco-tourism and sustainable development, and education and health. The plan targeted the southern Sonora corridor connecting four key cities – Ciudad Obregon, Guaymas, Empalme and Navojoa – by organising a "logistics backbone" of airports, railroad and Wi-Max broadband coverage, and developing the agriculture, aerospace and ecotourism clusters. Within the framework of this plan for Southern Sonora, ITSON has played a pivotal role, by "incubating" new organisations, linking them to the markets and attracting consumers and investors to the region. The programme has created 34 new organisations and 960 new sustainable jobs during the 2006-2008 period and aims to create 14 000 new jobs by 2014 (Bernardez, 2009). See also Box 5.1 and Chapter 5 for more information.

Figure 2.1. South of Sonora Ecosystem



Source: Bernardez, M. (2009), *The Power of Entrepreneurial Ecosystems: Extracting booms from busts*, ITSON, Obregon.

The Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems is a promising initiative, and efforts should be

made to implement it and scale it up to a state-level plan. While the plan has been endorsed by the different participating bodies and the State Secretary of Economy, it is unclear how much public investment it has led to and whether it is actually being pursued. The plan has not so far been extended to the rest of Sonora and there appear to be no intention on the side of the executive branch to do so. The state of Sonora is still lacking a comprehensive R&D and innovation strategy.

Entrepreneurship and transfer of technology

Sonora's state policy is focused on FDI attraction, but less concerned about striking a balance between inward investment and local firm development. FDI has benefitted Sonora in terms of employment and capital deepening: the *maquila* industries provide nearly 9% of manufacturing jobs in the border states and a more important share of skilled employment. FDI also provides knowledge and technological spillovers that are reflected in higher productivity levels. As economic analysis shows, entrepreneurship levels depend on innovation and R&D, regardless of the firm size. Business R&D is particularly important, as it is closely related to the creation of new products and production techniques. Sonora has witnessed limited spinoffs from the *maquila* industries, suggesting that the way that innovation and new technologies are disseminated to SMEs and the state economy in general is suboptimal. Low absorptive capacities and underemphasised federal and state policies for entrepreneurship constrain business formation. The lack of state data makes more detailed conclusions difficult (for information on national performance in entrepreneurship see Box 2.2).

Box 2.2. Mexican entrepreneurship activities

According to the Global Entrepreneurship Monitor (GEM), Mexico is faring relatively well with regard to total entrepreneurship activity (TEA). The drop in economic activity following the recent financial crisis, however, has affected its TEA, which fell from 13.1% in 2008 to 10.5% in 2010. The early stage activity is mainly nascent entrepreneurship (9.2%) while only 1.4% of the adult population are new entrepreneurs. One important aspect in the entrepreneurship phenomenon in Mexico is the consolidation of firms, which is still a problem given that the established business owners' rate was 0.42%, the lowest of the GEM participating countries.

Source: GEM (Global Entrepreneurship Monitor) (2012), Global Entrepreneurship Monitor, *www.gemconsortium.org*.

It is widely acknowledged that universities, technological universities and technological institutes can be important actors of technology transfer. Mexico's federal government and the state of Sonora have developed private and public R&D institutions such as CIAD or ITSON centres that are unique in the country. They are not, however, sufficiently used by firms, so part of the potential benefit is wasted.

Sonora ranks 9th for patent application per million inhabitants (about 2 patents per million inhabitants, which is lower than the Mexican average). The performance is three times better in the Federal District and two times better in Nuevo Leon. More generally, Sonora lags behind in innovation inputs. These weak achievements make it more difficult for the state to nurture innovation processes that establish the dynamics for growth. Local supply is also curtailed by a low level of skilled workers. Human capital for science and technology in Sonora is 1.4% of the whole of Mexico, while Sonora's GDP accounts for 2.9% of Mexico's. Sonora's links to co-patenting are few and mainly local or domestic; the international character of Sonora is under-utilised to foster innovation.

The provision of business parks and incubating services is the main means to assist new and innovative entrepreneurs. Through joint investment from the federal government, state government and ITSON, the SonoraSoft technology park began operating on the main ITSON campus in late 2008 (see Box 2.3). This IT-focused park leases or sells spaces to candidate companies and has a realistic, well-focused operation plan. Furthermore, 19 of the 450 decentralised business incubators in Mexico are in Sonora, including 7 traditional and low-tech incubators, 14 medium-tech incubators and only 1 high tech incubator. In 2012, ITSON's incubator in Ciudad Obregon, IDEA, is expected to admit 40 start-ups that will create 150 jobs. IDEA will also deliver training services to about 120 entrepreneurs. Accepted projects originate mainly in Ciudad Obregon, which also provides around half of the startups created. The survival rate for the 25 enterprises incubated in 2011 is 90%.

Box 2.3. SonoraSoft Technology Park at Ciudad Obregon – Developing the Software Industry

The SonoraSoft Technology Park was established in 2007 as part of a joint effort between the Sonora State Government, Sonora's IT Business Association (TI Sonora) and ITSON. SonoraSoft aims to contribute to the transformation of the local economy by creating highly-skilled jobs and by providing space and value-added services to software development companies. SonoraSoft's management unit seeks to attract new companies and provides human capital development services, such as certifications and training programmes. .

Box 2.3. SonoraSoft Technology Park at Ciudad Obregon – Developing the Software Industry (continued)

SonoraSoft is a "focused park" with a realistic development plan. When finalised, it will cover an area of 180 000 m2 (45 acres). Currently only Building 1 is operational, with 45% of its 6 000 m2 in use by software-oriented companies. SonoraSoft will open Building 2 in 2013 with an area of 8 000 m2 available for rent. ITSON, the Sonora State Government, and the Federal Government have invested MXN 105 million (USD 1.4 million) for Building 1 and MXN 90 million (USD 1.2 million) for Building 2.

The largest tenant at SonoraSoft is Novutek, a software-development company owned by ITSON. The entire park currently hosts around 400 employees in seven companies. SonoraSoft allows the tenants to use shared space, such as meeting rooms, conference rooms and training rooms, on the basis of the area rented by the tenant. Additional hours can be purchased on demand. SonoraSoft has fostered the development of a new high-tech industry in Southern Sonora, creating IT job opportunities for graduates of software-related engineering programmes, as well as providing an income stream for ITSON

Incubators in Sonora often lack some basic expertise and have limited resources. For example, IDEA is not well equipped with legal experts and needs to co-operate with TX TEC. A.C. – the UNISON incubator – to access specialised types of knowledge. ITSON has an annual budget of USD 30 000 for IDEA. Funding for operations, training and promotion of the incubation programme must be sought from federal funds, state funds, entrepreneurs or from extra services that the incubators provide[4]. International experience from the Netherlands and Germany shows that dedicated commitment and renewed support is needed to ensure a flow of new, self-sustaining activities and firms. Putting emphasis on a strong entrepreneurial culture is crucial in that context (See Boxes 2.4 and 2.5).

Box 2.4. Twente TOP Programme

Launched in 1984 by the University of Twente, the TOP (Temporary Entrepreneurship Position) Programme assists university graduates, staff and people from trade and business to start their own company. The programme has been a great success and has benefited to more than 400 entrepreneurs over the period. This has led to the creation of 320 businesses, 75% of which are still ongoing. On average, each business has eight or nine employees. This provides an enormous boost to the region. More people now work for these start-up businesses than at the University of Twente itself. It is estimated that 75% of new businesses would never have gotten off the ground without the TOP programme.

Box 2.4. Twente TOP Programme (continued)

Despite TOP's success, it is still the only one of its kind in the Netherlands. The TOP Programme has strengthened Twente's business culture and vice versa. The essential element of the TOP Programme is that the doors of Twente's departments are open to everyone in the area. The success of the scheme has been due in part to the involvement of various businesses and institutions across the region.

The programme is open to any entrepreneur who wants to develop a product or service with the help of the University of Twente. These new entrepreneurs receive an interest-free loan of EUR 20 000 and assistance with many issues facing a new start-up. The interest-free loan is meant to cover the living costs of the entrepreneur, so that he can devote his time to getting the business off the ground. The most important elements are the intensive supervision and assistance that the entrepreneurs receive, and the access they have to all the departments of the University of Twente.

Source: University of Twente (2012), University of Twente, *www.utwente.nl/en.*

Box 2.5. Entrepreneurial culture and the EXIST Programme in Germany

The Entrepreneurial Culture programme supports projects in universities and non-university public-sector research institutions that contribute to the establishment of an entrepreneurial culture. These projects are designed to boost the creation of new spin-offs from universities and non-university research institutions. Consequently, the recipients of funding are the universities rather than the potential entrepreneurs themselves. Between 2006 and 2008, 48 projects were selected for support in three rounds of funding applications.

In the new competition "University for Entrepreneurs" ("*Die Gründerhochschule*"), candidates have to submit clearly defined proposals implemented in co-operation with partners that focus on special courses, adaptations of the overall curriculum, and other complementary activities. In the first round started in 2010, proposals were submitted by 84 universities, ten of which were selected for funding and three given additional distinction. Currently, the following universities receive support: *C-v-O Universität Oldenburg*, *TU Berlin*, *Universität Potsdam*, *MLU Halle-Wittenberg*, *Ostfalia Hochschule für angewandte Wissenschaften*, *TU Dortmund*, *HHU Düsseldorf*, *FSU Jena*, *TU Munich* and *FH Munich*. Projects start with a "conceptual phase" of six months during which their proposal has to be further developed and its viability convincingly demonstrated.

Box 2.5. Entrepreneurial culture and the EXIST Programme in Germany (continued)

The maximum amount of funding allocated for that purposes is EUR 70 000. If the project itself is approved, it will be supported with annual funding of up to EUR 1 million for a period of up to five years. Thus, EXIST III – Entrepreneurial Culture allows the universities to implement initiatives of substantial scope and ambition.

EXIST is a programme of the Federal Ministry of Economics and Technology with a long history dating back to the mid-1990s. Over the years it has continuously been adapted and gradually improved. EXIST III and the EXIST-*Gründerstipendium* programme are co-financed by the European Social Fund (ESF). The key advantage of this line of projects is the long learning curve, so that by now most of the support packages and seminars offered under this framework have been proven to work and generate "additionality" in practice – while a number of others have been discarded. The overall programme has been closely monitored through accompanying research as well as regular evaluation from its onset, which has added momentum to the gradual process of improvement.

While EXIST is not a regional programme in itself, it aims at leveraging the regional potential of universities. Moreover, regional governments are expected to contribute to follow-up financing after the five years of project financing have ended.

Source: Kroll, H., E. Baier, and T. Stahlecker (2012), "The Role of Universities for Regional Innovation Strategies," EU Regional Innovation Monitor, *www.rim-europa.eu/index.cfm?q=p.file&r=94c05a1956e77cb12e5ed86b21f8ff15*; Bundesministerium für Wirtschaft und Technologie (2012) "EXIST – Gründungskultur," EXIST Existenzgründungen aus der Wissenschaft, *www.exist.de/exist-gruendungskultur/index.php*.

Loose regional innovation system (RIS)

While Sonora has an available knowledge pool (universities, R&D institutes), it needs to co-ordinate existing knowledge in order to connect innovative outputs. In particular, its scattered resources, such as research facilities, often dilute potential opportunities for innovation. Although Sonora ranks fourth in Mexico for the regional knowledge index (Kutsnetsov and Dahlman, 2008), it is characterised by a number of relatively small scale research bodies in various areas that remain sometimes underused due to the lack of critical mass and financial support.

The current situation in Sonora does not help to elevate the level of efficiency of the regional innovation systems, particularly since the major actors are underperforming in RDI and are often reluctant to collaborate. First, only 6% of Sonora's firms invest in "process technological R&D", compared to the Mexican average of 9%.[5] Second, the regional innovation system (RIS) is weak because large international firms are not participating (the "*maquiladora* effect"). Less than 2% of BERD in Mexico comes from abroad and Sonora is no exception. Third, efforts from Mexican firms to source knowledge in research institutions to strengthen their innovative activities remain limited. According to CONACYT innovation surveys, new products and processes were mainly developed in-house, 79.4% and 72.6%, respectively, in 2001. These figures increased in 2006 to 83.7% and 83.1%, respectively, indicating a lower recourse to external collaboration[6]. It is likely that the financial crisis at the end of the 2000s has not altered this trend.

Mexico's federal and state policy does not seem to target the consolidation of regional innovation systems (See the Korean experience in Box 2.6). Mexican public spending (compared to the GDP) is low compared to international standards and this is especially true for R&D assistance. Though Sonora received a relatively larger amount of money from *Fondos Mixtos* (FOMIX) than average in Mexico, the state does not get more than USD 15 million through INNOVAPYME, PROINNOVA, FOMIX and INNOVATEC. This amount is not enough to strengthen the clusterisation process and consolidate the loose links between firms, PROs (public research organisation), TEIs and multinational companies in Sonora.

Box 2.6. Regional innovation system and TEIs in Korea

The Korean Government, some years ago, endorsed the concept of regional innovation system as a basis for its innovation policy. It promoted a new type of support organisation in the 14 provinces based on the establishment of regional innovation councils, activation of regional innovation networks, and holding of regional conventions, exhibitions, and the training of manpower for innovation.

A regional innovation council is an organisation which deliberates and co-ordinates important issues for balanced national development and also devises development plans for regional innovation. The member of the council consists of professionals representing diverse organisations such as industries, universities and research institutions. In the case of the Busan Region, the innovation council is composed of 56 representatives, with more than 10 belonging to the HE sector.

Box 2.6. Regional innovation system and TEIs in Korea (continued)

Local TEIs are also contributing to the strengthening of networks through the establishment of Inno-cafes and network hubs as places for innovation diffusion through interactions and face to face meetings of regional specialists.

The third component of the strategy is to foster an atmosphere conducive to innovation throughout the region by holding Regional Innovation Convention and Expositions. Regional Universities are involved in many activities of these innovation "festivals".

Source: OECD (2012b), *OECD Urban Policy Reviews, Korea 2012*, OECD Publishing. *http://dx.doi.org/10.1787/9789264174153-en*.

Another issue contributing to the underdevelopment of Sonora's regional innovation system is the weakness or non-existence of Sonora's intermediate organisations or venture development organisations that can catalyse innovation inputs and assets.

Much is in the hands of universities and other TEIs. They are certainly the best placed to activate regional innovation system links and improve the governance of the regional system. Thus far, only ITSON has taken on this role and developed leadership functions helping to increase the visibility of Sonora in Mexico and at the international level.

Weak university-industry relationship

Tertiary education institutions in Mexico generally have weak ties with the productive sector and industry. There are, however, different forms of interaction between institutions and industry, of which collaborative research and informal contacts are the most important. Collaborative research, as it normally involves funding, is easier to trace. In 2007, the proportion of tertiary education expenditure on R&D financed by industry amounted to 1.3% – one of the lowest levels in OECD countries. Moreover, as opposed to the trend in OECD countries, the contribution of industry to R&D in higher education (3.4% in 1993) has declined in Mexico. Given that Higher Education R&D (HERD) in Mexico is particularly low (0.09 % of the GDP in 2007)[7], the amount of HERD that is financed by the business sector is close to negligible (OECD, 2008).

The contribution of the productive sector to research funding in Sonora is marginal. This is true also for technological universities and institutes whose RDI efforts remain modest. Informal contacts with industry in

research-related matters are not the norm either, although the technological institutes, the technological universities and the polytechnic universities maintain contacts with firms to provide professional training for their undergraduate students.

The weak interaction between Sonora's tertiary education institutions and the productive sector may be related to a number of factors. Local firms rely primarily on sources of information other than R&D to innovate, such as clients and competitors. Thus, they have little need to interact with the local research institutions. In consequence, local firms do not hire professionals with advanced degrees and have little or no absorptive capacity to make use of the knowledge generated by universities and other TEIs. Less than 10% of Mexican researchers work in the business sector, including state-owned enterprises. This means that private firms employ a negligible proportion of the research workforce and therefore lack qualified personnel to interact with researchers in tertiary education institutions.

Mexico and Sonora have no policy to induce TEIs to connect to SMEs and international firms, and consequentially, they have no incentive to do so. CONACYT has a programme for technological development and innovation addressed to companies. This programme seems to emphasise linkages with the academic sector but it is rather modest (EUR 8 million for 28 projects in 2010 in Sonora). There is a need to tackle this problem seriously with more funding mechanisms (see the example of innovation vouchers in Europe to remedy this problem in Box 2.7). Experiences of other Mexican states may be a source of inspiration. In Guanajuato, for example, several meetings and forums have been organised by the Council for S&T on a systematic basis with the participation of 50 CEOs and research leaders. The objective is to identify areas of collaboration and to achieve concrete results and projects. In the mid-2000s, this has led to the creation of clubs of innovators (business/research) and the establishment of networks. Altogether 15 innovation networks are now operating and 35 projects are supported (for one year only) by the state government in various fields such as optoelectronics, agro-food (strawberries), new materials, biotech and aeronautics. 11 networks are now self-sustaining and one is in difficulty.

Box 2.7. Innovation vouchers in Europe

The objective of Innovation voucher initiatives is to improve the links between public knowledge providers and small businesses and, in the long run, to create a cultural shift in the small business community's approach to innovation.

Typically, innovation vouchers are small-scale grants worth around EUR 5 000, which have to be invested in the acquisition of knowledge and/or consultancy from a regional research institute or a regional university. The main objective of such initiatives is to help overcome the traditional differences in mentality between the universities and the SME sector that prevail in many regions. Many SMEs tend to subscribe to a general perception that public research is too abstract and unsuitable for their needs. Consequently, they are very hesitant to invest in such co-operations. The idea of the innovation voucher programme is to enable first encounters on a concrete basis, but at no extra cost. Together with promotion campaigns, it is hoped that regional firms can be convinced to give co-operations a try if they are associated with no or little additional risk.

Innovation voucher initiatives have been initiated in Netherlands and subsequently launched in a number of countries, including Germany, France and the United Kingdom via Ireland, Spain, Italy, and the Czech Republic, in many cases based on EU Structural Funding.

In general, innovation vouchers have been found to develop a relevant facilitating effect in regions in which the general propensity to co-operate is already high. However, their major weakness is that they are of no use if the perception of the local SMEs is actually right. From that perspective, the measure must be assessed critically in regions in which the strategic orientation of research institutes is not yet focused on applied issues. Moreover, it will not be able to achieve any effects in regions where the business models within the SME sector do not tend to be innovation-oriented. Although a number of innovation vouchers could be assigned even in peripheral Convergence Regions in the European Union, they have not achieved a transformative effect on the overall nature of the relations between public research and the private SME sector.

Innovation vouchers are a suitable measure to add momentum to a latent interest or existing ideas for co-operation and to energise the innovation system of somewhat, but not highly-developed regions. At the same time, they have a limited transformative effect.

Source: JIC South Moravian Innovation Centre (2009), Innovation Vouchers, *www.jic.cz/innovation-vouchers.*

Trans-border co-operation translating into few RDI projects

Sonora's and Arizona's economic interests are closely connected. Exchanges between Arizona and Mexico mainly take place at the two main border ports of entry (BPOE): Nogales and Douglas (Aqua Prieto). About USD 16 billion of goods goes through Nogales each year and USD 1.1 billion though Douglas. As many as 235 000 jobs in Arizona rely on trade with Mexico, while 25.8 million northbound visitors cross the border annually (SE, 2010).

The most advanced cross-border cluster is agri-business. Related activities are based on traditional, family-based ties, close relationships between growers, distributors and brokers, and associations. In a number of other sectors, cross-border clusters have not yet materialised, but intensive linkages have been established between the two sides of the border, such as in the hospitality industry, health services and the manufacturing sector (Pavlakovich and Lim, 2009). Some developments have also taken place in complementary high tech sectors, which includes areas of potential co-operation such as software and computer services, aeronautics, medical, measurement equipment and mining.

The Arizona-Sonora Commission's Strategic Planning Committee (SPC) is engaging in four new initiatives: i) setting up new border security infrastructure; ii) expanding trade flows at Border Ports of Entry (BPOE); iii) promotion of economic regional development (organisation of forums, production of statistics and indicators, diffusion of tourist guides) and iv) enhancing the quality of life in the bi-national region (exhibitions, conferences and training programmes). The SPC is poised to build appropriate metrics and indicators and collect the information needed to assess the impact of these initiatives. Co-operation has also developed in the TE sector. For example, ITSON and the Arizona State University have established a partnership around a specific theme: sustainability through design[8].

Cross-border co-operation could nevertheless be developed further, for example, in tourism, water, renewable energy, copper mining, and waste management in order to build a dynamic bi-national regional economy. UNISON, ITSON and other TEIs could expand their current exchange of students and staff (see Box 2.8), focus on the design of a shared Arizona-Sonora vision, and increase the number of research projects with South Arizona TEIs and firms.

Box 2.8. The Øresund cross-border region

The Øresund Region comprises two regions that belong to different states. Nonetheless, the national government bodies of both Denmark and Sweden aim to make political initiatives and support programmes in the region available to as many of its inhabitants as possible. The best example for this is the "The Øresund Committee", a regional community created in 1993 to improve political co-operation and overcome administrative boundaries. In short, the region is well-integrated and well-managed.

The universities in the region share the belief that their mission goes further than htertiary education and research alone. In their mission statements they consider themselves proponents of education in a wider sense and "good citizens" – contributing to the common good and to the development of society at large.

Beyond the political domain, the Øresund Institute has been set up to encourage integration within the Øresund region. This is done through qualified analysis, objective fact-finding and boundary-crossing debates about different issues. The institute integrates the region's 14 universities into public life, where information, analysis and ideas are created and spread in order to support the integration process and the development of the region. The members of the Institute are public authorities, corporations, organisations and universities. It is financed primarily through membership fees and is independent of special interest organisations, political parties, public authorities, companies and nations.

Local universities offer a wide range of programmes and courses related to the so called "creative" areas. They are "sources" of innovative and creative students and researchers in top league internationally of design, architecture, film and the arts. Universities promote the work of students and researchers by holding exhibitions, concerts and conferences. Some universities focus specifically on fine arts and the performing arts. This is facilitated by the fact that Copenhagen, as a capital, is home to several unique art education institutions such as the National Film School and the Royal Danish Academy of Music.

In this context, universities are among the most important providers of cultural "products" consumed locally and globally. Given the Danish and Swedish reputation for design and arts, cultural products from the universities have a great impact on the development of new businesses in many fields. Cultural products in art and design are a central component of potential provided by universities and as an indispensable basis for entrepreneurial projects and successful innovation.

Source: Oresund University (2005), Self-Evaluation Report for the Oresund Region to the OECD/IMHE-project: "Supporting the contribution of higher education institutions to regional development," OECD, *www.oecd.org/dataoecd/28/51/35996176.pdf*.

Conclusions and recommendations

Sonora's economy experienced significant growth and diversification but remains FDI-driven and focussed on low tech sectors. Sonora's economy has grown significantly in the recent period, nurtured by the revival of the *maquiladora* sector (+7% in 2011). A number of sectors have shown growth, notably aerospace, agriculture, automobile, mining and fisheries. The industrial base is increasingly diversified and the manufacturing sector has nearly doubled its share of GDP since the beginning of the last decade. Despite the recent emergence of a number of high tech activities, the low tech sector remain dominant (low tech and mid-low tech accounting for 67% of gross value added in manufacturing[9]). From this perspective, the Sonora economy is more similar to those of Mexico State, Nuevo Leon or San Luis Potosi than to the neighbouring high-tech oriented states such as Chihuahua, Aguascalientes or Guanajuato.

The economy of Sonora is presently constrained by several factors: the weak absorptive capacities of firms and SMEs, the low level of research spending, the limited level of co-operation between the TEIs, as well as between TEIs and the business sector, and the modest level of funding provided by both the federal and the state government devoted to R&D activities. Very few TEIs are engaging in the task of animating the Regional Innovation Systems. The state government is mainly reactivating the *maquila* model and prioritising the acquisition of foreign technologies.

The present fragmentation of industrial and service activities contributes to the fragility of Sonora's economy and increases its vulnerability with regard to competition from South East Asian countries, notably China. Recent analysis shows that Sonora has augmented its degree of specialisation in clothing, plastics, and automobiles, but has witnessed a decreasing specialisation in ICT and Pharma during the 1980-2003 period (OECD, 2009b). These trends seem to reflect some type of erosion in the development of the knowledge base of the economy. It also suggests that the tertiary education sector will remain a bottleneck unless new investment allows it to enhance the skill level of the labour market and better serve regional economic development.

Sonora needs a more balanced RDI strategy, giving more room to initiatives that encourage endogenous development and research spending on a number of niches. Universities and other TEIs have an important role to play in this context. They should become agents of the new smart specialisation strategy and align their education policy with business demand, with a special focus on the main areas of Sonora's comparative advantages. They also need to be more intensely incentivised to collaborate with other universities and domestic TEIs on innovation projects and

education initiatives. Good practices as those demonstrated by ITSON should be rewarded and scaled up to a system. Such a strategy would give a boost to Sonora's research and innovation performance, help reduce business sector gaps, and favour increased participation of the tertiary education sector in Sonora's knowledge economy.

To unleash the potential of universities and other TEIs for the development of Sonora's economy and regional innovation system, the OECD review team recommends that the following measures are taken.

Recommendations for the federal and state policies

- Articulate a state-level innovation plan and technological vision, and focus on implementation. Sonora's economic strategy has traditionally stressed the development of the *maquila* industries, recruitment policies and infrastructure building, rather than R&D and new product and process innovations. The state would nonetheless benefit from a clearer focus on technological perspectives. Drafting an innovation plan would help policy makers to develop a vision for Sonora's future and make clear technological choices. This requires the mapping of linkages between the state clusters and should lead to an assessment of the consequences of different technological assumptions and priorities. A state-level innovation plan would help policy makers focus on the merits of endogenous R&D policy for certain niche sectors (aerospace, alternative energy, desalinisation plant, logistics and measurement instruments) and to depart from the "technology-follower" model that has been prevalent in Sonora for the past decades. This framework will provide TEIs with a roadmap for the future and make their R&D programme more coherent and easier to evaluate. The process of designing the plan would be facilitated by referring to ITSON's Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*), which was developed at the end of the 2000s in collaboration with state and sub-state authorities. Given that Sonora underperforms in obtaining federal research funding compared to other states like Nuevo Leon and Baja California, an innovation plan would significantly help the state obtain more funding for innovation and R&D development from the federal ministries and CONACYT.
- Improve the alignment of universities' and technological institutes' education and research policies with the state's comparative advantages, bearing in mind the dominate role that low technologies continue to play in Sonora. The availability of skilled and semi-skilled personnel is a key

factor in the choice of location for multinational companies. At the same time, MNCs target areas of strength within the state in order to foster their competitive edge. Even if search for low-cost labour is paying an important in FDI strategies, investors also look for skills. Sonora and Mexico are in competition with many other emerging countries trying to attract companies and talents. The htertiary education sector therefore needs to engage in regional development through a stronger focus on training in skills and technologies in Sonora's areas of comparative advantage. If TEIs want to become engines of economic growth in Sonora, they must align their teaching and education policies with the appropriate segments of the market. TE research policies should also echo these concerns. Thus far, the distribution of nationally certified SNI researchers does not favour industrial research topics (only 11% of SNI researchers work in engineering and only 10% work in chemistry and biology). The technological institutes are also very weak in engineering R&D. A better balance of research must be achieved that is more in line with Sonora's specialisation assets.

- Continue to build on good practices in technology transfer, such as focussed parks like Sonora Soft Technology Park, and impose a rigorous cost-benefit and environmental analysis of large-scale programmes such as Knowledge City in Hermosillo. Thus far, Sonora has made moderate use of technology transfer instruments such as parks and incubators, but there are now ambitious plans to transform Hermosillo into a knowledge city. Many studies have shown that while university-based science parks perform better than non-university-based parks, they are not a panacea. There is limited evidence that networking with science parks has positive effects for SMEs. Various studies that compare firms located on and off science parks have revealed limited evidence of significantly enhanced performance by the science park enterprises. Incubators, often located in science parks, are another mechanism for transferring academic research to start-up firms. The increasing development of incubators in Sonora is a welcome trend. There is, however, a risk of fragmentation, particularly for incubators linked with the new technological institutes. Focussing on the formation of sector-specific incubators, *e.g.* in the biotechnology or engineering sector, and state-wide networks may increase the chances of achieving the necessary critical mass that ensures the sustainability of these activities.

- Define frameworks and increase incentives for inter-university co operation and joint programmes between higher technological institutes (ITS) and university. This process should involve the federal government (SEP, SES, and CONACYT) working together with the state authorities (State Secretary for Education and Culture). Many

research and innovation opportunities are lost due to insufficient collaboration between different tertiary education institutions. Research in engineering (UNISON, ITESM- Monterrey Tech, ITSON, ITH, ITN, ITESCA, ITSC, ITSPP) and in agrobusiness and fisheries (UNISON, ITSON, Instituto Technologico del Mar, CIAD, UES) is particularly fragmented. The technological institutes have often forged relationships with SMEs, providing them with technical assistance and co-operation in incremental innovation. They have also embarked on the process of building a common space (*Espacio comun*). This space needs to prioritise academic collaboration and the implementation of joint R&D and innovation projects. Collaboration between universities and institutes should receive special attention, as it could help large institutions such as UNISON to improve their interaction with SMEs. This could be further reinforced by the creation of joint one-stop-shops that offer an integrated range of supply services to firms, emphasising the relationship between market-based and less-applied research. Mapping out the strengths and knowledge fields of different TEIs would be useful. Synergies could be developed through common projects and graduate theses.

- Promote an evaluation culture based on robust data at an institutional level. A more efficient TE sector can act as a springboard for achieving a more innovative and robust Sonoran economy. Monitoring the outcomes and assessing the impact of engagement policies would help secure a greater innovation-based trajectory for Sonora's economy. State authorities should embark on a comprehensive evaluation programme of their TE policy and its outcomes. This would imply regular strategic meetings between agency directors and university rectors with the goal of regularly assessing progress. This would require the establishment of a data collection methodology, the use of indicators and the definition of the assessment's objective. With regard to the policy support for technology transfer or network creation, Sonora's authorities should build an evaluation platform that users indicators such as the number of business ideas screened and the number of development products generated. In the case of university start-ups, incubators and science parks, indicators should include the capacity of these organisations to establish large scale partnerships and to obtain private funds. The number of universities involved and the number of firms and jobs created are often quoted as indicators of success. More sophisticated analysis, such as using questionnaires addressed to customers or cost benefit analysis of programmes, would be welcome.

Recommendations for the Sonora's universities and other TEIs

- Forge stronger links with the SME sector and relevant industry clusters (this is especially important for UNISON). Align institutional education policies and research programmes with the demands of the state economy. Give more attention to internship policies and long-term collaboration with the private sector.
- Streamline institutional internationalisation policies and diversify areas of research collaboration. Some TEIs have signed a great number of agreements which often remain umbrella frameworks that do not lead to concrete projects. While EU co-operation is excessively focussed on the agribusiness sector, there is strong potential for collaboration Sonora's other areas of strength such as engineering, solar energy and water technologies.
- Clearly articulate institutional technology transfer policies and increase networking with other institutions. Focus on specialising the incubators and increasing the professionalisation of technology transfer offices in areas where a sufficient critical mass of researchers can be achieved.
- Make efforts to ensure a broad diffusion of entrepreneurship programmes in education institutions, notably technological institutes. Give these programmes an important role in the education strategy of the institutions. Despite the recent increase in the number of entrepreneurship support programmes at the federal level, e.g. within the framework of PeCiTi (a federal programme for STI) and national efforts to diffuse a culture of entrepreneurship among researchers (Programme Mexico Emprende), Sonora's universities and technological institutes are not fully mobilised to develop a comprehensive approach to entrepreneurship teaching. While UNISON has implemented a programme to diffuse enterprise culture (Programma institutional de Fomento a la Cultura Emprendedora) that is based on lectures, focus groups and product displays and ITSON has hosted a 2012 event called Caravan of the Entrepreneur, that aims to raise awareness and drive society towards more entrepreneurial and innovation-oriented attitudes, entrepreneurship is in most cases not part of the core curricula. Scaling up the effort made by ITSON, steps need to be taken to create comprehensive entrepreneurship modules and to integrate them into the curricula.

Notes

1. The IMCO city competitiveness ranking places Cajeme in a high position (8) and rank Hermosillo (30) and Guaymas (64) lower.
2. Instituto de Educacion Superior.
3. This number only includes students enrolled in undergraduate and graduate programmes. The entire student population at UNISON is 36 382 which includes students enrolled in arts workshops and language courses.
4. Last year Fondo PYME supported 30% of the cost for training and business plan development for IDEA incubated firms. Support was received for establishing the CISCO Entrepreneur Institute, which will provide a platform for virtual activities and also for entrepreneurial content and courses for training.
5. Sonora is ranked 21st for this indicator. See OECD (2009a).
6. See Innovation surveys 2001 and 2006 quoted in OECD (2009b).
7. Mexico's GERD does not exceed 0.04% of the national GDP.
8. The collaboration put emphasis on eco-tourism, microenterprise development, environment planning and alternative energy.
9. Figures are similar for Mexico state (67%), Nuevo Leon (64%) and San Luis Potosi (65.4%). Low/mid low tech tech is less important for Guanajuato (55%), Federal District (46%), Aguascalientes (39%) and Chihuahua (24%). In Sonora, the manufacturing gross value added is realised for 43.4% (percentage of manufacturing industries) in the low tech segment, 23.5% in the mid-low tech, 18% in the mid-high tech and, 15% in the high tech.

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Chapter 3.
Social, cultural and environmental development

Social, cultural and environmental development supports economic growth, improves health and welfare, and social cohesion, and contributes to a healthy and sustainable environment. Universities and other tertiary education institutions (TEIs) have an important role to play in addressing environmental, social and cultural challenges and opportunities facing the state of Sonora. This chapter reviews the contribution of Sonora's TEIs to these critical areas, with special focus on efforts made to address water scarcity, inequity in access to education, social exclusion and cultural diversity. The chapter concludes with recommendations for TEIs to contribute to the development and preservation of sustainable local economies and regional cultures and addressing community development and social inclusion issues.

Introduction

Tertiary education institutions (TEIs) have an important role to play in addressing the significant social, cultural and environmental issues in Sonora and its constituent communities. Against the long term demographic and environmental trends, this chapter focuses on the critical areas for Sonora where TEIs can enhance their contribution through teaching and learning, RDI and social service: inclusion through widening access to education, community development and economic development through tourism and cultural connections, as well as promotion of environmental sustainability.

Poverty and its associated problems remain a challenge for a significant portion of Sonora's population, and is concentrated among rural and indigenous communities. While Sonora along with other northern states has lower levels of poverty than southern Mexico, in international comparison the poverty rates are high. Poverty, poor health, low levels of literacy and limited access to education and adequate housing affect a significant portion of Sonora's population. The spatial distribution of the population contributes to patterns of unequal access to services including tertiary education across Mexican regions and within states, particularly affecting the rural population. Rural population in Sonora is poorer than the urban population, and includes a higher proportion of the indigenous population, among which the poverty rate is higher.

Sonora is also faced with difficult environmental challenges, due to drought and water scarcity. Sonora has experienced drought since the mid-1990s and is facing a growing threat of desertification. The demand for water in the urbanising northern portion of the state and the continued demand for water by agricultural water users in the southern part have produced water disputes, but no long-term solutions to the water shortage. Sonora's water situation is likely to continue to deteriorate due to in-migration, land and real estate development and inefficient use of water resources.

This chapter addresses the following questions

- Are the universities and tertiary education institutions activities targeting the key challenges in Sonora's social, cultural and environmental development?
- Are there gaps in delivery? Are resources aligned with the objectives?

- What lessons can be learned from international experience?

3.1 TEIs and social inclusion

This section outlines the role of Sonora's TEIs in responding to the need for broadening of opportunities for tertiary education and for greater social inclusion. Sonora stands out in Mexico as a state that will face increasing demand for tertiary education due to industrial demand for skills and the increasing ability of families to see the value of increased education and finance educational opportunities. Acknowledging the need to widen participation, the state government and Sonora's TEIs are devising their strategies to respond to need to widen access to and participation in education (through scholarship programmes, programmes to identify student populations with special needs, and a strategy of reaching students where they live). Sonora's TEIs are also developing community service programmes that address the needs of the low income population by taking advantage of Mexico's mandatory requirement of community service for all students and developing social enterprise around alternative tourism.

Inclusion through access to tertiary education

In Sonora, access to tertiary education is constrained by geographical, cultural and financial barriers as well as lack of preparation in primary and secondary education. The spatial distribution of the population contributes to patterns of unequal access to services and tertiary education across the state, particularly affecting the rural population. Among the northern states, Sonora has the highest proportion of indigenous population. The indigenous population in Mexico has a multi-dimensional poverty rate of 75.7% with 39.2% in extreme poverty (CONEVAL, 2009) and generally features weaker education and labour market outcomes. See Annex 3.A.1 for Sonora's indigenous populations.

The state and TEIs in Sonora have introduced a number of programmes to improve the access of the population to higher education by reducing financial and geographical barriers. For example, the state of Sonora has been a leader in Mexico in providing assistance to needy students through a public sector loan programme, Sonora Student Loan Institute (*Instituto de Credito del Estado de Sonora*, ICEES). Altogether 54 TEIs have been established in the state, some of them also in rural communities to reduce geographical barriers. Some tertiary education institutions have also branch campuses, e.g. ITSON has five branch campuses hat offer educational opportunities and support for entrepreneurship in local communities. The establishment of tertiary education institutions in many locales in Sonora

reduces the total cost of education for students who are able to live at home and commute to the campus.

Sonora is also home to TEIs that directly address the educational needs of indigenous population groups in the state. These include the *Instituto Tecnologico del Valle del Yaqui* (ITYV) and UES (*Universidad Estatal de Sonora*, formerly known as CESUES). These institutions address the particular needs of industrial sectors that are concentrated in these regions and are historically connected with the ways of living of the indigenous population. They serve the special higher education needs of students coming from culturally-distinct or low-income communities, and provide academic, social and financial support to encourage access to and success in tertiary education. For example, UES, which has campuses in five municipalities including Navojoa and Benito Juarez, where 70% of the population is made up of indigenous Mayan people, has developed a competency-based learning model that provides employability skills and focuses on fields relevant to local communities. It also provides a range of financial support mechanisms for students. UES plays an important role in providing educational opportunities to the local population, but faces significant challenges, because of its low per student funding. (Per student funding at UES is USD 3 622 so higher than at ITSON [USD 2 800], but lower than at UNISON [USD 5 500]). Due to challenging circumstances, UES needs to strengthen its links with the TE sector, local commercial and social sectors, and orient its emerging RDI activities toward their needs.

Box 3.1. UES

UES (*Universidad Estatal de Sonora,* formerly known as CESUES) seeks to serve the educational needs of Sonora's low income and/or indigenous population groups and address the challenges they face obtaining access to higher education. UES began its activities on the campus of the Universidad de San Luis Río Colorado in 1983 and later opened four branch campuses: Hermosillo (1984), Navojoa (1992), Magdalena (1998) and Benito Juárez (2001), where the economic activities focus on manufacturing, commerce and agriculture. In 2012, UES enrolled a total of 7 538 Bachelor's degree students and 153 Master's degree students, making UES the third largest university in the state of Sonora.

Students at UES campuses face many difficulties accessing higher education and UES has made a major effort to reduce dropout rates. Many students come from rural locations and face economic hardships that lead them to drop out. 70% of students at the Benito Juárez campus are indigenous and face financial difficulties. Between 2010 and 2011, the dropout rate rose from 12% to 25% primarily due to students leaving school to work. UES has many academic and non-academic programmes to help at-risk students.

Box 3.1. UES (continued)

Annual tuition fees cost MXN 2 000 (USD 180) and may be cancelled for low income students. 1 595 students (21% of the student body) receive need-based scholarships, 971 students (13% of the student body) receive scholarships as members of indigenous communities and all 496 students at the Benito Juárez campus receive two low-cost meals per day on campus. 458 students receive health care and psychological services. One-third of students participate in academic support activities and 4% have been awarded a laptop for excellent academic performance.

UES' academic programmes and competency-based learning model help students integrate into the local labour market. UES offers Bachelor and Master degrees in accounting, business, engineering, computer systems management, horticulture, aquaculture, agribusiness and athletic coaching. All campuses offer internet with access to a Virtual Learning Environment for faculty and students, as well as English-learning software for students. UES also ensures opportunities of academic mobility for its students, with 1 in 23 students participating in a summer internship or academic semester abroad or elsewhere in Mexico. Since 2007, UES has a competency-based educational model, ENFACE, which reviews all academic programmes to determine their social impact and relevance. The ENFACE model is academically flexible, student-learning centred and based on competences. It has a focus on sustainable development, social responsibility and employable skills. All of the professors at UES campuses are trained in this educational model.

UES aims to produce locally-relevant and internationally-recognised research. 51% of its professors hold Master degrees and 9% PhDs. UES sponsors 24 research projects focused on improving the environment, industry, software and aquaculture, for example, a study on pathogens in shrimp cultures, a relevant issue for the community of Benito Juárez, which is heavily involved in aquaculture. UES also aims to participate in international research, with 21% of researchers per year involved in international projects and 40 articles published in international journals.

Source: CESUES (El Centro de Estudios Superiores del Estado de Sonora) (Centre for Higher Education of the State of Sonora) (2012), "CESUES," PowerPoint presented at OECD Review Visit, Hermosillo, 13 March 2012.

Inclusion through TEIs' community development activities

TEIs' long term community development activities can improve the inclusion of low income populations in Sonora. While Sonora's poverty rate (26.7%) is lower than in the southern Mexican states, it remains high in OECD comparison. Poverty and its associated problems – poor health, low levels of literacy as well as low education and labour market outcomes, and poor housing conditions – affect a significant portion of Sonora's population.

Community development by Mexican universities is supported by the national requirement for tertiary education students to complete extensive social service (240-500 hours) before they graduate. The formal requirement for mandatory community service for all students has many strengths but also weaknesses. TEIs' community service can help transform communities and ensure high quality experiential learning opportunity for students. The mandatory requirement can help mainstream community service activities into the core business of TEIs. At the same time, mandatory community service for all students can also constitute a strain on TE faculty if well developed mechanisms are not in place to manage and organise the community service and compensate for the lack of staff.

Sonora's universities recruit students into service learning opportunities on a volunteer basis and have developed programmes to place students in internships with local companies or with community-serving not-for-profit organisations in the social services or cultural sectors. Student participation in learning and service activities outside the university is taken for granted because of a national commitment to societal development in the public tertiary education system and also in many private institutions. Students generally participate in service learning programmes after the fifth semester of their enrolment.

TEIs in Sonora have adopted many different approaches to facilitate students' community service. For example UNISON is known for its extension services especially in rural areas and has been recognised as a socially responsible organisation by the Mexican Centre for Philanthropy. This recognition is granted to educational institutions that implement social responsibility beyond formal obligations and whose community action has positive impacts on the environment (UNISON, 2012). The private university ITESM (Tecnológico de Monterrey) is renowned for its outreach function that utilises student community involvement. ITESM's technology knowledge transfer activities support not only hitech spinouts but also small scale social enterprises, facilitating the move from informal economy to micro-companies.

A world-class example of university community service is ITSON's University Centre for Community Development (*Centro Universitario Para El Desarollo Communitario*, CUDDEC) that is built on long-term presence in the micro-community, robust measurement of outcomes and continuous improvement of activities. CUDDEC engages students and staff in programmes to achieve strategic objectives with and for the community in which the centre is located, including improving educational attainment, building job skills, improving health and the local environment. CUDDEC has successfully integrated community action into research and teaching (see Box 3.2).

Box 3.2. CUDDEC

The University Centre for Community Development (*Centro Universitario para el Desarrollo Comunitario*, CUDDEC) initiative was launched by ITSON in February 2009. It grew out of a community intervention project undertaken by the University Centre for Community Engagement (CUEC) in 2000 in vulnerable areas in southern Sonora.

After years of community engagement and a long tradition of collaboration with marginalised micro-communities, ITSON wanted to see more tangible improvements in the local community. After mapping international experience in community service, ITSON decided to target its community outreach on the most vulnerable area in Ciudad Obregon. This area was not serviced by the city and had alarmingly low socio-economic development outcomes with high rates of crime, unemployment, school dropouts and gang activity. Following two years of community actions, ITSON established the CUDDEC centre. Working first with school children and mothers to reduce school dropout, CUDDEC has gradually expanded its portfolio to address the needs of the community, building the basis for socio-economic development and sustainability. CUDDEC aims to dignify the community by making it self-sufficient, sustainable and healthy and focusing on families in vulnerable communities.

CUDDEC provides a diverse range of activities in sports, arts, education and skills training. It runs a psychological clinic, computer centre, child care centre and veterinary clinic that was created to address one of the health problems in the community: stray dogs which carried diseases. CUDDEC offers community leisure activities, cultural events, and community "gardens". Children learn by playing. CUDDEC also organises various activities to animate the community and encourage integration. Sport events are one of the most successful activities for youths; ecological projects are aimed to increase the awareness about the environment and community gardening projects teach families how to produce their own vegetables. One of the most valuable activities is the vocational orientation programme aimed at encouraging self-employment and integration of informal economic activity into the local economy to become a self-sustaining economic base of the community.

CUDDEC collaborates with ITSON's academic and administrative departments, public services, schools, community groups, the private sector and social organisations. The backbone of the CUDDEC work is the mandatory social service that students undertake as part of their learning programme (up to 500 hours during a course of study).

Box 3.2. CUDDEC (continued)

Between 2009 and 2012, 13 723 people in the community have directly benefited from CUDDEC's services. 61 communities collaborated with CUDDEC, 461 students participated in the CUDDEC projects, 55 professors from ITSON, 29 external collaborators assisted and supervised projects and 84 public, private sector organisations and NGOs collaborated with CUDDEC. Annual operations amount to MXN 1 million (about USD 80 000), 90% of the funding coming from ITSON and the rest from private donations (monetary support and volunteer service). The land was donated by the municipality.

Thanks to its permanent presence in the community, CUDDEC has grown with the community, and supports personal, social and economic development of individuals and groups, facilitating long term community empowerment. The dangerous gangland where police would not enter has reinvented itself with the help of CUDDEC and is now safer and more vibrant. The community has become economically dynamic, gang activity has decreased, household incomes improved, and the proportion of the population studying and working have increased. During the period from 2006 to 2012, unemployment rate dropped from 31% to 23%; businesses grew from 12 to 28, average income increased from USD 240 to USD 540. CUDDEC has supported the residents' move away from an informal to a formal economy, and the community environment, including buildings, has visibly been upgraded.

CUDDEC has developed a sophisticated measuring system to evaluate its impact with five strategic areas and ten measurable targets. It aims to contribute to the development of communities to make them more resilient, economically sustainable and healthy, with a higher sense of well-being and quality of life. The strategic objectives and targets are:

- Education: reduce the dropout rate; increase the number of students entering tertiary education.
- Economic development: provide technical training to the adult population; increase the number of microenterprises and their stability in the market; increase household income in the vulnerable zone.
- Culture: promote participation in cultural activities and the arts.
- Health: improve public health through participation in health programmes; reduce the rate of addiction, delinquency, and the number of gangs in the area.
- Ecology: promote awareness of the effective use and management of natural resources.

Source: ITSON (Instituto Tecnológico de Sonora) (2012a), "Centro Universitario para el Desarrollo Comunitario (CUDDEC)," PowerPoint presented at OECD Review Visit, Ciudad Obregón, 15 March 2012.

Despite its many strengths and achievements, CUDDEC faces challenges for its long-term sustainability. While CUDDEC needs to reach out to a greater population and offer more work training and certification programmes, expanding CUDDEC operations has proved difficult due to the narrow and limited funding base. Aligning CUDDEC efforts with the federal government programmes could help achieve complementarities and diversification of funding sources from private sector and federal government. CUDDEC also needs to involve a greater number of students and teachers in service learning and integrate its public service into academic life as the leading social laboratory for the ITSON students and faculty.

Inclusion through promotion of social and economic development: tourism industry and cultural connections

Tourism is a growth industry from which countries and regions at all levels of development can potentially benefit.[1] For Mexico, tourism is a key economic sector and an important source of regional development, jobs and economic activity. In 2009, tourism accounted for 8% of GDP, higher than the combined totals of agriculture and the food industry, and employed 2.45 million people (6.9% of total employment). (OECD, 2012c)[2]

Governments at different levels in Mexico have aligned their efforts to capitalise on cultural heritage in regions to foster economic development that is built around cultural celebrations, culinary routes and sites that reflect the history and diverse cultures. The federal government's "Routes of Mexico" programme includes ten routes throughout the country, enabling travellers to benefit from Mexico's natural, architectural, historical and cultural heritage in all 32 states (OECD, 2012c). The state of Sonora has aligned its development plans with the federal government's programmes: consecutive plans have emphasised the role of tourism, by promoting skills development, ecotourism and rural tourism (2003-2009) and supporting the tourist routes (2003-2009).

Sonora's TEIs have the potential to contribute to cultural tourism through the demand for visits to festivals, museums and galleries as well as music, dance and theatre performances. More generally, TEIs also add to the cultural ambience and traditions in Sonora which can become an attraction for tourism. Current efforts include TEIs fostering a continuing appreciation of local cultural traditions and practices. For example, the students in Benito Juarez campus of UES participate in national day celebrations, musical events and other cultural activities, such as "Day of the Dead" preparations and local celebrations. ITSON is supporting the efforts to boost cultural tourism associated with the Alamos festival, by involving the Regional

Centre of Popular Arts in a new experiment drawing from the local heritage and crafts, collaborating, for example, with *Centro de Culturas Populares*, and the Convention and Tourism Office. ITSON's arts and cultural programme not only aims to train well-rounded graduates, widen access to education and showcase talent nurtured in the university, but it also aims to educate audience for cultural events and add to the cultural offer that can attract talent and tourism (see Annex 3.A.2).

ITSON has also created a tourism development programme in Southern Sonora that reflects contemporary practice, building tourism "corridors" or trails in the state that encourage visitors to stay for longer periods (see Box 3.3). The tourism strategy emphasises Sonoran cuisine and the development of local businesses and co-operatives in food and crafts to magnify the economic impact of visitors especially in indigenous communities. ITSON has extended the development of business skills to the locations where tourist development is taking place. For example, ITSON offers courses in tourism at the Navojoa campus and helps support new projects aimed at tourism. New plans include developing cultural circuits that connect Obregon, Navojoa, Guaymas and Empalme in order to create a "cultural region" that has links with the tourism corridor.

Box 3.3. ITSON: Developing alternative tourism corridors in southern Sonora

ITSON is engaged in the promotion of social and economic development in southern Sonora through its Alternative Tourism Corridors project. Southern Sonora is rich in natural resources and has many activities that would appeal to tourists, but it lacks the funding and skills necessary for a developed tourism industry. The region also suffers from unemployment, stagnant development as traditional activities become unprofitable, and loss of human capital as graduates migrate to other cities. Federal and state priorities target the development of sustainable tourism as a means of encouraging economic growth in the region.

ITSON's alternative tourism project, created in 2006, promotes sustainable and fair ecotourism in order to benefit local communities. It also seeks to train leaders able to design, execute and promote projects of sustainable tourism and plan new tourist areas that promote the sustainability of the environment and culture. The project identified five regions with 12 communities (La Manga, Manga II, Álamos, Aduana, La Sierrita, Yavaros, Moroncárit, Navojoa, Cocorit, Hornos, Buena Vista, Yécora) with high tourism potential. ITSON has provided technical and administrative assistance to community-based enterprises through academic groups composed of faculty and students from a variety of disciplines. These groups provide specialised equipment and knowledge to help local enterprises offer competitive services in commerce, hotels, restaurants and transportation. ITSON also provides training through university degree programmes in tourism. In addition to economic development, the project has aimed to increase earnings of the working population of the corridor, reduce emigration, and increase employment opportunities and education, particularly for women and indigenous people.

Box 3.3. ITSON: Developing alternative tourism corridors in southern Sonora (continued)

Between 2006 and 2012, the alternative tourism project has involved 54 beneficiary families that have undertaken tourism projects, generated 20 direct jobs and 5 partnerships with businesses. Over 230 ITSON students and faculty from various disciplines participate in the project annually. In addition, 115 students per year pursue Bachelor degrees in ITSON's tourism programme. The project has successfully created a tourism infrastructure and improved human capital in the region. It has helped ITSON to forge alliances with municipal governments, environmental groups and the National Commission for the Development of Indigenous People. Many communities in the project have successfully achieved "commercialisation" status; they have developed tourist enterprises, such as a scenic ranch in La Sierrita or boat tours in Yavaros. Economic development in the communities has disrupted the trend of outmigration; the community of Álamos has grown 3.5% annually in the past five years.

Source : ITSON (Instituto Tecnológico de Sonora) (2012b), "Corredores de Turismo Alternativo en el sur de Sonora," PowerPoint presented at OECD Review visit, Ciudad Obregón, 15 March 2012.

Tourists are the main consumers of recreational and cultural services, as well as a variety of creative products such as crafts and music. Building on the experience of the alternative tourism project, ITSON and other TEIs could help devise policies and interventions to ensure that the cultural and creative industries are able to capture a greater share of tourists' expenditures in Sonora. They could also develop a stronger base of creative businesses that are able to supply goods and services of good quality and sufficient quantity to respond to the demand from the tourism sector.

3.2 Promotion of environmental sustainability

Sonora faces difficult environmental challenges because of the fragility and limits of its desert environment, poverty, population growth and industrialisation. This section provides an overview of Sonora's key environmental issues – water access and quality, air quality and greenhouse emissions, and energy alternatives – and how TEIs respond to these issues. The engagement of Sonora's TEIs in issues relevant to the regional environment and economy provides the basis for concerted and collaborative action to address the region's critical environmental concerns, particularly issues of water quality and access. Sonora's TEIs have engaged sustainability issues at multiple scales, including research, curriculum development and campus sustainability initiatives. Their various efforts

indicate the recognition of the issues, but at the same time, co-ordination, investment and technical challenges remain to be addressed.

The critical issues of water access and quality

Access and quality of water are critical issues for Sonora's sustainable development. Sonora has experienced drought since the mid-1990s and is Mexico's leading state for land under irrigation. Sonora's important industries, particularly agriculture, are intensive water users. At the same time, urban expansion in the northern portion of the state has been land-intensive and insufficiently planned to use existing, limited water resources efficiently. One third of aquifers are over-drafted, especially in Caborca, Guaymas and in Hermosillo. Sonora is facing a growing threat of desertification (Sonora's Regional Steering Committee, 2012). The demand for water in the urbanising northern portion of the state and the continued demand for water by agricultural water users in the southern part have produced water disputes between different water users, but no long-term solutions to the water shortage. Maintaining an adequate, safe supply of drinking water is a concern in some areas.

Sonora's water situation is likely to deteriorate in the future due to a number of factors. First, there is a continuous in-migration into Sonora which threatens to accelerate the situation. Second, land and real estate development in Sonora contributes to inefficient use of water resources. Third, the lack of a strategy to address unsustainable development fosters inefficient use of water resources, while low levels of real estate taxes encourage extensive, unplanned development. Inefficient water users are, in effect, subsidised.

A recent OECD territorial review on the neighbouring state of Chihuahua reinforces the regional concerns regarding water use:

> Climate change is expected to increase the frequency and severity of drought in the larger region of northern Mexico and the south-eastern US. If it does, then the consequences for agriculture will be severe. Pressure on aquifers will increase as farms try to offset missing precipitation with increased pumping, and aquifer recharge rates will decrease. There will be major consequences for the livestock sector if forages are depleted and cattle herds have to be reduced. Competition for scarce irrigation water for crops will require new water allocation schemes if the water supply is not to be exhausted (OECD, 2012b).

Despite the severity of water problems in Sonora, the state of Sonora has not yet developed a strategy to address real estate development that fosters efficient use of water resources. One of the examples of Sonora's ambitious land and real estate development is the high profile plan to build a Knowledge City, pooling the leading private TEIs and part of the public TE sector in the northern part of Hermosillo. This type of a plan requires a rigorous cost-benefit and environmental impact analyses.

Sonora needs a comprehensive, regional approach to water planning and growth management, and should mobilise TEIs' joint academic expertise for this purpose. A comprehensive, regional approach to water planning and growth management should address the full range of water uses – in agriculture, manufacturing, and in residential and TEI developments. The Sonoran TEIs can play a key role in contributing to a better understanding of the geologic conditions and in the planning process. They can also contribute to the development of new technologies to conserve and use water efficiently. Some research that bears on water use is being conducted by research institutes outside of TEIs, such as the Centre for Food Research and Development (*Centro de Investigacion en Alimentacion y Desarrollo,* CIAD) and individual researchers in TEIs. Although this individual research is important, there are no collaborative efforts on the part of Sonora's TEIs to develop multidisciplinary and cross-institutional initiatives to respond to water challenges.

One opportunity for potential collaborative efforts that could contribute to effective water planning in the state of Sonora derives from the development of cross-border planning capacity (US-Mexico), particularly joint initiatives to construct geographic information systems that provide spatial data for the border region, encompassing Sonora. A comprehensive data system that would combine environmental and social-demographic data and present a picture of Sonora as an integrated ecosystem could also have a galvanising effect on policy makers by demonstrating how actions taken in one part of the region may have unintended consequences for the border region as a whole. Data gathering and joint initiatives linked to water resources could begin the process of addressing environmental problems on a regional scale and in a less fragmented way. They could underpin governmental efforts to provide a more comprehensive approach to natural resource management and provide a model for a related set of initiatives, for example in land use planning within the state of Sonora.

The state of Sonora and its TEIs could find inspiration in the Paso del Norte efforts to develop co-ordinated water resources planning. See Box 3.4.

Box 3.4. Strategies to develop co-ordinated water resources planning

In the Paso del Norte region, the University of Texas at El Paso established the Binational Water Programme in 1992 as a response to potential conflicts over the use of the region's diminishing water resources and public anxiety over health risks. It has brought together federal, state and regional agencies, municipalities and irrigation districts, as well as private sector and nongovernmental organisations.

The programme has been extended and expanded over the years, culminating in the establishment of the Paso del Norte Water Task Force, which provides a forum for the exchange of information and development of a regional Geographic Information System (GIS) to facilitate the compilation, mapping and analysis of the region's water resources. This initiative was developed through the University of Texas at El Paso (through the Regional Geospatial Service Center), New Mexico State University and the Autonomous University of Ciudad Juárez to develop a Coordinated Water Resources Database and GIS website, as well as to develop a model of Rio Grande water flows. One goal of these efforts is to share regional water resource data needed for groundwater availability models.

A flood control model for the entire Paso del Norte region has been developed thanks to this information sharing and collaboration. The universities' brokerage role in addressing the challenges linked to water resources and air quality, as well as data gathering and sharing initiatives, began the process of addressing environmental problems on a regional scale and in a more integrated manner. This underpinned governmental efforts to provide a more comprehensive approach to natural resource management.

Source : OECD (2010a), *Higher Education in Regional and City Development: Paso del Norte, Mexico and the United States 2010*, OECD Publishing, *http://dx.doi.org/10.1787/9789264088887-en*.

Sonora's TEIs and technological institutes could also play an important role in disseminating good practices, for example by training the trainers. Inspiration could be found from the University of Texas at El Paso's Center for Environmental Resource Management (CERM), which collaborates on a long-term basis with the City of El Paso and reaches out to low income neighbourhoods to provide energy efficient and water disinfection technologies. CERM's award winning *Agua para Beber* (Drinking Water) is a community-based, train-the-trainer programme that teaches appropriate water disinfection technology and home sanitation, and healthy home environments in low-income neighbourhoods. This programme uses *promotoras*, community advocates, to educate residents of low-income neighbourhoods to recognise environmental risks in their homes and to use environmentally-benign products (OECD, 2010a).

Part of the R&D efforts by Sonora's technological institutes and for example ITSON's incubators in the branch campuses could be directed to

developing frugal innovations with a social mission. Frugal innovations produce products that are low cost, outperform the alternative, and can be made available at large scale. For example in India Tata has created a low cost water purifier targeted at rural families which operates without requiring electricity or running water. By combining a common waste product – rice husk ash, with coating of silver nano-particles to filter water, this water purifier uses cutting-edge science to help create social and economic value from waste. Tata are exploring sales opportunities not just in India, but in Latin America and Africa. (NESTA, 2012)

Air quality and greenhouse gas emissions

With support from U.S.-Mexico environmental programme Border 2012, the state of Sonora, including faculty from Sonora's TEIs, has completed a greenhouse gas emissions inventory (EPA, 2012). Border 2012 is a results-oriented "bottom-up" programme that improves the environment and protects the health of the nearly 12 million people living along border. It addresses the environmental and public health needs of the border region with focus on cleaning the air, providing safe drinking water, reducing the risk of exposure to hazardous waste and ensuring emergency preparedness. The green house gas emissions inventory accounts for the amount of greenhouse gases emitted into the atmosphere or removed from it during a specific time period, usually twelve months. For Sonora, the 2005 inventory showed about one-third of greenhouse gas emissions were due to the generation of electricity. Emissions from transportation sources – such as cars, trucks and buses – accounted for 25% of greenhouse emissions in Sonora. In Sonora, about one-sixth of emissions were due to agricultural activities, attesting to the importance of agricultural production in Sonora's economy. The inventory projected that greenhouse gas emissions will continue to grow steadily, increasing by an estimated 70% above the 2005 levels by the year 2020.

Sonora also faces air quality problems because of the strategies used by low-income residents to save money by burning wood and other combustibles in order to cook food and provide heat. This problem has been recognised as contributing to poor air quality in the border communities and strategies have been recommended to address it (Bureau of Applied Anthropology, The University of Arizona at Tucson, 2007). These strategies could be adapted to similar conditions across the State of Sonora.

Sonora needs a comprehensive, regional approach to air quality and green house emissions and should mobilise TEIs' joint academic expertise for this purpose. A comprehensive, regional approach to air quality should address green house emissions in agriculture, manufacturing as well as in

residential use. The Sonoran TEIs can play a key role in contributing to a better understanding of the issues.

Energy alternatives

Sonora is among locations with the best solar energy potential in the world. The state recognises that this potential could be used for export as well as to provide energy in Mexico. In response to this potential, Sonora's state administration is collaborating with other Mexican states to build an energy corridor to produce solar and wind energy to serve Mexico, as well as California and Arizona. To date, Mexico's solar sector has concentrated on off-grid photovoltaics (PV). The federal government has identified PV as one of the most cost-effective solutions for providing power to the three percent of rural Mexicans not currently connected to the grid. Approximately 60 000 to 80 000 PV systems are now in operation across rural Mexico.

TEIs in Sonora have recognised the state's potential as a supplier of solar energy and have taken steps to engage in industry-related projects and RDI programmes. For example, UNISON is developing a utility-scale solar system with a U.S. company. The Institute for Technology Transfer at UNISON, TxTec AC, works with companies in aquaculture, agriculture, metallurgy, geology, energy and the environment. One of TxTec initiatives is a collaborative project between the National Laboratory of Solar Concentration Systems and the leading public university in the country, *Universidad Nacional Autónoma de México* (UNAM). This initiative provides research facilities as well as consulting services.

TEIs in Sonora could consider focusing part of their efforts to disseminate energy alternatives to low income communities, by creating inclusive business models and ecosystems conducive to inclusive solar power. For example in India, a private company (SELCO) has worked to bring solar power to underserved business and households, connecting 120 000 households, mainly in Karnataka. The company provides products, services and access to finance through partnership with banks, cooperative services and microfinance institutions. Within three years it hopes to have designed a model that allows for solar power provision to customers earning 1000 rupies (USD 20) a month. (NESTA, 2012).

Environmental initiatives aimed at industrial sectors

The two leading universities in Sonora, UNISON and ITSON are each individually taking steps to become more engaged in supporting the environmental sustainability efforts of the *maquila* industry and other

industries. For example, a group of researchers located at UNISON in the Engineering Division focuses its research on the prevention or elimination of environmental and occupational risks in industrial organisations, including in the *maquila* industries and in the university sector, itself. This group has strong international connections and conducts collaborative research with its international partners. UNISON has been nationally recognised, for example, for its holistic approach to issues related to sustainability (Velazquez, 2002). In Southern Sonora, ITSON has undertaken co-operative engineering projects with industry, particularly the *maquiladoras* located in Guaymas, to address the need to process wastewater effectively and, when possible, to recycle it for reuse. ITSON has also been actively engaged in technology transfer projects in eco-tourism initiatives and bio-engineering, which directly address environmental issues in Sonora.

In the absence of a comprehensive state-wide approach and incentives, Sonora's TEIs are less likely to make rapid progress in supporting sustainability and green economy. There is also a risk that the main beneficiaries of university technology transfer will be the large multinational enterprises and *maquila* industry, delaying the market penetration of the green market by local SMEs. Positive outcomes would require concrete action from the federal and state governments to facilitate innovations in water management, to make low-carbon technologies more attractive and to develop skills to make wider use of green technologies.

3.3 Benchmarking with international experience

Sonora features commendable examples of TEIs contributing to social, cultural and environmental development in their communities. These initiatives and collaborations often involve underprivileged populations in low socio-eonomic or poor environmental conditions and/or indigenous groups. The activities often remain underfunded without long-term commitment from public or private stakeholders and lack policy impact at the state and federal level. Useful benchmarks in this context come from the interdisciplinary efforts of *Universidad Católica de la Santísima Concepción* (UCSC) in the Bío Bío Region in Chile, the University of Arizona's Southwest Institute for Research on Women (SIROW) and Universiti Sains Malaysia's AIDS Action and Research Group (AARG). These examples can serve as an inspiration to Sonora's TEIs when devising sustainable community engagement.

Combining social, economic and environmental development of the Mapuche in Chile

In devising their programmes to partner with indigenous populations, Sonora's TEIs could find inspiration from the Bío Bío Region in Chile where the *Universidad Católica de la Santísima Concepción* (UCSC) is supporting sustainable community development in rural areas by combining social, economic and environmental development. In Coronel, the university supports a project of mussel aquaculture developed by a private sector company and is carrying out research in soft water fish farming. Collaboration has encouraged the local fishing 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 economic needs of the Mapuche population. These two projects not only address the needs of local, low-income minority populations, but collaborate with the communities to build their sustainability and capacity to develop local solutions to global challenges. See Box 3.5.

Box 3.5. UCSC building sustainable communities in the Bío Bío Region

Coronel mussel farming project

The Community of Coronel has traditionally had the highest concentration of fishery production in the Bío Bío Region, but for decades has suffered from unemployment and youth out-migration. In 2008, the *Universidad Católica de la Santísima Concepción* (UCSC) embarked on a mussel farming project 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 in the micro areas of Llico and Dichato. The fishermen's associations provided farming spaces, raw materials, experience and work input. The industry partner provided commercialisation channels, purchasing capabilities, technology and financing. The university undertook research in soft water fish farming and played a brokerage role between the fishermen and the firm. The costs, USD 570 000, were evenly divided between the regional development programme (*Innova Bío Bío*) and the industry partner. Collaboration was built on a win-win basis: the university benefitted from the RDI work and practical learning opportunities for students (the research team included three students worked on their theses). The fishermen profited from higher income and improved quality of life. The company developed new business opportunities, production lines and markets. The region benefitted from the economic and social impact through wealth creation, employment and move from capture fisheries to aquaculture. As a result of the project, the mussel growth rate has been faster and compares positively with the leading regions in Chile. Between 2008 and 2010, the project generated 10 new permanent jobs and 100 temporary positions, retrained the local workforce away from capture fisheries to aquaculture and contributed to the establishment of a new vocational education institution in Coronel to support the development of aquaculture.

Box 3.5. UCSC building sustainable communities in the Bío Bío Region (continued)

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

The Bío Bío Region has the fourth largest indigenous population in Chile (54 000 in 2002), mostly Mapuche (53 000), who are concentrated in the Arauco province, one of the poorest areas in Chile. The *Universidad Católica de la Santísima Concepción* is the only TEI with a permanent presence in the province. Around 1 500 students attend the University's Cañete Agricultural Technology Transfer Centre. Local schools and the university have made progress in improving access to formal education, but the generation gap among Mapuche remain far greater than among non-indigenous population. In 2009, to address the challenge of lifelong learning and reskilling needs, and to extend its services from education to RDI, the UCSC's Cañete centre launched technology transfer activities to serve 200 rural and Mapuche families. The aim is to improve graduate retention, build entrepreneurship based on Mapuche traditions, to develop a productive cluster extending from environmentally-sustainable cultivation and fertilisation technology and organic production to management and entrepreneurship training. The centre develops and produces wine, livestock (beef and pork) and vegetable products for export purposes and has identified an export company that will support the pursuit.

Source: OECD/The World Bank (2010), Higher Education in Regional and City Development: Bío Bío Region, Chile 2010, OECD Publishing, h*ttp://dx.doi.org/10.1787/9789264088931-en.*

Ensuring sustainability and policy impact of urban community engagement projects in Arizona and Malaysia

University of Arizona's Southwest Institute for Research on Women (SIROW)

Founded in 1979, University of Arizona's Southwest Institute for Research on Women (SIROW) is a regional research and resource centre that develops, conducts and disseminates inter-disciplinary and inter-institutional collaborative outreach, education and research projects relevant to the diverse groups of women in the south-western US and north-western Mexico. In the absence of effective regional development agency for Southern Arizona, SIROW has developed a system to secure external funding from federal grants to projects that address local community needs, drawing 90% of its funding from external sources. Most importantly SIROW has also developed a mechanism to ensure sustainability of its projects through collaboration with, and training of local public agencies or

NGOs who take over the activities once the research funding has ended. SIROW has contributed to public health research and advocacy for the homeless, lower income and Latina/o communities, serving as a broker between the individuals, groups or communities involved and government agencies, non-profit organisations or political and economic groups or institutions. SIROW's projects on *Mujer Sana*, STD testing and substance abuse 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. (See Box 3.6).

Box 3.6. *Mujer Sana* and adolescent substance abuse treatment initiative by SIROW

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. The *Mujer Sana* Centre is located in the disadvantaged part of Tucson, which has a high incidence of drug trafficking, prostitution and violent crime. Homeless or near-homeless women, often suffering from continuous trauma, benefit from psychological, capacity building and healthcare services and help in job search strategies. *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. Based on this work, SIROW faculty collected data showing high rates of hepatitis infection and published the results, subsequently influencing the Pima County Department of Health to now include hepatitis screenings.

In 1997-98, community members and service agency personnel in Southern Arizona expressed increased concerns with regard to illicit substance use among adolescents in Cochise, Pima, Santa Cruz and Maricopa counties in Arizona, as well as 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 SIROW 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).

Box 3.6. *Mujer Sana* and adolescent substance abuse treatment initiative by SIROW (continued

This work generated a book/edited volume detailing effective programmes, numerous products and publications, a national conference and a national evidence-based programmes. 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 community and v) genuine concern for the issue.

Source: OECD (2012a), Higher Education in Regional and City Development: Southern Arizona, United States 2011, OECD Publishing, *http://dx.doi.org/10.1787/9789264028036-en*.

Universiti Sains Malaysia's AIDS Action and Research Group (AARG)

The AIDS Action and Research Group (AARG), based in the school of social sciences at Universiti Sains Malaysia in Penang, was established in 1992 to address a growing need to prevent the spread of HIV/AIDS and help those infected and affected by HIV/AIDS. Over the years, AARG has grown into a multi-disciplinary centre of excellence, acknowledged by the federal and state authorities for its research, policy advice, counselling and community service. AARG is active in community service through its drop-in centres, which now cover the entire country, especially in the needle exchange programme for the community of drug users and capacity building related to HIV/AIDS counselling and harm reduction. AARG engages not only academic and non-academic staff, but also volunteers, often with history of substance use to be fully aware of the needs of the community.

Box 3.7. The AIDS Action and Research Group AARG influencing policy and practise

The HIV/AIDS pandemic is a major health and social problem in Malaysia and the state of Penang. The AIDS Action and Research Group (AARG) based in the School of Social Sciences at Universiti Sains Malaysia was established in 1992 by a group of academic staff of the school of social sciences. Today, it consists of a multidisciplinary group of academic and non-academic staff and volunteers. It aims to: i) to create awareness of HIV/AIDS, ii) provide educational training in psychosocial aspects of HIV/AIDS related issues, iii) co-operate with all parties in reducing HIV/AIDS infections in Malaysia, iv) fight the stigma and discrimination associated with HIV/AIDS, and to v) to conduct research on issues related to HIV/AIDS.

Box 3.7. The AIDS Action and Research Group AARG influencing policy and practise (continued)

To achieve these objectives AARG works with all agencies, NGOs, national ministry of health, health department, hospitals, and police. Activities and services include: i) educational, training and counselling programmes on prevention, management and conflict resolution related to HIV/AIDS, ii) seminars and educational campaigns, iii) hotline telephone counselling, iv) community action programmes, v) facilitation of public debate and exchange of knowledge and experience, vi) research on knowledge, attitudes, behaviour and policies related to HIV/AIDS education, prevention and treatment in Malaysia including the social and psychological impact of HIV/AIDS. The AARG activities are part of the university's social responsibility.

AARG maintains a broad range of activities. It offers practical training and job opportunities for students and graduates of social sciences. It engages with the community and provides research-based knowledge, for example on the knowledge and attitudes of university students on HIV/AIDS. AARG also acts as a resource centre for HIV/AIDS information and a training centre for psychosocial topics on HIV/AIDS, running workshops for women and girls with HIV/AIDS. With the support from the ministry of health, local NGOs and stakeholders, AARG has launched a number of harm reduction programmes. It runs harm reduction workshops for the police department and a needle and syringe exchange programme (NSEP) at drop-in centres and stand alone premises. Between 2006-09, the number of NSEP centres increased from 3 to 12 in 8 states providing service for nearly 6 000 clients in Malaysia. AARG aims to increase its advocacy work with stakeholders and awareness raising programmes, using a mobile unit.

Source: OECD (2011), Higher Education in Regional and City Development: State of Penang, Malaysia 2011, OECD Publishing, *http://dx.doi.org/10.1787/9789264089457-en.*

Conclusions and recommendations

Sonora's tertiary education institutions have responded to the needs of the region at multiple scales, including research, curriculum development, campus initiatives and outreach activities. They have each responded, in accordance with their specific missions, to the social, cultural and environmental needs of the state and/or its constituencies. They act as a source of expertise in the local community through research, education, community service and demonstrating good practice through on-campus development and outreach activities. Sonora's TEIs have a great potential to contribute more to social, cultural and environmental development, using the state and its regions as a laboratory for their research, outreach and student learning.

The various efforts by Sonora's TEIs indicate the recognition of the key challenges in Sonora, but at the same time co-ordination, investment and technical challenges remain to be addressed. Despite significant efforts, resources are spread thinly, and the scope and impact of the activities remain limited. There are many fragmented and non-co-ordinated initiatives, and a lack of critical mass to generate projects, which would create greater impact at the local and regional level and generate multiplier effects. There is limited evidence of collaboration across the tertiary education sector, and in most cases, although not all, a lack of focus on the implementation and monitoring of results which could help evaluate the outcomes of the outreach activities and help scaling up good practice examples into a system. There is also a lack of co-ordination among activities, programmes and plans among the state of Sonora, municipalities and tertiary education institutions.

There also appears to be a lack of focus from the state government on the social, cultural and environmental role of the TEIs. Some of the TEIs' community service initiatives, such as CUDDEC, provide a world class example of university's community action that empowers disadvantaged communities and helps them address their own challenges by strengthening skills, social economy, cultural identity and environmental sustainability. In spite of a record of positive impact, these types of initiatives seem to rely on institutional funding from the universities without support from the local or state governments. Without public acknowledgement and funding, university-led community programmes are vulnerable to cuts and downsizing when governments and institutional leadership change.

The opportunities for sustainable and extended third mission activities in Sonora tertiary education institutions lie in building on and scaling up the current good practice models that exist in addressing the economic, social and cultural needs of the population, such as CUDDEC, tourism trails and various initiatives to widen access to education and address the critical environmental challenges. These areas should be recognised by the public and private stakeholders as important to Sonora's future. Sustainable engagement in these areas will require prioritisation and building critical mass in RDI. It will also require closer collaboration and pooling resources, mobilising both private and public sources, and aligning these projects more closely with the federal and state initiatives. In addition to each TEI collaborating with their own stakeholders they could partner with each other to build local capacity.

In the field of environmental sustainability, it would be useful to acknowledge that while climate change and persistent drought are a challenge for Sonora, they can also be an opportunity to develop a more resilient and sustainable economy through up-scaling TEIs' research,

development and innovation effort. Climate change and drought can encourage positive developments, by enhancing efficiency in energy management, industrial production, spatial development, public and private transport, construction and operation of buildings and water management. Internationally, jobs related to renewable energy and energy efficiency are projected to increase to several millions by 2030, many of them in a small number of innovative regions. Focusing efforts on environmental sustainability could bring improvements to the quality of life in low income neighbourhoods but also help develop endogenous business development in Sonora as many examples of frugal innovations in India show.

Sonora has many activities for the promotion of environmental sustainability, and empowering local communities. These initiatives need to be better co-ordinated, institutionalised, rewarded and profiled within institutions, local and regional communities, and state and federal governments. To continue to deepen the contribution of the tertiary education institutions to social, cultural and environmental development of Sonora, the OECD review team recommends that the following measures are taken:

Recommendations for state and local government

- Create a forum for the systematic exchange of information and experience among tertiary education institutions with regard to social, cultural and environmental matters. This forum could organise thematic events with regular information retrieval and exchange facilitated by a dedicated website. The forum would permit the tracking and monitoring of different initiatives and their outcomes, along with the identification of best practices for publication and policy fine-tuning. As a first step, all the social initiatives and projects of tertiary education institutions should be mapped and published in a shared platform. Build on existing examples of good collaboration between universities and local government, most notably ITSON's work in southern Sonora, which could be used as a model for collaborative and joint intervention in other areas.

- Provide incentives in the form of competitive funds (with public and private support) dedicated to supporting "challenge-driven" research to connect university research to community development. Incentivise "translational research" and frugal innovation to address the critical issues in Sonora.

- Collaborate with the public and private sector to support sustainable environmental and economic development through a comprehensive regional approach, where tertiary education institutions can contribute to the diagnosis of regional environmental conditions and sustainability, the ecological education for the community at large and research solutions to existing environmental problems.

- Mobilise TEIs to contribute to environmental sustainability by encouraging the Commission of Ecology and Sustainable Development of the State of Sonora (*Comision de Ecologia y Desarrollo Sustentable del Estado de Sonora*, CEDES) to identify and directly engage with TEI researchers with the capacity to contribute to approaches to environmental issues in a multi-disciplinary framework.

Recommendations for universities and other tertiary education institutions

- Improve the monitoring and follow-up of the success and results of the community engagement initiatives, projects and programmes to provide evidence on their impact and to show the return on public investment, building on the example of CUDDEC. The lack of robust and comparable data constrains the visibility and impact of universities' activities. It also makes it difficult to measure the real success or failure of programmes.

- Align initiatives for social, cultural and environmental development with the plans designed by the federal and state authorities in order to have a stronger impact at the local and community level. Collaborate with other tertiary education institutions in the design and implementation of extension activities.

- Engage in long-term community development seeking ways to empower communities to find their own solutions to various economic, social, cultural, environmental challenges which are global, national and local in nature. The region should be seen as a "laboratory" for developing research, students' community service and experiential learning and development projects in many different fields.

- Develop the international dimension of extension activities in order to maximise their potential impact and promote exchanges and networking with other parts of the world that are experiencing similar problems with focus on south-to-south collaboration. Mobilise international co-

operation and networks for the social, cultural and environmental development of the region.

- In addition to widening access to education and providing services to disadvantaged communities through students' social service activities, engage in long term community development by capitalising on and scaling up world class good practice examples in Mexico, Malaysia, Chile and the US. Learn from and engage in successful models such as the CUDDEC facility and programme sponsored by ITSON to enhance TEI's impact on economic and educational opportunities in low-income communities.

- Contribute to the development of the local/regional tourism economy by developing and expanding programmes in entrepreneurship and non-profit management, both in formal degree programmes and through outreach efforts.

- Mobilise and build on existing cross-border collaborations between US universities and colleges and Sonora's TE campuses across the border for urban planning, and energy and environmental planning. For example, develop Geographic Information Systems collaboration focused on environmental/hydrologic conditions in Sonora through bi-national research programmes.

- Develop a co-ordinated, multidisciplinary, cross-institutional research effort to address water access and water quality in the state.

- Develop a process for evaluating the environmental footprint of TEIs' expansion in the state of Sonora. Support both individual and collaborative initiatives to foster university demonstrations of green building practices, including retrofitting of old buildings.

Notes

1. Globally, tourism is a USD 3-billion a-day business. Worldwide, international tourist arrivals have increased about one percentage point

faster than global GDP in real terms. Despite periodic setbacks, in many countries tourism has been growing faster than the economy as a whole.

2. While domestic tourists accounted for the majority, 85.7%, of the tourism output of USD 108.2 billion, international arrivals have increased by 3.5% a year on average over the past 20 years. By 2011, Mexico's share of global international arrivals was 2.3%, with 22.7 million arrivals. The National Agreement for Tourism, established in 2011 has aimed to strengthen Mexico's image as a tourist destination through a multistakeholder collaboration and sets out a long term goals for tourism: *i)* position Mexico as one of the top five tourist destinations in the world by 2018; *ii)* achieve 50 million international tourists and 300 million domestic tourists by 2018; and *iii)* raise revenues from tourism to USD 40 billion. (OECD, 2012c)

Annex 3.A.1. Indigenous people in Sonora

Among the northern states of Mexico, Sonora has the highest proportion of indigenous people. INEGI data (INEGI, 2004) shows that 61 270 persons, aged three years or older, speak indigenous language in Sonora. This represents 2.5% of the state's total population. About 72% of this population resides in five municipalities: Guaymas, Etchojoa, Huatabampo, Hermosillo and Navojoa.

Sonora has eight indigenous groups: comca'as (seri), Yoeme (yaqui), Yoreme (mayo), macurawe (guarijío), o'ob (pima), kuapá (cucapá) tohono o'odham (pápago) and kickapoo (kikapú). Other indigenous groups, such as triquis, mixtecos and zapatecos, have recently migrated to Sonora, primarily from Oaxaca and Chiapas. The 32 000 yaquis (Yoeme) have traditionally represented a fierce resistance against any intruders and today form a nation which has become a symbol of southern Sonora.

The state legislation of Sonora (Law of the Rights of the Indigenous People and Communities) recognises the collective rights of the indigenous people and communities to maintain and develop their languages and traditions (Gobierno del Estado de Sonora, 2011). For example, in San Miguel de Horcasitas, Etchojoa, and Huatabampo, the majority of the population speaks an indigenous language. The 2012 National Population Census shows that, in Sonora, 90% of the population that speaks an indigenous language considers themselves to be indigenous, whereas only 10% of those who do not speak an indigenous language consider themselves to be indigenous.

Indigenous populations in Sonora and Mexico generally have poor education and labour market outcomes. In Sonora, among women aged 15 and older who speak an indigenous language, one fourth (25.5%) have no formal schooling, half (50.7%) have achieved up to primary education, 13.5% secondary education and 4.5% upper secondary education. Nevertheless, education attainment levels have improved. Among women aged 15+ years old, 9.2% have no formal education, compared to 58.2% among women 65+ years old.

Source : Puente Andrés, Ma. I., Ma. G. Zorilla Bernal, and M. E. Eyzaguirre Ordóñez (2011), *Bordando una identidad*, GARABATOS, Oaxaca.; Gobierno del Estado de Sonora (2011), "Ley de

Derechos de los Pueblos y Comunidades Indígenas de Sonora," Secretaría de la Contraloría General del Estado de Sonora, *www.contraloria.sonora.gob.mx*; INEGI (2004), *La población indígena en México*, INEGI, Aguascalientes, *www.inegi.org.mx/prod_serv/contenidos/espanol/bvinegi/productos/censos/poblacion/poblacion_indigena/Pob_ind_Mex.pdf*.

Annex 3.A.2. ITSON's arts and cultural programme

ITSON's arts and cultural programme aims to train well rounded graduates, widen access to education and showcase talent nurtured in the university. Each student at ITSON needs to complete 45 hours of art or culture.

ITSON's directorate for expansion includes a department of culture which is in charge of three lines of operation: cultural education, cultural dissemination and an art gallery. Each of the lines of action includes outreach activities that benefit the local population:

- ITSON's cultural education is provided in dance, music, theatre, literature, visual arts and crafts on five campuses. Altogether 100 000 18-year-olds benefit from the offer annually. As part of cultural education outreach, ITSON organises workshops at schools and targets at people with disabilities.
- ITSON's cultural dissemination includes a rich event agenda, eight artist groups (a professional jazz dance group, a theatre and Mexican music group) and an annual arts festival which improves and diversifies the cultural offerings in southern Sonora. 300 000 18 year-olds benefit from the offerings annually and a large number of southern Sonorans participate in the arts festival. ITSON collaborates with a wide range of stakeholders, such as Ciudad Obregon's cultural department, the Autonomous University of Mexico (UNAM) and the national network of festivals (COANCULTA). Dissemination and conservation of cultural heritage focuses on the work of Héctor Martínez Arteche.
- ITSON's art gallery provides exhibitions. These exhibitions have been visited by about 66 000 18-year-olds in Southern Sonora. The art gallery also organises urban installations that take art and culture outside of the gallery to reach the local population.

Source: ITSON (Instituto Tecnológico de Sonora) (2012c), Departamento de Extensión de la Cultura, *www.cultura.itson.mx*.

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Chapter 4: Globalisation and internationalisation

This chapter examines how effectively the universities and other tertiary education institutions contribute to the regional development in Sonora and in particular to Sonora's integration into the global economy. It analyses the progress of the tertiary education internationalisation process and the effectiveness of the tertiary education sector in preparing globally competitive graduates, and knowledge and innovations. It identifies main strengths and areas for improvement in internationalisation strategies, as well as achievements and deficiencies of international programmes, student and faculty mobility, curricular internationalisation, the teaching of foreign languages and cultures, and the internationalisation of research. It analyses the institutional strategies for the internationalisation process of Sonora's TEIs. The chapter concludes with recommendations for the state government to foster internationalisation of tertiary education sector, and for tertiary education institutions to carry out a viable process of comprehensive internationalisation.

Introduction

Mexico is at the crossroads of globalisation. To maximise its opportunities in the global economy and to shift towards more inclusive development, Mexico needs to move up the value chain by continuing the process of structural reforms in labour, energy, telecommunications and taxation, and by significantly improving the quality of its education. These reforms would enable Mexico to improve its international competitiveness and knowledge economy.

Sonora, like other Mexican states bordering the United States, is leading the globalisation efforts in Mexico, but needs to better mobilise its tertiary education sector to support these efforts. Thanks to the development of global value chains in medium and high technological manufacturing, Sonora has been able to capitalise on its geographical position and the opening of trade. Due to competition from other regions for international markets and foreign direct investment (FDI), Sonora now needs to make better use of its key assets and train highly skilled human capital that is competitive in a global setting. In order to reach this goal, Sonora needs to improve the quality and relevance of its tertiary education. At the same time, it needs to mainstream internationalisation in the key functions of tertiary education: teaching and learning, RDI, and service, by educating graduates with international and updated qualifications and generating globally-competitive and locally-relevant knowledge and innovations.

In this context, the aim of this chapter is to review the level of advancement of the internationalisation process in Sonora's tertiary education sector, addressing five key questions:

- To what extent is the tertiary education sector able to support Sonora's integration into globalisation?
- Are universities and other tertiary education institutions implementing adequate strategies to deepen their internationalisation process?
- To what extent are universities and other tertiary education institutions developing an internationalised academic offering, curriculum and education, with the capacity to provide graduates with the global and intercultural skills for a successful insertion into a global job market and economy?

- Are the universities and other tertiary education institutions producing the type of knowledge, innovation and education with the capacity to increase regional international competitiveness?
- What is the level of advancement, strengths and areas of improvement for the internationalisation strategies and programmes of Sonora's tertiary education system?

4.1 Mexico and Sonora in context

This section outlines the progress Mexico has made integrating into the global economy, highlighting its current position particularly in relation to BRIC countries. It provides an overview of Sonora's key assets and threats in view of global competition, compared to other states in Mexico, particularly in the northern part of the country. Sonora has strengths and areas of opportunity within the national context, but lags behind other northern states in almost all key indicators. Sonora's main challenge is to improve its competitiveness by making better use of its human capital and accelerating the move towards a knowledge-based economy.

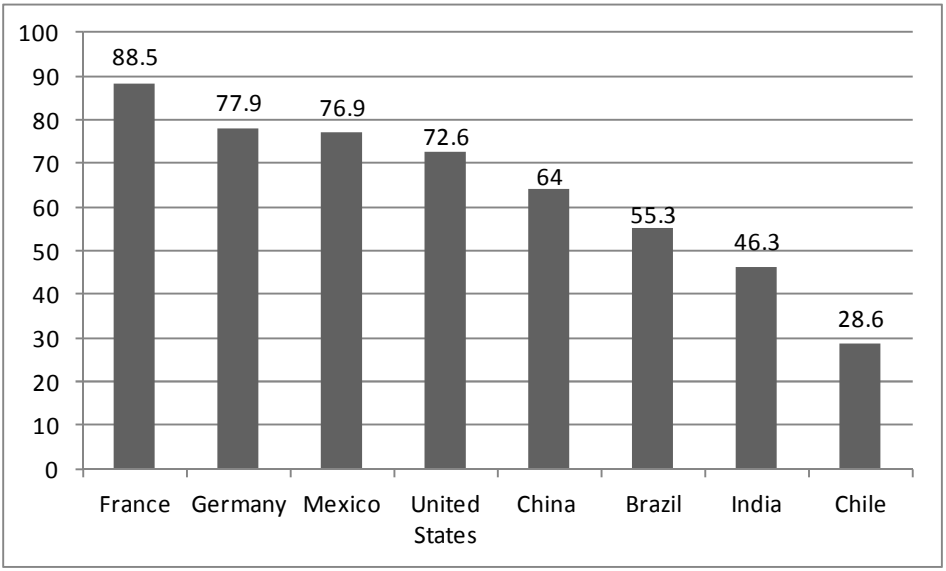
Mexico in the global context

After two decades of successful FDI attraction under the *maquiladora* programme, in 1986 Mexico opened to trade by joining the General Agreement on Tariffs and Trade (GATT) and in 1994 by signing the North American Free Trade Agreement (NAFTA). The *maquiladora* programme and the GATT and NAFTA agreements were important milestones that paved the way for Mexico's major economic structural reform that has resulted in macroeconomic stability, lower levels of inflation and participation in the global economy.

Mexico's integration in the global economy is driven by increased foreign trade and foreign direct investment (FDI). Currently, Mexico participates in 49 trade agreements with countries in North America, the European Union, Asia and Latin America (SE, 2012). Its trade-to-GDP ratio has risen significantly from 18.1% in 1995 (OECD, 2005) to 28.4% in 2009, above the BRICS countries (22.2%) but behind the OECD average (41.3%), and export-oriented countries such as Belgium (70.2%), Germany (38.4%) and Korea (47.9%) (OECD, 2011a). Mexico attracted capital flows worth USD 22.9 billion in the period 2005-2009, which is below the level for Brazil, USD 28.4 billion (OECD, 2010). Yet, the index of inter-industry trade of manufactured goods – an

important indicator for global value chains – shows a higher value for Mexico than Brazil, Chile and even India, which points out Mexico's integration into global economy (see Figure 4.1).

Figure 4.1. Index of inter-industry trade in manufactures, 1997-2008



Source: OECD (2010a), *Measuring Globalisation: OECD Economic Globalisation Indicators 2010*, OECD Publishing, *http://dx.doi.org/10.1787/9789264084360-en.*

In the new phase of globalisation, Mexico's traditional comparative advantages – geographical proximity to the US, Mexico's main trade partner, and the abundance of relatively low-skilled labour – are no longer sufficient. Since China's emergence as a global FDI and manufacturing hub, Mexico is facing intense competition in labour-intensive sectors that do not require proximity to the US. As a result, Mexico's share in the North American market has diminished in several manufactured goods. The economy is also vulnerable to external shocks (OECD, 2007; OECD, 2012a)

In indicators measuring the economic, social and political dimensions of globalisation, Mexico ranks ahead of Brazil, far below Chile, and behind China and the Russian Federation (see Table 4.1). The 2011 World Economic Forum Report placed Mexico among the countries in transition from an efficiency-driven economy towards an innovation-driven economy, which means that Mexico has to prepare

itself to compete in the global context through product differentiation, quality, innovation and knowledge production. In the 2011-2012 Global Competitiveness Index (GCI), Mexico climbed up from 66th to 58th place (WEF, 2011), ahead of the Russian Federation, but behind China, Chile and Brazil. As a knowledge economy, Mexico is ranked ahead of China, but behind Chile, Brazil and the Russian Federation.

Table 4.1. Global competitiveness, knowledge economy and globalisation indices

	KOF Index of Globalisation 2011 ranking[1]	GCI 2011-2012 ranking[2]	KEI 2012 ranking[3]
Switzerland	5	1	10
Germany	16	6	8
Singapore	18	2	23
United States	27	5	12
Chile	33	31	40
South Africa	50	50	67
Russian Federation	52	66	55
China	73	26	84
Mexico	**75**	**58**	**72**
Brazil	78	53	60
India	116	56	110

Source: World Economic Forum (2011), "The Global Competitiveness Index 2011-2012: Setting the Foundations for Strong Productivity," *World Competitiveness Report 2011-2012*, WEF, Geneva; The World Bank (2012), Knowledge Economy Index (KEI) 2012 Rankings, *http://siteresources.worldbank.org/INTUNIKAM/Resources/2012.pdf*, accessed 17 April 2012; KOF Index of Globalization (2011), KOF Index of Globalization, *http://globalization.kof.ethz.ch/,* accessed 21 January 2012.

While Mexico is improving its rankings in different indices and achieving conditions to develop industrial manufacturing and services with a higher degree of technology, some areas inhibit progress, risking the national capacity to compete globally in higher-value-added sectors. The World Economic Forum points out the overall poor quality of the educational system in primary education (121st), tertiary education (107th), math and science education (126th), insufficient company spending in R&D (79th) and limited innovation capacity (76th) (WEF, 2011). The OECD has urged Mexico to take steps to improve key sectors such as telecommunications, to reduce informality, to simplify business regulations in order to improve efficiency, productivity and consumer welfare, and to raise the overall quality of education (OECD, 2011a; 2012c).

Sonora in context

The state of Sonora lies in Northern Mexico bordering the United States[4]. It is the second state in terms of territory and but only 18th in population (close to 2.7 million), of which 83% is urban.

Sonora is one of the richest starts in Mexico but ranks last among the northern states for state GDP, behind Nuevo León, Chihuahua, Tamaulipas, Coahuila and Baja California, holding the 14th place nationally. Sonora represents 2.5% of the Mexico's GDP and has the 11th highest GDP per capita among the Mexican states, (INEGI, 2011). According to the Mexican Institute for Competitiveness (IMCO), Sonora ranks below other northern states in terms of competitiveness and is in the penultimate position in terms of knowledge economy. See Table 4.2.

Table 4.2. Mexican states GDP, competitiveness and knowledge economy indices

	State GDP		**State GDP per capita**		
Northern states	% of National GDP	National ranking	National ranking	Competitiveness Index 2008 IMCO	Knowledge Based Economy Index 2011
Baja California	2.9	12	15	6	5
Chihuahua	3.3	10	12	9	7
Coahuila	3.2	9	5	4	6
Nuevo Leon	7.8	3	3	2	3
Sonora	**2.5**	**14**	**11**	**11**	**8**
Tamaulipas	3.3	8	10	8	9

Source: INEGI (Instituto Nacional de Estadística y Geografía) (National Institute of Statistics and Geography) (2011), *Perspectiva estadística: Sonora (Statistical Perspective: Sonora)*, INEGI, Aguascalientes; IMCO (Instituto Mexicano para la Competitividad A.C.) (Mexican Institute for Competitiveness A.C.) (2011), *Índice de Competitividad Estatal 2010 (State Competitiveness Index 2010)*, IMCO, Mexico D.F; Molina, A. and C. Hernández (2011), *La economía basada en el Conocimiento: La evolución de los Estados Mexicanos (The knowledge-based economy: The evolution of the Mexican States)*, ITESM, Monterrey.

Sonora's economy is dominated by manufacturing and services. The manufacturing and service sector represent 43.3% and 30.6%, respectively, of Sonora's Gross Value Added (GVA), followed by the mining sector (12.3%) and other industries (11.7%). In the agriculture, livestock and fishing sector (2.1% of the state GVA), Sonora is a national leader (INEGI, 2011). The manufacturing sector is important because of the on-going process of a regional specialisation in auto industry, electric machinery and electronics, as well as emerging

clusters in medical and aero-spatial equipment (OECD, 2009b; de la Peña-Sánchez *et al.*, 2009). These industries take part in global value chains mostly at mid-high technological and high-tech levels (OECD, 2009b). Sonora ranks sixth in Mexico in the Manufacturing, Maquila and Export Services Industry (IMMEX) Programme for intermediate importing-exporting goods and services (see Table 4.3).[5]

Table 4.3. Sonora's participation in global value chains and share in FDI

State	IMMEX income in thousands of pesos (MXN)	FDI in USD millions received by state	State % of FDI
Aguascalientes	56 732 626	3 078.3	1.1
Baja California	69 053 777	11 688.4	4.4
Chihuahua	22 610 817	13 325.5	5.0
Coahuila	202 588 396	3 321.1	1.3
Federal District	52 577 839	148 522.4	55.9
Jalisco	85 713 601	7 831.1	2.9
Mexico	165 198 001	15 289.7	5.8
Nuevo Leon	276 332 658	29 989.7	11.3
Puebla	128 897 191	4 200.7	1.6
Sonora	**78 805 050**	**4 192.3**	**1.6**
Tamaulipas	92 318 688	4 451.3	1.7

Source: INEGI (Instituto Nacional de Estadística y Geografía) (National Institute of Statistics and Geography) (2011), *Perspectiva estadística: Sonora (Statistical Perspective: Sonora)*, INEGI, Aguascalientes, *www.inegi.org.mx/est/contenidos/espanol/sistemas/perspectivas/perspectiva-son.pdf.*

In respect to the FDI, Sonora lags behind the majority of the northern states as well as the Federal District, Jalisco and Puebla (see Table 4.3). However, contrary to other northern states, most of Sonora's FDI (86%) is evenly oriented towards mining (43.3%) and manufacturing (43.0%), whereas in Baja California 86.4% of the FDI is geared to manufacturing, 80.6% for Chihuahua and 70% for Nuevo Leon (INEGI, 2011).

In the face of global competition, Sonora has assets, but also faces threats. In the Mexican context, Sonora has a well-developed infrastructure: its road network (2nd place nationally), railroads (4th) and five international airports. Nevertheless, a weakness of the state is the provision and high cost of its electricity supply; 41% of the agricultural land depends on the amount of water available during the rainy season. Under the ongoing climate change, Sonora is faced with a threat of a growing desertification (Sonora's Regional Steering Committee, 2012) with potentially huge impacts on future development.

In education, Sonora has made good progress in improving education attainment levels and strengthening technological education. Sonora's population averages more years in formal education than the Mexican national average (9.4 compared to 8.6), although in international comparison there is much room for improvement. More than half of Sonora's population aged 15 years or older have lower secondary education (INEGI, 2011). Sonora has also made progress in upper secondary education, achieving far better results than the national average with fifth highest participation rates, third lowest dropout rates and best completion rates among the Mexican states (see Table 4.4). Sonora's tertiary education system has recently developed a public, federal- and state-funded technological sector that holds fourth place nationally in the percentage of technological institutes per state.[6] Tertiary education attainment rates have rapidly improved: 30% of the 25-34 year olds have tertiary education compared 15% for the 55-64 year olds, far above the national averages and third among the Mexican states.

Table 4.4. Sonora's upper secondary education

	Sonora	National average	National ranking
Participation rate	75.5	66.7	5
Dropout rate	7.8	14.5	31
Completion rate	74.6	63.3	1

Note. In terms of dropout rate Sonora ranks 31st out of 32 states, *i.e.* has the second lowest dropout rate in Mexico.

Source: INEGI (Instituto Nacional de Estadística y Geografía) (National Institute of Statistics and Geography) (2011), *Perspectiva estadística: Sonora (Statistical Perspective: Sonora)*, INEGI, Aguascalientes, *www.inegi.org.mx/est/contenidos/espanol/sistemas/perspectivas/perspectiva-son.pdf.*

At the same time, the quality of education remains a concern in Sonora. For example in secondary education Sonora's 2009 PISA scores are lower than the national averages in reading (24th), science (22nd), and mathematics (23rd), which in turn are weak in international comparison (INEE, 2010). Sonora's tertiary education faces difficulties in retention and completion with dropout rates that are consistently higher than the national average.

There is also room for improvement in knowledge generation in Sonora. In respect to national research and knowledge production, Sonora is 20th in the overall Ranking of Science, Technology and Innovation for Mexico,[7] behind the northern states of Nuevo Leon (2nd), Coahuila (5th), Baja California (7th), Chihuahua (9th), and Tamaulipas (16th). Sonora occupies 9th place in the ranking on "scientific

production per 10 000 inhabitants"[8] where further progress can be made (FCCyT, 2011). (See also Chapter 3 for more details on Sonora's research, development and innovation).

Due to global competition for new markets and FDI, particularly in medium and high technological industrial manufacturing, Sonora's main challenge is to improve its competitiveness by making better use of its human capital and accelerating its move towards a more inclusive and knowledge-based economy.

Because of the global transformation of economies, systems of trade, research and communication, as well as the impact of globalisation at a local level, there is need for a comprehensive internationalisation of the tertiary education sector (Hudzik, 2011). Sonora must not only improve the quality and relevance of its education and research, but also integrate an international dimension in the core functions of the tertiary education institutions. The internationalisation of the tertiary education system is a global trend which underlines the need to produce cutting-edge knowledge and innovation, to provide graduates with a relevant and high-quality education, and to offer up-to-date and internationally-competitive professional qualifications. Sonora requires a tertiary education system with the capacity to train a technically-skilled labour force that is internationally competitive and able to participate in technological innovation.

4.2 Internationalisation and the state education policy

This section provides an overview of the Sonora's education policy with respect to its international dimension. It highlights the need for a comprehensive internationalisation strategy and necessity to make better use of existing mechanisms, such as the cross-border commissions with Arizona and New Mexico. It underlines the need to develop a state strategy to promote tertiary education abroad, highlighting good practice from Mexico and Spain.

Box 4.1. Defining internationalisation

Internationalisation can be defined as:

- "the process of integrating an international, intercultural or global dimension into the purpose, functions or delivery of tertiary education at the institutional and national levels" (Knight, 2008)
- "a process of organisational change, curriculum innovation, staff development and student mobility for the purpose of attaining excellence in teaching, research and the other activities which universities undertake as part of their functions" (Rudzki, 1998).

International dimension of the state educational policy

The state of Sonora lacks a TE internationalisation policy, but has identified some objectives for internationalisation that relate to the education sector. The State Programme for Education 2010-2015 does not include an explicit policy of internationalisation for TE, but includes references to internationalisation objectives: "…support for learning English at all educational levels…"; "… foreign language study through the integration of English into TE curricula to achieve 60% in proficiency of English upon graduation…"; "… support of faculty, senior staff and student exchange programmes…"; and "….the strengthening of international networks and the promotion of inter-institutional agreements with foreign TEIs…" (SEC, 2010).

In order to achieve these objectives, Sonora has launched some initiatives that embrace the education sector. These include a special programme for teaching English at primary schools and in TEIs that depend directly on the state.

The Sonora-Arizona and Sonora-New Mexico Commissions also aim to boost cross border student and faculty mobility, and TE networks and co-operation (see Boxes 4.2 and 4.3).

Box 4.2. The Sonora-Arizona Commission

The Sonora-Arizona Commission was established 52 years ago with the aim of developing collaborative solutions for the two states in four core areas: competitiveness, quality of life, security and sustainability. The areas of competitiveness and quality of life are directly linked to education and human capital development, whereas the in security and environmental sustainability the links are more indirect but reveal great underutilised potential for tertiary education sector.

In the area of competitiveness, the aim is to: *i)* strengthen economic growth with an emphasis on an innovative and entrepreneurial population; ii) improve the qualifications of the labour force to compete in the global economy; *iii)* create a highly-specialised and networked economy; *iv)* develop an institutional structure to enhance comparative advantages and co-operation between governments, businesses and citizens; *v)* foster collaboration among TEIs and scientific research institutes, and between the TE and the business sector, and *vi)* ensure transportation infrastructure for economic competitiveness and quality of life.

In the area of quality of life, the aim is to improve the treatment and prevention of epidemics and chronic diseases and to improve the offering of high-quality education to residents. Arizona State allows the youth from Sonora to study in Arizona by granting them the status of local resident, whereas Sonora has granted 100 tuition waivers to Arizonians in public TEIs.

In security issues, the aim is to: i) prevent and reduce the crime rate; ii) improve the citizen's understanding of each government's laws and judicial systems; iii) enhance citizen's sense of personal security while travelling within the region; and iv) to ensure an smooth traffic at ports of entry.

In the area of sustainability, commission aims to: i) create awareness of water-limited conditions, ii) adopt effective water conservation programmes, iii) promote equitable access to clean water through the application of environmental regulations, and iv) implement action plans to increase and foster the use of renewable energy.

Source: Gobierno del Estado de Sonora (2012), Comisión Sonora-Arizona (Sonora-Arizona Commission), *http://arizona.sonorainternacional.gob.mx/*, accessed 16 March 2012.

Box 4.3. The New Mexico-Sonora Commission

The New Mexico-Sonora Commission was established by the New Mexico Legislature in 2009 and has a focus on five areas of common interest for the two states: education, economic development and trade, health, public safety and tourism.

In education some of the objectives are to: *i)* foster exchange programmes between secondary and post-secondary professors and students; *ii)* carry on joint studies and analyses for education, competitiveness, growth and employment*; iii)* offer opportunities to New Mexico's professors in social sciences, humanities and those specialised on border issues to visit Sonora and Sonora's students to attend New Mexico's scientific research centres; and *iv)* promote Sonora's tertiary education international accreditation. The Commission has worked on a pilot programme in New Mexico to train Sonora's basic education math teachers. Workshops have been organised on co-operation, scientific research, faculty and student exchanges, summer courses, and the promotion of academic and cultural activities.

In the field of economic development and trade, the commission has organised the first aerospace expo for suppliers. In the case of renewable energy, the objective is to promote New Mexico's advancement on research and technology development, encouraging component suppliers of renewable energy to establish manufacturing and research centres and develop clean energy.

In security issues, the aim is to launch a project on "the protection of our communities and public officials" that will help develop joint strategies and procedures. This project will embrace tertiary education institutions and stakeholders such as: UNISON, UES (*Universidad Estatal de Sonora,* formerly known as CESUES), CONACYT (National Council of Science and Technology) and the University of New Mexico.

Source: Número Uno Online (2011), "Trabajan Sonora y Nuevo México en fortalecer programas educativos" (Sonora and New Mexico are working to strengthen Educational Programmes), *Número Uno Online*, 25 June 2011.

The state of Sonora should make better use of the Sonora-Arizona Commission and the New Mexico-Sonora Commission by establishing adequate mechanisms and structures to encourage and foster wider academic collaboration between Sonora TEIs and those of New Mexico and Arizona. While the results of the projects linked to the Sonora-Arizona Commission and the New Mexico-Sonora Commission have not yet been published, they appear to have limited impact on cross-border collaboration in education and student mobility. The main destinations of Sonora's students are Latin American and European institutions, while student mobility between the US and Sonora remains extremely low: in 2011, UNISON reported an outbound mobility of 4 students to the USA, while ITSON sent 11 students to the University of

Arizona (UoA) for professional practice and hosted one UoA student under the international project titled PROMESAN (Student Mobility Program for North America). In 2012, one student from ITSON participated in the UoA summer research programme. (The travel advisories to Mexico from the State of Arizona as well and the US Federal Government have significantly diminished these interactions between the two border states).

Promoting tertiary education abroad: Learning from Jalisco

Sonora could consider developing a strategy to promote its tertiary education abroad. In collaboration with the tertiary education sector, the government of the state of Sonora could design a strategy and action plan in order to promote the state TE sector, in order to increase the flow of international students and scholars to the region. As a first step it could learn from the internationalisation strategies of states like Jalisco, where the government perceives human capital as a key asset. It has developed strategies and implemented internationalisation programmes for the educational sector like: "Jalisco, Your Academic Destination"; "First University Fair Chicago 2011"; and Sister State Associations. Jalisco has been the first state of Mexico that has made systematic effort to position itself an international academic destination. (Box 4.4).

Box 4.4. Internationalisation strategies of Jalisco State Government

In 2011, the state of Jalisco launched the bilingual publication "Jalisco, Your Academic Destination" with the aim to promote the state's tertiary education system abroad. This publication describes the TEI's educational offerings, academic infrastructure, main attractions for international students and contact information. It has been sent to Mexican representation offices abroad, chambers of commerce, and international offices of foreign universities. Jalisco aims to translate this publication also into French, German, Chinese, Italian and Portuguese and to produce an electronic version with a web-based enquiry management system, which will be constantly updated by universities in order to provide accurate and timely information.

As part of this initiative, the First University Fair Chicago 2011 was organised to provide Jalisco's immigrant population living in the US Midwest with information on the state's academic offerings and to promote Jalisco as an academic destination. This event took place in Casa Jalisco in Chicago, and brought together 16 universities of Jalisco, Illinois and Indiana. It marked the launch of Jalisco's Virtual High School Programme that the Upper Secondary School of the State of Jalisco (*Colegio de Bachilleres del Estado de Jalisco,* COBAEJ) is offering to Jalisco's community living outside of Mexico.

Box 4.4. Internationalisation strategies of Jalisco State Government (continued)

Since 1993, the State of Jalisco has been establishing associations with sister states. This implies collaboration with states, provinces or regions in other countries in areas of common interest in economy, culture, environment, urban planning, health, research and technologic training, rural development, business co-operation, regional development, family and women development, education, historic heritage, tourism, and municipal development. There are presently 12 agreements with the following regions: Alberta and Manitoba in Canada; Bavaria in Germany; Idaho, Wisconsin, Maryland, Washington and Missouri in the United States; Gyeongsangnamdo in Korea; Maule in Chile; and Shanghai in China.

Source: Gobierno de Jalisco (2012), "Convenios de Hermanamiento del Estado de Jalisco" (Sisterhood Agreements of the State of Jalisco), Dirección de Asuntos Internacionales, *www.asuntosinternacionales.jalisco.gob.mx/consejo.html*, accessed 16 March 2012.

Attracting talent to the region: learning from Catalonia

Sonora is building its research base, but would benefit from attracting international talent. In many regions and states, the government authorities have sponsored talent attraction programmes. The ICREA programme in Catalonia provides an example for talent attraction that has helped to build the biotech research capacity in the region. It has been emulated in many other regions throughout the world and has continued during the financial and economic crises. ICREA has been successful in building knowledge generation capacity in Catalonia to gain competitive national and EU research funding (see Box 4.5).

Box 4.5. The Catalan Institution for Research and Advanced Studies (ICREA)

The Catalan Institution for Research and Advanced Studies (ICREA) is a dedicated head-hunting and recruitment agency to identify high quality people to come to work in Catalonia – whether of Catalan/Spanish origin or not. It was established in 2001 to recruit top scientists for the Catalan R&D system in order to boost Catalonia's competitive position. Successful candidates must be capable of leading new research groups, strengthening existing groups, and setting new lines of research on the right track. The programme brings top researchers to the Catalan innovation system. They play an active role in the university in terms of research and teaching (either direct classes or, at a minimum, oversight of student research).

Box 4.5. The Catalan Institution for Research and Advanced Studies (ICREA) (continued)

ICREA has hired a total of 249 researchers in different areas of research: 31% in life and medical sciences, 28% in experimental sciences and mathematics, 11% in social sciences, 15% in humanities and 15% in technology. ICREA researchers have collectively attracted more than their costs in research funds from outside the region. They have higher average publication rates than researchers in the region generally. ICREA researchers have also applied for 42 patents since 2004 and launched three start-up firms.

Unlike similar schemes in other countries, the positions are for permanent, full-time positions funded from the public purse. In addition to the region attracting highly-skilled talent and investment, ICREA scholars have a responsibility to develop human capital potential through education and training. There is a strong correlation between ICREA scholars and successful European Research Council grants. ICREA is a foundation supported by the Catalan Government and guided by a Board of Trustees.

Source: OECD (2011b), *Higher Education in Regional and City Development: Catalonia, Spain 2011*, OECD Publishing, *http://dx.doi.org/doi: 10.1787/9789264089006-en;* iCrea (2012), Institució Catalana de Recerca I Estudis Avançats, *www.icrea.cat/web/home.aspx*

4.3 Internationalisation of Sonora's tertiary education sector

This section reviews the degree of integration of comprehensive internationalisation into institutional development of Sonora's TEIs, and the implementation of appropriate organisational and programmatic strategies, which support the viability of the process within institutions.

The review was carried out in a limited number of Sonora's TEIs, with focus on those among the 54 TEIs that have a relatively good number of international activities, such as UNISON, ITSON, UES (*Universidad Estatal de Sonora*, formerly known as CESUES), *Instituto Tecnológico y de Estudios Superiores de Monterrey* (ITESM) *Campus Sonora Norte*, *Universidad del Valle de México Hermosillo* (UVM), as well as some technological tertiary education institutions: *Universidad Tecnológica del Sur de Sonora* (UTS), *Universidad Tecnológica de Hermosillo* (UTH), and *Instituto Tecnológico Superior de Cajeme* (ITESCA). The level of internationalisation is uneven across Sonora's tertiary education sector with focus on student mobility. There is a need for comprehensive institutional internationalisation strategies.

Box 4.6. Comprehensive internationalisation

Comprehensive internationalisation refers to "a commitment, confirmed through action, to integrate international and comparative perspectives into the teaching, research, and service functions of tertiary education. It shapes institutional ethos and values and embraces the entire tertiary education enterprise. It is essential that institutional leadership, governance, faculty, students, and all academic service and support units, embrace it. In that sense it is an institutional imperative, not just a desirable possibility" (Hudzik, 2011). In other words, the concept of comprehensive internationalisation goes beyond the traditional notion of international co-operation and physical mobility of individuals. Accordingly, internationalisation strategies must be integrated into all institutional policies and programmes, at the three levels of the educational process: macro (decision making and policy design), medium (curricular structure and policy) and micro (teaching and learning process in the classroom) (Gacel-Ávila, 2006).

A comprehensive internationalisation process is fostered and implemented through two types of strategies: organisational and programmatic strategies. Organisational strategies refer to the strategies whose objective is the integration of the international dimension into the institutional mission, vision, planning and quality assessment procedures, general policies on teaching, research and human resources, as well as the administrative structures and legal framework. Programmatic strategies refer to the establishment and implementation of specific programmes for the internationalisation of the learning, research and community services.

The term strategy is used to stress the difference existing between international activities, which mainly arise from individual initiatives or are a mere response to external offers, and the notion of a more planned, integrated and strategic approach to the making of institutional policies and programmes.

Box 4.6. Comprehensive internationalisation (continued)

In other words, the incorporation of the international dimension in tertiary education requires two basic factors: first, the purely academic response to achieve the internationalisation of the main functions; and second, the necessary administrative procedures and bureaucratic forms to implement any academic initiative of this nature. Both strategies are complementary and have to be implemented simultaneously, as the deficiency of one structure will automatically provoke the failure of the other (Gacel-Ávila, 2006). To sum up, both strategies are equally important, and are "at the core of the success and sustainability of internationalisation at the institutional level" (Knight, 2008).

Source : Hudzik, J. (2011), Comprehensive Internationalization: From concept to action, NAFSA, Washington D.C., *www.nafsa.org/uploadedFiles/NAFSA_Home/Resource_Library_Assets/Publications_Library/2011_Comprehen_Internationalization.pdf*; OECD (1994) Institutional Strategies for Internationalisation: an outline for the OECD/IMHE and state of the art reports, OECD/IMHE, Paris.; Knight, J. (2008), "An Internationalization Model: Meaning, Rationales, Approaches, and Strategies," Higher Education in Turmoil, Sense Publishers, Rotterdam, pp. 21-35.

Organisational strategies

This section reviews the process of internationalisation at TEIs in terms of organisational strategies linked to the development, planning and evaluation of internationalisation activities. It reviews the financial support and human resource policy for internationalisation, giving special attention to the position and resourcing of international offices. Sonora's TEIs have made progress in devising the organisational strategies for internationalisation. To ensure success in future, these strategies need to be restructured and updated in terms of management, planning and assessment procedures.

Institutional strategies for internationalisation

Sonora's TEIs have diverse approaches to devise institutional strategies for internationalisation. Some of the TEIs have included internationalisation as a strategic line in institutional development plans (UNISON, ITSON), while some have included internationalisation as a programme (UES, UVM, UTS). These plans include among their objectives the organisation of a wide range of international activities, such as student and faculty mobility, international joint research projects, international joint and double degrees (JDD), learning of

foreign languages (mainly English) and cultures, summer programmes abroad and international accreditation. Some programmes have been implemented to meet these goals, but other activities are still lacking specific implementation strategies, including more innovative topics such as the internationalisation of the curriculum, intercultural training, internationalisation at home or area studies.

In Sonora's TEIs, international activities are marginal to core institutional policies and strategies, and the potential of internationalisation to contribute to institutional modernisation and quality improvement of education is not fully exploited. While Sonora's TEIs have developed individual activities, they have not implemented institutional mechanisms and procedures to systematically integrate an international dimension in teaching and research. Policies for institutional development lack an international dimension. This might be due to a lack of awareness from institutional leaders, or of appropriate know-how to implement proper strategies, but it might also be due to the lack of public policy for internationalisation in Mexico. TEIs' main efforts focus on the implementation of the national policies set by the Federal Ministry of Education (*Secretaría de Educación Pública,* SEP). Their policies on curriculum, teaching, research, human resources are not internationalised. As a consequence, TEIs have no clear overall institutional strategy for internationalisation, with objectives and benchmarks. Their international activities are carried out with little reference to institutional development policies and not explicitly linked to institutional priorities. The main and often only activity is student and staff mobility (partially subsided by the SEP in the case of public institutions), responding to individual initiatives and interests.

Budget and financial resources

Financial support for internationalisation in Sonora's tertiary education institutions remains underdeveloped. Staff in the TEIs reviewed could not report any institutional budget line or amount spent on the fostering of internationalisation. In general, budget for international activities remains scattered throughout the different senior administration units (academic provost, postgraduate and research deans, international office, etc.), schools and academic departments. No single office is in charge of gathering all data on internationalisation. The international offices of all institutions noted that the funding dedicated to internationalisation is insufficient to adequately foster the internationalisation process and that the topic does not receive adequate attention in the institution.

Planning, policy monitoring and quality assessment

Data collection on and quality assurance of internationalisation activities and programmes remain a challenge for all TEIs in Sonora. None of the TEIs was able to give an aggregated single number on faculty and researcher mobility, student mobility, international scholarships, research collaboration projects, etc. Within each TEI, several units are dealing with international activities and no specific area is made responsible for systematic data collection and follow-up, which point to the lack of an adequate organisational strategy and monitoring of the achievements met, the advancement and impact of the internationalisation strategies.

Sonora's TEIs have not yet established quality assessment procedures to review the impact and benefits of internationalisation on institutional academic improvement, which indicates that internationalisation activities are marginal to institutional development. This marginality puts internationalisation at risk, as it is widely acknowledged that evaluating its benefits and positive impacts on academic life can reinforce the whole internationalisation process and prevent budget cuts in times of financial difficulties. As a result, international activities might be seen more as an expense than as a cost-effective investment towards quality improvement.

Human resources policy

Sonora's TEIs' have not yet taken advantage of developing internationalised institutional policies for human resources. International experience or involvement in international projects is not included in the criteria for staff recruitment, reward, promotion and advancement. Sonora's TEIs have no policy for the international recruitment of scholars and international talent. No institutional database has been set up on the scholars and staff with international experience, who could lead internationalisation strategies, and could be useful in the advancement of the internationalisation process.

Internationalisation offices

International offices have been established in the main TEIs in Sonora but they remain poorly resourced and lack strategy. The main TEIs in Sonora have an international office. The international offices are mainly dedicated to the organisation and promotion of student mobility and the reception of international students. Faculty mobility and their participation in international networks are usually dealt directly through

the offices of academic provosts, postgraduate and research units or through schools and academic departments, without co-ordination with the International Office. In the absence of an institutionally-planned process of internationalisation, each unit develops its own approach in the organisation of programmes. Consequentially, international activities are a result of isolated and individual actions, with limited links to institutional priorities. For example, funds given by the federal government through the Comprehensive Institutional Strengthening Programme (*Programa Integral de Fortalecimiento Institucional*, PIFI) to support faculty mobility are not spent in due time because of the lack of institutional capacity to make appropriate arrangements. Faculty mobility remains limited in all TEIs.

A key challenge in the internationalisation is to develop an integrated institution-wide approach which can be achieved through a single office in charge of the TEIs' international activities. Advancing the internationalisation process is challenging due to the fact that international activities are dealt in different and unrelated units with no institutional overall co-ordination. Due to isolated and individualistic activities, institutional synergy and potential for promotion of internationalisation are lost.

Each TEI should establish a single office responsible for the co-ordination of the overall institutional internationalisation strategy and programmes under the supervision of a dedicated internationalisation committee. This committee should have senior staff from different units involved in the advancement of the internationalisation process, such as the offices of the academic provost and the ones responsible of teaching, research, curricular design, postgraduate programmes, human resources and finance administration, amongst others. Depending on the scope and extent of international activities of each TEI, this office is recommended to be established at the level of senior administration with a direct link to the president office, and to adopt a decentralised organisational scheme with sub-offices in schools or academic divisions. In any case, all offices have to work co-operatively to create synergy and prevent the duplication of functions, which disperses and wastes the already scarce financial and human resources.

This central office is the basis for the establishment of a comprehensive internationalisation strategy cutting across all institutional policies and programmes on teaching, research, human resources and community services. It should be in charge of the overall strategy and promotion of internationalisation programmes (student mobility, faculty mobility, international academic networks for teaching and research, institutional representation in associations or networks

promoting TE collaboration), and should be granted the financial and human resources in accordance with the importance assigned to internationalisation in institutional agenda. In summary, while the internationalisation committee should be in charge of the decision taking and the design of institutional policies and strategies, the internationalisation office should be responsible for the fostering and coordination of all institutional strategies and programmes, with an appropriate decentralised scheme of operation, if required.

The organisational strategies for internationalisation of Sonora's TEIs need to be restructured and updated in terms of management, planning and assessment procedures. Sonora's TEIs should develop a comprehensive plan or an overall strategy for the internationalisation of the institution:

- to implement the different aspects of an internationalisation process and create a supportive culture;
- to assess and continually enhance the quality and impact of the different aspects of the internationalisation process;
- to reward and recognise faculty and staff involvement in international activities;
- to link internationalisation programmes with institutional policies for innovation, staff development and quality improvement;
- to relate government policy and institutional initiatives;
- to integrate an international dimension into the general curriculum and to link this process to quality assurance;
- to look towards support structures at national, regional and supranational level such as databases, exchange of experiences and information.

In order to set up a systematic approach to the planning, implementation and monitoring of the different stages of the process of internationalisation, a proposal has been made (see Box 4.7).

Box 4.7. Organisational strategy for comprehensive internationalisation

According to the British Columbia Centre for International Education (McKellin, 1997), the internationalisation process of TEI can be divided into three stages: initiation, implementation and monitoring.

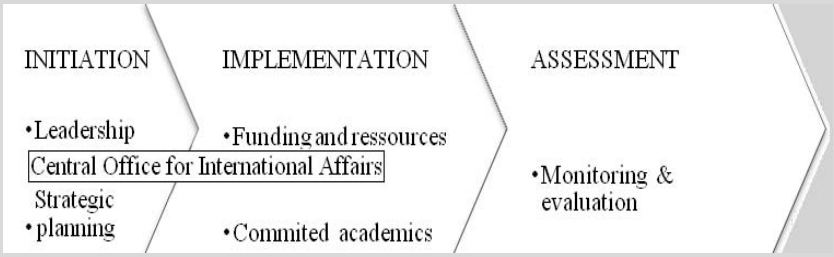
Initiation: The initiation stage has two crucial elements: i) the planning and leadership of the rector and ii) senior executives who drive the process in its beginning. It is necessary to have a leading figure that indicates, recognises, values, motivates and promotes the new process; to create wider awareness of the importance and benefits of internationalisation for students, staff and faculty, and to build within the community a commitment to the process of integrating an international dimension into the teaching/learning, research and service functions of the institution. The planning requires a prior stage where the institution should identify its strengths and weaknesses, to serve as a basis of an effective and a visionary strategy specifically designed to meet institutional priorities and demands.

Implementation: The implementation stage includes: i) the development of a comprehensive plan or strategy for the internationalisation of the institution; ii) the establishment of a central office to promote and co-ordinate the process; iii) the implementation of a comprehensive internationalisation strategy with all the different aspects it implies and to create a supportive culture; iv) the allocation of a budget for the international programme launching and operation; and v) the introduction of mechanisms to reward and recognise faculty and staff participation. The implementation phase implies the expansion of the number of international programmes and projects; the development of international competences among faculty and staff, and the internationalisation of course contents and curricula.

Assessment: The on-going and systematic monitoring of the internationalisation process is crucial to ensure that objectives are reached, quality is improved, and constant progress is made. Adequate and systematic assessment procedures should be established to continually enhance the quality and impact of the different aspects of the internationalisation process.

Box 4.7. Organisational strategy for comprehensive internationalisation (continued)

Towards an effective internationalisation



Source: McKellin, K. (1996), Anticipating the Future. Workshops and Resources for Internationalizing the Post-Secondary Campus, Centre for International Education, Vancouver.

University of Granada and comprehensive internationalisation strategy

Sonora's TEIs could also find inspiration from the University of Granada, which has positioned itself as the leading Spanish university in international student mobility and maintains a broad internationalisation strategy that includes mobility, research collaboration, projects that improve competitiveness of local businesses, linking international students with local employers and improving command of foreign languages. Weak foreign language competencies in Andalusia have a negative impact on regional development and the internationalisation of local businesses. In addition to a strategy to improve the language competencies of the members of the university community, the University of Granada also participates in language learning efforts at local schools (see Box 4.8).

Box 4.8. University of Granada and focus on internationalisation

The University of Granada is the leading university at the Spanish and European level in student mobility, for both incoming and outgoing students. In Spain, it is also the leading university in terms of number of students in international work placements, financed by the Erasmus Programme. It is a founding member of the Coimbra Group of universities which pride themselves of their historical strong impact on locally and regional development.

Outgoing student mobility is considered important for students, as it provides them capacity-building opportunity to acquire language, intercultural and interpersonal competencies, as well as initiative and personal autonomy. The strong international activity has contributed to the University of Granada having the highest percentage of any university in Spain of graduates working abroad: 3.6% of graduates (in 2006). Incoming mobility is seen as vital for the internationalisation of the university impacting the entire institution. International students are integrated in the university and also local activities, such as voluntary work programmes organised by the Science Museum and the Development Co-operation Centre (Cicode). During the welcome week at the beginning of each semester for all incoming international students, they are appointed as "Ambassadors of Granada" by the City Mayor, recognising the importance the impact of their stay in Granada may have for the image of the city in their institutions, cities and countries of origin.

The University of Granada participates in 40 European projects on different programmes. It runs four Erasmus Mundus Master's programmes that have regional impact, for example EuroPublicHealth, which is co-ordinated jointly by the university and the Andalusian School for Public Health, a regional institution devoted to continuing training programme for health professionals and administrators.

Two projects with Latin America involve local and regional stakeholders and have potential for business development. The GERM project compared university-business links and knowledge transfer in Europe and Latin America, identified good practice and strengthened these links. It involved local companies and Chambers of Commerce in the participating countries. The VertebrALCUE Project (Alfa III 2008-11) contributed to the development of regional integration of Latin American Higher Education Systems and the implementation of the EU-LAC Common Area of Higher Education. It strengthened academic co-operation through the design and implementation of liaison structures and supporting closer co-operation among universities, enterprises, local government and society, thus contributing to local development and social cohesion.

Box 4.8. University of Granada and focus on internationalisation (continued)

The university has also pioneered initiatives related to foreign language learning. It participates in the Plurilingualism Plan of the Regional Government of Andalusia which has introduced bilingual sections in primary and secondary schools. The university sends both final year language students and international students to local schools in Granada and also smaller towns. The university has also developed a syllabus and pilot scheme for the teaching of Arabic as a foreign language in secondary schools in co-operation with the Regional Ministry for Education. The scheme is of interest both to the large Arabic-speaking immigrant community and to other students interested in widening their language options. Finally, the Confucius Institute was opened by the university in co-operation with the University of Beijing and Hanban Chinese language institute in 2008, and now offers courses and cultural activities to the local population.

Source: OECD (2010b), Higher Education in Regional and City Development: Andalusia, Spain 2010, OECD Publishing, *http://dx.doi.org/doi: 10.1787/9789264088993-en.*

Programmatic strategies

This section reviews the progress made by Sonora's TEIs in international student mobility, internationalisation of the curriculum, including competence-based curriculum, teaching of foreign languages, international research and research mobility, international accreditation and visibility of TEIs in international rankings. The most common and in most cases the only mechanism that the TEIs in Sonora have created in internationalisation is student mobility, but this remains limited in number and scope: in average less than 0.1% of total student enrolment engages in international mobility.

Student mobility and international students

Most public and private TEIs in Sonora have programmes for student mobility and international students, but the mobility figures remain generally low with some significant differences in levels of achievement. The private university ITESM and the biggest public TEIs in Sonora, UNISON and ITSON, are the leading institutions among Sonora's TE sector. The numbers remain modest, particularly for the public universities given their size and scope: In 2011, TEIs in Sonora reported the following number of international outgoing students: UNISON (59), ITSON (20), ITESM (80), UVM (80), and in 2012 UTS

(2). There were less than 70 international incoming students (UNISON 14, ITSON 7, ITESM 26, UVM 20 and UTS 0). The main destinations for Sonora's students are institutions in Latin America, Europe, Canada and the US. In the case of the UVM in Hermosillo student mobility is channelled to sister institutions belonging to the Laureate International University Network. The UVM grants its graduates an international certificate, and offers its students the opportunity to take a virtual course in an institution abroad that belongs to the Laureate network.

The numbers of international students are very low, especially from the US, given that Sonora shares a border with the US. The commissions for Sonora-New Mexico and Sonora-Arizona have not yet improved the student mobility between Sonora and the two states. ITSON reported hosting one student from the University of Arizona in 2011. In 2011, UNISON and ITSON reported the movement of four and eleven students to the USA.

Stronger efforts should be made to increase international student mobility and to link the international students to on- and off-campus activities. Given the fact that Sonora is a relatively safe and well-equipped state, stronger efforts should be made to make the institutions more attractive to foreign students. Foreign students interviewed during the OECD review in March 2012 reported the lack of cultural life, but mentioned that they were enjoying their stay thanks to the hospitality and kindness of the local people. Despite the limited numbers of incoming international students, more efforts could be made to use them for on-campus internationalisation, such as involving them in language learning efforts, linking international students with the employers in Sonora or mobilising them as ambassadors for Sonora.

To increase international student mobility, a number of steps could be taken: A special promotion strategy for Sonora as an international academic destination could help increase the number of international students (see Box 5.4. for Jalisco's strategy.) Other strategy to attract more international students would be to establish Spanish language courses and schools all year around, as well as courses and programmes taught in English. These policies would be particularly appropriate for Sonora's main public TEIs. Currently, only UNISON provides Spanish courses for foreign students during the summer.

The internationalisation of the curriculum

Sonora's TEIs have not yet developed an explicit and comprehensive policy for curricular internationalisation. As a result, Sonora's TEIs lack

- institutionally established mechanisms and strategies designed to foster the systematic integration of an international dimension into the contents and structure of the study programmes,
- the presence of teachers with international experience (local and visiting),
- student physical or virtual mobility as part of the educational strategy and programme,
- international joint degree programmes
- courses and programmes taught in foreign languages,
- courses on international and intercultural topics (area studies),
- the presence of international students and their use as pedagogical resource,
- courses specially designed according to international students' demands.

Sonora's TEIs have made limited efforts to internationalise their curricula. Latin American TEIs, in particular public institutions, are usually not proactive in the establishment of joint degree programmes, although they are widely acknowledged as an efficient strategy to internationalise curricula, update educational models and structures, and enlarge and innovate academic offerings (Gacel-Ávila, 2009). Sonora is not the exception and joint degree programmes are extremely rare, if not totally absent, in public TEIs. Although some TEIs' development plans may refer to joint degree programmes, no implementation strategy has been established .[9] The UVM is the only institution offering a double degree programme in administration with Walden University in the USA. Sonora's TEIs do not offer joint academic programmes, although it is a worldwide strategy to internationalise local students and attract international students. ITESM offers some courses taught in English in a limited number of areas (but never more than 10% of the whole study programme).

Sonora's TEIs do not offer area studies, but could consider establishing them to internationalise their curricular. Area studies refer to the interdisciplinary fields of scholarship and research in particular cultural topics and regions in social sciences and humanities. Through these areas, international and intercultural topics are usually taught to help students acquire some knowledge on world events and trends, culture, history, social, economic and political contexts. These areas are an efficient way of promoting students' global consciousness, which

refers to the understanding and receptivity of foreign cultures, the acquisition by the student of certain knowledge and information on global socio-economic and ecological topics (Oxford Dictionary of New Words, 1991). Unlike many other universities in Mexico,[10] the TEIs in Sonora do not have research centres specialised on the study of cultural and regional areas, such as North American, Asian or European studies. These centres are usually used to offer these area studies for students enrolled in different fields, and interested in international topics of all kind. Area studies are used to integrate courses on international subjects into the study plans of all disciplines. This is an area of opportunity for TEIs, especially main universities, to establish such centres to support the internationalisation of the curriculum for all students, as well as the research areas.

Sonora's TEIs have not yet taken full advantage of developing a competence-based curriculum and internationalised the student's learning experience in this way. Sonora's TE curricular design for the *licenciatura* (bachelor level) and postgraduate studies has limited focus on competences. Although Sonora's TEIs may state that their curricular design is based on the development of skills and competences of students, in practice the traditional Latin American model prevails, as witnessed in the overload course content, note taking and memory-centred learning. The majority of teachers are part-time and not trained in new curricular models and pedagogy to make competence-centred teaching a reality. Such international models as Tuning are not being used as input to update and internationalise the traditional curricula structure and academic models. The Tuning model is recommended as a way for Sonora's TEIs to establish an internationalised curriculum (See Box 4.9).

Box 4.9. Tuning Latin America: A model for the internationalisation of Latin American TE systems

The ALFA Tuning Latin America Project is an independent project, promoted and co-ordinated by TEIs in 19 Latin American countries with the support of the ALFA Programme of the European Union Commission. This project is based on the original European Tuning project aimed to design the academic structures for the Bologna Process, by developing the main points of reference for the convergence of the TE systems in order to establish the European Higher Education Area (EHEA). Tuning's main characteristics are: a curricular approach based on learning outcomes, the establishment of a set of generic and subject-specific competencies across different disciplines and professional fields; the establishment of a system of comparable credits (ECTS), and degree qualifications for each subject area. Thus Tuning is a project designed to support the reform and re-design of TE curricula.

ALFA Tuning Latin America applies the same approach to design and implement new curricular structures for the participating Latin American TEIs. Currently, this project is being worked out in other regions of the world including 11 eastern European countries, Ukraine, Russia, Georgia, 53 African countries, the USA, Australia and Canada, with a total participation of 60 countries and 14 languages. Additionally, the Tuning learning outcomes methodology has become part of the OECD programme for the Assessment of Higher Education Learning Outcomes (AHELO) designed for the international assessment of TE student learning outcomes.

Tuning Latin America formally began in October 2004 and the first phase ended in 2007 with the participation of 190 Latin American TEIs of the following countries: Argentina, Brazil, Bolivia, Colombia, Costa Rica, Cuba, Chile, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. Its main result was the design of new curricular structures based on competencies in 12 professional and disciplinary subjects: administration, education, history, mathematics, law, medicine, architecture, civil engineering, chemistry, physics, geology and nursing.

Currently, the Tuning Latin America Project is in its second phase for the period 2011-2013, and aims at completing the new curricular structures with a framework of degree qualifications and the corresponding graduates' profiles for the areas of humanities, social sciences, health sciences and engineering. Additionally, further curricula are being built for new areas, including psychology, agronomy and informatics.

As Latin America is not pursuing the establishment of a TE common area yet, the Tuning methodology offers an international model which can be used for Latin American tertiary education system to introduce a learning outcome based approach curriculum including the identification of generic and subject-specific competencies. As this model sharply contrasts with the traditional Latin American approach, it provides the basis for a greatly-needed academic reform. This new methodology will enable participating institutions to update and internationalise their academic model and thus improve students' performance.

Source : Beneitone, P., et al (eds.) (2007), Reflections on and outlook for Higher Education in Latin America, University of Deusto, Deusto, Spain, *http://tuning.unideusto.org/tuningal/*.

Sonora's TEIs could also find inspiration in the various "global citizen initiatives" developed by universities in the State of Victoria in Australia. Several universities in Victoria are restructuring or reformulating their approach to teaching, learning and research, by creating "global citizen initiatives". For example, the University of Melbourne has restructured its curriculum, introducing six 3-year undergraduate degrees. An innovative feature of the Melbourne Model is the development of university breadth studies, which adopt an inter-disciplinary approach to disciplinary or global challenges, *e.g.* climate change, human rights and global justice or emerging technologies for transformation. Other global citizen initiatives include "Monash passport" and RMIT University's "Global passport" that enables students to combine degree programmes with international exchanges, leadership programmes, work training programmes and volunteer and research opportunities. These initiatives broaden the curriculum to develop additional skills either in Australia or abroad to enable student to "excel in an open world economy" (RMIT Global Passport). They have a strong focus on employability and soft skills, by providing experiential learning opportunities (see Table 4.5).

Table 4.5. Global citizen initiatives

Initiative	Main Features
Melbourne Model, University of Melbourne	Six broad-based undergraduate degrees with key features: disciplinary depth, breadth studies, knowledge transfer and capstone experience. Together with increased prospects for internships, study abroad and participation in industry projects, the degrees offer the chance to explore a range of interests before committing to a particular career path. *www.futurestudents.unimelb.edu.au/about/melbournemodel.html.*
Monash Passport, Monash University	Combines degree programmes with international exchanges, leadership programmes, work training programmes and volunteer and research opportunities as a grounding for careers. *www.monash.edu.au/education/passport.*
Global Passport, RMIT University	International education and industry networks provide a wide range of opportunities for students to enhance their education or research experience – at the university's campuses in Melbourne and Vietnam; with partner institutions in Singapore, Malaysia and China and through education and industry links throughout the world. *www.rmit.edu.au/globalpassport.*
Graduate Capabilities Statement, Victoria University	Graduate capabilities transcend technical skills and curriculum content and enable students and graduates to be work, career and future ready. On graduation, students will receive a Victoria University Graduate Capabilities statement as part of the Graduation Statement. *http://wcf.vu.edu.au/GovernancePolicy/PDF/POA050510000.PDF.*
Curriculum Framework Project, Swinburne University of Technology	Model for Professional Learning which emphasises real world learning experiences within a supportive environment, integrated with skills development in order to prepare graduates to make the transition to professional practice. *www.swin.edu.au/hed/framework.*

Source: OECD (2010c), *Higher Education in Regional and City Development: State of Victoria, Australia 2010*, OECD Publishing, *http://dx.doi.org/10.1787/9789264088979-en*.

As the comprehensive strategy for curriculum internationalisation is practically absent in Sonora's TEIs, this is an area of opportunity and should become a high priority for TEIs. This particular strategy deepens the TEI's process of internationalisation, as it impacts the whole system and all students (not only the very small number of students in mobility), by bringing transformations in terms of structures, academic models and course offerings.[11]

The internationalisation of the curriculum is a systematic and comprehensive approach for TEIs to adapt to the global context. This strategy requires the following conditions: *i)* institutional autonomy; *ii)* sufficient flexibility in curriculum regulations within the TEI; iii) a senior academic moderation of the process; *iv)* broad involvement and commitment of staff; *v)* staff with specific teaching and cross-cultural communication skills; *vi)* endorsement from the top management; *vii)* a combined top-down and bottom-up strategy; *viii)* consistency with the institutional mission and policy; *ix)* administrative support, infrastructure, and services for the reception of foreign students and staff; and *x)* additional funding (Van Der Wende, 1997).

Teaching of foreign languages

All TEIs in Sonora recognise the importance of learning foreign languages, in particular English. Most of Sonora's TEIs have integrated the learning of English as a compulsory curricular subject with a higher-intermediate level of English corresponding to a B2 level of the Common European Framework Reference of Languages (CEFRL) or a 450 point-TOEFL.

In practice, more efforts are needed to improve the language learning results in Sonora's TEIs. Despite the fact that the command of English is a graduation requirement, students do not achieve the required levels due to weaknesses in the strategy design. First of all, TEIs have not established a specialised area in charge of the design, implementation, co-ordination and monitoring of the institutional linguistic and foreign language teaching policy. Secondly, TEIs do not take into account national and international recommendations that need to be incorporated in the programme design to assure that learners acquire the desired level. Some of the neglected aspects include: the number of hours to be taught in class to achieve the linguistic goals, the type of standardised evaluations needed to assess levels of proficiency, the language teaching methodology, and the teacher's linguistic and academic profile. For example, some TEIs claim that students graduate with a B2 of the CEFRL with only 300 hours of study, when national standards[12] recommend a minimum of 550 hours

unless students acquire a B1 during upper secondary school, which is never the case in Mexico for the public sector. No standardised test or an international certification is used for evaluation and exams depend on the teacher's own planning and design, which means that there is no way to prove that students have actually achieved the announced level. No unified teaching methodology has been implemented and in the majority teachers do not hold degrees in the teaching of foreign languages.

The majority of TEIs in Mexico share these shortcomings in language learning. National and international reports on education (see OECD, 2008) continuously highlight poor foreign language skills in Mexican students. Some universities in Mexico, such as the University of Guadalajara, have adopted successful strategies in this respect, and could serve as an inspiration for further development in Sonora's TEIs (see Box 4.10). Sonora's TEIs are advised to design an institutional linguistic strategy based on the establishment and implementation of a unified teaching methodology, exams that meet international standards, a professionalised teaching team (BA or MA in the teaching of a foreign language), and the creation of a special unit in charge of the strategy co-ordination, design and monitoring.

Box 4.10. Institutional language policy for English at the University of Guadalajara, Mexico

As part of the internationalisation strategy to develop the students' international profile, the Internationalisation Office at the University of Guadalajara (UDG) has, since 2007, implemented an institutional language policy in accordance with the international recommendations for tertiary education. As the lack of foreign language proficiency of Mexican students is mainly due to poor teaching strategies and insufficiently-professionalised teachers, the UDG mainly focused on quality teaching and appropriate strategies to meet desired learning outcomes in students. The UDG strategy applies the quality control standards set by the SEP to incorporate foreign language teaching practices to optimise learning outcomes. These standards include: an adequate number of hours of teaching in relation to students' previous language knowledge and desired linguistic level, course contents designed according to a specific teaching methodology, faculty with an academic profile in foreign language teaching, the use of standardised tests to assess language proficiency and the monitoring of instructors' teaching quality.

The UDG strategy's linguistic guidelines incorporate the benchmarks of the CEFR for course contents, development, implementation and assessment. The expected linguistic outcomes are designed according the level of proficiency acquired by students during upper high school.

Box 4.10. Institutional language policy for English at the University of Guadalajara, Mexico (continued)

A specific English language programme was designed to meet the quality requirements and has to be followed by all teachers. It consists of six levels of English (600 hours of study divided in 100 hours per semester). It is based on methodologies using communicative and interactive teaching approaches, and offers a blended learning model of 60 hours of face-to-face classes together with a 32 hours online study combined with workshops and tutorial sessions offered in self-access centres. This learning model does not only reinforce the linguistic knowledge, but also helps to personalise the learning process and develop student's autonomous learning through TICs.

Source : Gacel-Ávila, J. and V. Pimienta (2012), "Institutional language policy for English at the University of Guadalajara," CGCI, UDG, Guadalajara.

Mobility of faculty and researchers

In Sonora, the leading institutions in terms of the mobility of faculty and researchers are UNISON and ITSON, but numbers are low compared with Mexico's other public universities. Faculty mobility programmes are mainly supported by the public TEIs, while private institutions are not engaged in these kinds of programmes, offering no mobility opportunity for their faculty, which indicates a low international profile of scholars.

International research and mobility

In Sonora, the leading institutions in terms of the mobility of faculty and researchers are UNISON and ITSON: UNISON reported an international mobility of 38 professors (Sonora's Regional Steering Committee, 2012) and ITSON of 14[13], but numbers are low compared with Mexico's other public universities.[14] In respect to membership in the National System of Researchers (SNI)[15], Sonora ranks 13th out of Mexico's 32 states. Sonora's nationally certified SNI researchers, almost two-thirds of them based in UNISON, represent only 2.27% of the national total (SEC, 2012), which is a very low percentage if the state wants to build a solid knowledge base and increase its generation of knowledge.

Although Sonora falls behind other northern states at 20th place in the overall Ranking of Science, Technology and Innovation for Mexico,

its 9th place ranking for the specific indicator "scientific production per 10 000 inhabitants" has been singled out as an opportunity to pursue (FCCyT, 2011). According to the international collaboration index (IC), *i.e.* the institutional output ratio produced in collaboration with foreign institutions (Scimago Institutions Ranking, 2012),[16] the leading institution, UNISON, occupies the 12th place nationally with an International Collaboration index of 33.9%. It comes in ahead of the University of Veracruz (UV), the Autonomous State University of Hidalgo (UAEH) and the Autonomous State University of Morales (UAEM), which represent TEIs with a comparable scientific output. At the same time UNISON lags behind smaller universities with much higher production like the Autonomous University of San Luis Potosi (UASLP) and the University of Guanajuato (UGTO) (see Table 4.6). ITSON, with a significantly smaller scientific production (114 published articles) and 6% of the state SNI researchers has an IC index of 44.7%, and COLSON with 4% of SNI members obtains a 63.6% IC. These results suggest that ITSON and COLSON are beginning a process of specialisation in certain research fields (Scimago Institutions Ranking, 2012). Thanks to its well focused research ITSON holds the 4th place for the number of citations, compared to the 14th place for UNISON.

The international mobility of researchers in Sonora's TEIs is very limited.[17] International contacts and projects are mainly left to each scholar's own initiatives, restrained by lack of funding and without assessment of the quality and impacts. TEIs do not have robust data on mobility, international projects, funds and researchers with international experience. Due to the lack of institutional and co-ordinated strategy designed to promote research, the support for researcher mobility is scattered in different units with no link among them and international offices are not in charge of it. While this approach might work for the maintenance of existing links, it is not appropriate to widen the scope of co-operation partners and projects. The lack of a proactive approach limits TEIs' potential to take advantage of the international co-operation projects. In general, when interviewed, researchers identify the lack of financial resources and sustained institutional effort as barriers to participate in international projects and networks.

Table 4.6. International collaboration index of Mexican TEIs

Ranking	TEIs	Scientific documents published	% of international collaboration
1	Universidad Iberoamericana (UIA)	452	54.2
2	Universidad de Guanajuato (UGTO)	1 396	42.4
3	Universidad de las Américas Puebla (UDLAP)	491	40.5
4	Universidad Autónoma de Baja California (UABC)	1 055	39.2
5	Universidad Nacional Autónoma de México (UNAM)	18 350	38.3
6	Universidad de Colima (UCOL)	482	37.3
7	Universidad Autónoma de San Luis Potosí (UASLP)	1 295	36.8
8	Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV)	6 632	36.4
9	Instituto Tecnológico de Estudios Superiores de Monterrey (ITESM)	1 533	34.6
10	Universidad Autónoma de Yucatán (UADY)	720	34.6
11	Benemérita Universidad Autónoma de Puebla (BUAP)	1 593	34.2
12	Universidad de Sonora (UNISON)	716	33.9
13	Universidad Veracruzana (UV)	707	32.5
14	Universidad Autónoma de Nuevo León (UANL)	1 638	32.0
17	Universidad de Guadalajara (UDG)	1 870	31.7
18	Universidad Autónoma del Estado de Morelos (UAEM)	1 316	31.0
19	Universidad Autónoma de Querétaro (UAQ)	551	30.9
20	Universidad Autónoma del Estado de Hidalgo (UAEH)	656	29.9
21	Universidad Autónoma del Estado de México (UAEMEX)	744	28.2

Source: Scimago Institutions Ranking (2012), *Iberoamerican Ranking SIR 2012*, *www.scimagoir.com/pdf/ranking_iberoamericano_2012_en.pdf.*

Sonora needs to increase its number of nationally certified SNI researchers, which is quite low compared with other Mexican states; and to reinforce the organisational structure to support researchers' participation in international networks and internationalisation of their institutional profile. It should also attract talent from abroad to develop research strength. University of the Free State in South Africa could

serve as an inspiration as it has raised its international profile in a very short time, by nurturing a new generation of researchers of international calibre and attracting international faculty.

Box 4.11. UFS building academic excellence and diversity

The higher education scene in the Free State province in South Africa is dominated by the University of the Free State (UFS), which offers a full range of undergraduate and postgraduate degrees and diplomas to more than 30 000 students in seven faculties. The UFS received the World Universities Forum (WUF) Award for Best Practice in Higher Education during 2010.

The UFS's innovations to transform the university include many initiatives with international perspective, such as: the International Advisory Council consisting of key thinkers and practitioners; the nurturing of the most promising young scholars by means of the Vice-Chancellor's Prestige Young Scholars Programme; attracting international talent to strengthen research; sending 71 first-year students to top US universities to assist with their development into non-racial campus leaders; the revision of the undergraduate curriculum to promote a cross-disciplinary approach to key societal problems; and campus-wide racial integration among students.

The Vice-Chancellor's Prestige Scholars Programme takes 25 young staff members with recent PhDs and teaches them how to become professors through intensive local and international mentorship, research support and academic training. This programme, unique in South Africa, focuses on the next generation of top researchers in South Africa who will fill the gap that is left by retiring academics. The programme also adds to the diversity of the professoriate at the university.

The University of the Free State has successfully recruited top professors around the world. Financial crisis has facilitated the recruitment process. Professors have been recruited based on traditional academic merits. These professors include Kwandile Kondlo (from the Human Sciences Research Council (HSRC) who is heading the Centre for Africa Studies), Hussein Solomon (from the University of Pretoria and joining the Department of Political Science), Hasina Ebrahim (from the UKZN joining the Faculty of Education), Sechaba Mahlomaholo (from the North-West University, joining the Faculty of Education), Greg Barr (from the US joining the Department of Music), Monty Jones (from Sierra Leone), Helena Strauss (joining the Department of English), Johan Neethling (joining the Faculty of Law), Cynthia Miller Naude (joining the Department of Classic and Near Eastern Studies) and Charles Dumas (of the US joining the Department of Drama and Theatre Arts).

Source: OECD (2012b), *Higher Education in Regional and City Development: The Free State, South Africa 2012*, OECD Publishing. doi: 10.1787/9789264169142-en.

International accreditation and rankings

In Sonora's tertiary education system, accreditation of TEIs and academic programmes is carried out by national organisations. Only the ITESM system, which has two campuses in Sonora, has been internationally accredited since 1950 by the Southern Association of Colleges and Schools (SACS) (Sonora's Regional Steering Committee, 2012).

In international rankings, the Autonomous University of Mexico (UNAM) is the only Mexican TEI included among the world's top 500 universities by the Academic Ranking of World University (ARWU) within the 151-200 range, while the University of Sao Paolo, the highest ranked Latin American TEI, is within the 102-150 range (ARWU, 2011). In the Iberoamerican Ranking SIR 2012 – based on research outcome – UNAM is the second both for Iberian and Latin America ranking, whereas Sonora's key institutions receive much lower rankings. UNISON places at 107th and ITSON at 320th in Latin America (see Table 4.7).[18] If enrolment is taken into consideration, then UNISON and ITSON are ranking low in terms of scientific output, compared with other Mexican universities of similar size (see Table 4.7).

Table 4.7. Ranking of Mexican TEIs within the Latin American region and their enrolment

Position in Latin America	Mexican TEIs	Enrolment
2	Universidad Autónoma Nacional de México (UNAM)	205 930
16	Instituto Politécnico Nacional (IPN)	98 526
44	Universidad de Guadalajara (UDG)	98 399
51	Universidad Autónoma de Nuevo León (UANL)	82 791
52	Benemérita Universidad Autónoma de Puebla (BUAP)	65 685
61	Universidad de Guanajuato (UGTO)	33 818
66	Universidad Autónoma del Estado de Morelos (UAEM)	18601
67	Universidad Autónoma de San Luis Potosí (UASLP)	24 171
77	Universidad Autónoma de Baja California (UABC)	53210
107	**Universidad de Sonora (UNISON)**	38437
320	**Instituto Tecnológico de Sonora (ITSON)**	**17 000**

Source: Scimago Institutions Ranking (2012), *Iberoamerican Ranking SIR 2012*, www.scimagoir.com/pdf/ranking_iberoamericano_2012_en.pdf.

Conclusions and recommendations

In the past few years, Sonora's tertiary education system has made considerable progress in advancing the internationalisation process, but its results and impacts remain modest, in view of the size of the tertiary education system. They are also modest given the economic strengths of the state, the needs of regional development of Sonora, and the state's proximity to the US.

While the internationalisation of the curriculum is the result of student mobility, faculty mobility, and curricular development (Van der Wende, 1997), in the case of Sonora's TEIs, the only existing mechanism of internationalisation is traditional student mobility, which remains limited in number and scope: on average less than 0.1% of total enrolment.

Internationalisation strategies and activities can support the transformation of Sonora's tertiary education system only if a systematic approach to the process is implemented by the institutions. For this to happen, TEIs need to develop a comprehensive internationalisation strategy at the institutional level. The main challenge is the deficiency of the *ad hoc* nature of institutional policies, which limit the scope of present activities, promotion and synergy within the community, and prevent TEIs from reaping the benefits from TE globalisation opportunities, international co-operation offers and mobility flows.

In the absence of adequately designed strategies, Sonora's TEIs are developing international activities, which remain marginal to institutional policies and disconnected from institutional plans and priorities. These activities stem principally from individual initiatives and students' and scholars' interests. This piecemeal strategy is not enough to transform the tertiary education system into a modern, relevant, high-quality and internationally-competitive system.

The OECD review team recommends that the following measures are taken to widen and deepen their internationalisation process of the Sonora tertiary education system:

Recommendations for the state government:

- In collaboration with the TEIs, design and implement a strategy to promote the state tertiary education system as an international destination for students and actively participate towards this end in different TE international events (see Box 4.4). Take full advantage of the opportunities provided by the Sonora-Arizona and Sonora-

New Mexico Commissions to support this goal by developing adequate mechanisms and structures that will foster student and faculty mobility, innovative joint-degree programmes and RDI collaboration.

Recommendations for TEIs

Restructure organisational strategies for the further advancement and viability of the institutional internationalisation process. To do so, the following steps are recommended:

- Restructure and update procedures in respect to planning, management, budgeting and assessment.
- Develop a comprehensive institutional plan for internationalisation based on the prior assessment of institutional strengths and areas for improvement, and establish institutional priorities for internationalisation activities.
- Create wider awareness within the TE and wider community on the importance and benefits of internationalisation for students, faculty and staff.
- Link internationalisation strategies to policies for innovation, quality improvement and staff development.
- Create the necessary budget conditions for the implementation of the internationalisation programmes.
- Create a supportive academic and administrative culture through the establishment of institutional policies with respect to human resources, legal regulations and management structures.
- Enlarge the functions of the international office in order to co-ordinate the overall institutional strategy under the direction of an internationalisation committee. The office functions should include: the co-ordination of all international activities and programmes including student, faculty and researcher mobility; the internationalisation of the curriculum and research; the recruitment of international students and their interaction with local students and the community; institutional participation in international networks and associations for TE collaboration; the promotion and communication of internationalisation process strategies; the establishment of an institutional database on internationalisation and internationally-experienced faculty; the co-ordination of special

programmes of international demand, such as Spanish language programmes.

- Assess and continually enhance the quality and impact of the different aspects of the internationalisation process.
- Encourage staff and faculty internationalisation through the establishment of a reward and recognition scheme for their involvement in international projects.
- Link government policy and institutional initiatives for internationalisation.
- Take advantage of support structures for internationalisation at national, regional and supranational levels such as databases, exchange of experiences and information.

Develop comprehensive programmatic strategies:

- Link internationalisation strategies to innovation, teaching, research and curriculum policies.
- Design and implement the different programmes related to the comprehensive internationalisation strategy that is linked to institutional priorities.
- Integrate an internationalised curriculum into the general curriculum and academic offering, linking this process to the quality assurance system.
- Promote the establishment of international joint-degree programmes as a means of internationalisation of the curriculum, academic model and offering; use international academic models like Tuning to aid curricular design; set up academic offerings in area studies or internationalised general education courses available for all academic programmes in order to develop students' global awareness, or establish a common curriculum cutting across all programmes including international general education; establish research centres or programmes on different regional world areas (North American, Asian and European studies).
- Design strategies to integrate foreign and domestic students in the classroom and in extracurricular activities.
- Promote the use of ICTs for virtual international student mobility.
- Broaden the offering of Spanish courses or special courses for international students; establish a unit in charge of designing,

co-ordinating and monitoring the institutional strategy for the teaching of foreign languages across the curriculum to implement a unified teaching methodology, course contents, standardised exams and recruitment of faculty specialised in the teaching of foreign languages.

- Promote internationalisation of research through a better organisational strategy and enhanced availability of financial resources.
- Design a dedicated strategy for international accreditation of programmes.

Notes

1. KOF Swiss Economic Institute is one of the leading economic think tanks in Switzerland. The name is an acronym for the German word "*Konjunkturforschungsstelle*," which means "business cycle research institute." It is associated with the Swiss Federal Institute of Technology. The index ranks 156 countries.
2. The General Competitiveness Index (GCI) for 2011-2012 covers 142 countries.
3. The Knowledge Economy Index 2012 (KEI) had the participation of 146 countries.
4. Sonora is a TL2 region according to the OECD classification of regions (OECD, 2009a).
5. By 2010, the IMMEX programme income represented 77% of the country total exports in manufacturing (Martínez Trigueros, 2011).
6. This indicator corresponds to the year 2010 and it includes only 12 Mexican states (FCCyT, 2011).
7. This ranking is based on ten indicators; one of them being scientific productivity and each indicator is composed by several sub-indicators (FCCyT, 2011).

8. The sub-indicator "scientific production per 10 000 inhabitants" is one of the seven sub-indicators composing the concept of "innovative productivity".

9. UNISON reported around nine students who have gained a double degree at different French universities. But this is not considered as JDD programmes, as it does not refer to the organisation of academic programmes established between both institutions and integrated into regular academic offer available to all students.

10. ITAM: Centre for Inter-American Studies and Programmes, Institute for European Integration Studies, Asia Pacific Studies Programme, Canadian Studies Programme; UNAM: Centre for Research on Latin America and the Caribbean, Centre for Research on North America; University of Colima: University Centre for Study and Research on the Pacific Rim, APEC Study Centre; University of Guadalajara: Department of Iberian and Latin American Studies, Centre for European Studies, Department of Studies on the Pacific Rim, Centre for Research on North America, Centre for Mexico-United States Studies.

11. For example, Levine's Theory of Change (2000) stresses the difference between an individual and a systematic strategy. On the basis of this theory, student and faculty mobility can cause changes on the individuals, but not on the system. Because curriculum is the most important trait and identity of an institution, the internationalisation of the curricular structure, model and offer entails deep and lasting changes not only on the curriculum but also on the TE system.

12. Set by the National Certification for Language Level (*Certificación Nacional de Nivel de Idioma*, CENNI) from the SEP.

13. Mónica Gómez-Juraz, personal communication, March 26, 2012.

14. For example: UNAM, UDG, UANL, UABP.

15. The National System of Researchers was created in 1984 by the Mexican Government to support the research in science and technology carried out by individual researchers. Membership is awarded on satisfying quality standards and high level of scientific output assessed by a peer review process in respective fields. By 2011, the system had 17 519 researchers (CONACYT, 2011).

16. In this respect, proper comparisons in the area of internationalisation of research are sometimes difficult to make within the Iberian- and Latin- American context since there are significant variations among TEIs. For example, the University of Sao Paolo, the highest for scientific production, has a 23.8 IC index, but UNAM a 38.3, the

University of Barcelona a 45.1, the University of Buenos Aires a 39.8 the University of Chile a 43.9 and the *Universidad Complutense de Madrid* a 35.1 index.

17. UNISON (38) and ITSON (14)

18. Differences with respect to the above IC index ranking are due to the fact that the 2012 Scimago Ranking is made of four other indicators oriented towards an assessment of the quality and impact of the published documents.

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Chapter 5.
Capacity building for regional development

The extent to which universities and other tertiary education institutions (TEIs) engage in regional human resource and skills development and innovation depends greatly on the policy context and the incentives that are in place to encourage such collaboration. This chapter provides an overview of Sonora's governance system, including the actors and agencies which are involved in Sonora's development, including its diverse set of TEIs. It outlines and evaluates the scope, mechanisms and capacity of TEIs to engage in regional development with a wide range of stakeholders. It provides an overview of the policy context for the regional engagement of TEIs including the "connection councils" and looks into the incentive structures. The chapter concludes with specific recommendations for federal and state governments as well as TEIs.

Introduction

Tertiary education institutions (TEIs) impact regional development in many different ways. As pointed out in the UNESCO World Declaration on Higher Education (UNESCO, 1998), higher education institutions have acquired an unprecedented role in contemporary society as a vital component of cultural, social, economic and political development and as a pillar of endogenous capacity building. The growing awareness of the importance of TEIs in the economic, social and cultural development of the regions and cities in which they are located has changed the way TEIs interact with governments, the private sector and communities.

In this chapter, capacity building for regional co-operation refers to the development of the capacity to build bridges between TEIs and the region. This depends not on isolated actions of individual actors, but also on joint collaborative work as well as policy context and incentives. The effectiveness of TEIs' contribution to capacity building, co-operation and regional engagement depends on a combination of factors, such as existing capacity, partnership opportunities, regional and local economic and political conditions, institutional leadership and TE and regional development policy and as well as available incentives.

Mexico's Federal Development Plan and the Ministry of Public Education's plan signalled that Mexico has redefined the role of TEIs as key players in overall social and economic transformation. This redefinition of TEIs' role in Sonora's society and economy has opened new opportunities, but also new challenges for TEIs, as seen in the Sonora State Development Plan 2009-2015.

This chapter examines the current capacity and capacity building activities among TEIs for local and region-wide co-operation in Sonora. It addresses the policies, strategies and tools used by the federal and state governments and TEIs. Specifically, this chapter examines the following questions:

- Do the state authorities in Sonora have a clear strategy for the development of tertiary education and the capacity to navigate the system to meet the economic, social and cultural needs of Sonora and its sub-regions?
- Are the current structures and mechanisms for co-ordinating the TEIs and other regional players efficient?

- Do the current structures and mechanisms support and incentivise regional and civic engagement of TEIs in Sonora?

5.1 Sonora's governance structure and TE system

This section provides an overview of Sonora's governance system, the actors and agencies which are involved in Sonora's economic development as well as Sonora's tertiary education system which is composed of a large number of TEIs, diverse in terms of both their missions, funding structures and governance.

Governance of Sonora

Sonora is one of 31 states which, together with the Federal District (*Distrito Federal* or D.F.), constitute the Democratic Federal Republic of Mexico based on the separation of executive, legislative and judicial powers. The state government of Sonora follows the same electoral procedures as the federal government and has relatively flexible powers to make laws, allocate public expenditures, and set programmes for social and sectoral development. The state congress is made up of a single chamber (unlike the two-chamber national congress) and its deputies are elected to a three-year term. The state judicial power is based on the Higher Tribunals for Justice (*Tribunales Superiores de Justicia*), appointed by the governor. The state government depends on the federal government for much of its revenue, which in turn is funnelled to municipal governments. Historically, decision-making authority at the state level resides in the governor who is elected by a simple majority vote and cannot be re-elected in consecutive periods.

The lowest level of Mexican government is the municipality (*municipio*). Sonora has 72 municipalities, including the capital city of Hermosillo and Ciudad Obregon, which are home to the leading universities in the state: UNISON and ITSON, respectively. The mayor or municipal president and municipal council are popularly elected for three years. Municipal governments are responsible for a variety of public services (water and sewage, street lighting, public safety and traffic), but can also assist state and federal governments in areas such as education, health and environmental protection. Although municipalities have authority to raise revenues, they rely heavily on transfers from state and federal governments. Municipalities have a minor role in TEIs and limited resources to impact the institutions.

Tertiary education governance, co-ordination and regulation take place at the federal and state levels (Table 5.1). At the federal level, policy is

established by the Ministry of Public Education (*Secretaría de Educación Pública,* SEP), specifically through the Sub-Secretariat of Higher Education (*Subsecretaría de Educación Superior,* SES). Its mission is to "facilitate, through policies and support programmes, the conditions necessary for Mexican society to receive, by means of higher education institutions, quality education, which plays a key role in the training of professionals and which significantly contributes to the country's development and a just society" (OECD, 2008). At the state level, tertiary education co-ordination is the responsibility of Sonora's Ministry of Education and Culture (*Secretaría de Educación y Cultura,* SEC), through different administrative units (*e.g.* Department of Education).

Table 5.1. The governance structure of Sonora

Federal Government	Mexico is a democratic federal republic made up of 31 states and the Federal district (*Distrito Federal*). The President is elected for six years by universal secret ballot. The National Congress is responsible for federal accords; approves federal funding for education; approves self-governing laws of autonomous federal TEIs and grants immediate official recognition to their study programmes. The Ministry of Public Education (*Secretaria de Educacion Publica,* SEP) establishes education policy at federal level. Facilitates provision of quality education & training of professionals; designs policies and support programmes. The Ministry of Higher Education (*Secretaria de Education Superior,* SES), within SEP, establishes policies at the federal level that govern tertiary education. Federal, non-autonomous TEIs (universities, technological institutes) report directly to SEP; SEP jointly establishes governing rule for state, non-autonomous TEIs with Sonora's State Ministry of Education; SEP authorises and regulates (awards and withdraws) official recognition of studies undertaken at private institutions; SEP and authorised federal institutions can grant authorisations and the RVOE (official certification of Studies) to programmes of private TEIs located in all states of the country. The Federal Government is represented in Sonora by a number of agencies, *e.g. Oficina de Servicio Federales de Apoyo a la Educacion* (OSFAE) in Hermosillo, *Agencia de Ministerio Publico de la Federacion* in Nogales, *Secretaria de Desarrollo Social* in Hermosillo, and *Comision Nacional del Agua* in Hermosillo.
State Government	The state government follows the same electoral procedures as the federal government; has relatively flexible powers to make laws and allocate public expenditures, as well as to set programmes for social and sectoral development. State governments depend on the federal government for much of their revenue, which is in turn funnelled to municipal governments. The decision-making authority at the state level resides in the Governor. He/she is elected by simple majority vote and cannot be re-elected in consecutive periods. Appoints justices of the Higher Tribunals for Justice. The State Congress consists of deputies elected for a three-year term. Approves self-governing laws of state, autonomous TEIs; grants immediate official recognition to their study programmes. State Ministry of Education and Culture (SEC), through different administrative units (*e.g.* higher education departments or general directions of higher education) co-ordinates tertiary education at state level. State non-autonomous TEIs report directly to state government through the state's Department of Education. State government authorities and state public higher education decentralised organisations approve study programmes of private institutions located in Sonora.

Table 5.1. The Governance structure of Sonora (continued)

Local Government municipality (*municipio*) 72 in Sonora	The lowest level of Mexican government. Sonora has 72 *municipios*, including the capital city of Hermosillo. Mayor or municipal president and municipal council are popularly elected for three years. Municipal government is responsible for a variety of public services (water and sewage, public safety and traffic etc). Municipalities can also assist state and federal governments in areas such as education, health and environmental protection. Municipalities have authority to raise revenues, but rely heavily on transfers from the state and federal governments.

Source: SEP (Secretaría de Educación Pública) (Ministry of Public Education) (2006), *OECD Thematic Review of Tertiary Education: Country Background Report for Mexico*, *www.oecd.org/education/highereducationandadultlearning/37746065.pdf*.; OECD (2008), *OECD Reviews of Tertiary Education: Mexico 2008*, OECD Publishing. doi: 10.1787/9789264039247-en.; Gobierno del Estado de Sonora (2009), "Plan Estatal de Desarrollo, 2009-2015," Gobierno del Estado de Sonora, *http://portal.sonora.gob.mx/documentos/plandedesarrollo/libroPED.pdf*.

Sonora's economic development actors and agencies

Both federal and state government are directly and indirectly engaged in Sonora's regional economic development through planning, policies and funding mechanisms (Table 5.2). The federal Science and Technology Act has established the principles for supporting scientific and technological ideas, strengthening scientific and technological capabilities, and upgrading the quality of researchers. Practically each state has adopted a high-tech focus as a core strategy. Aside from the general guidance toward national economic development in the National Development Plan 2007-12 (*Plan Nacional de Desarollo*, PND), which serves as a framework for state strategies, the federal government's primary tool for state economic development is through CONACYT.

In addition to formal government organisations charged with economic development, such as Ministry of the Economy, there are a number of other players that impact economic development through initiatives, support for strategies and individual projects, including industry associations and public-private partnerships. In the Mexican private sector, (large) businesses have traditionally been well-connected with federal, state and local government. Foreign-owned companies that provide the majority of manufacturing jobs and direct investments in manufacturing infrastructure deal with the state and regional governments either directly or through associations, such as the Association of *Maquila* Industries of Sonora (AMS).[1] In practice, public-private partnerships coalesce around specific proposals, such as the most recent City of Knowledge project in Hermosillo.

The Economic Development Council for Sonora (COPRESON) is a public entity acting as a liaison between the government of Sonora and state

producers through the development and implementation of joint strategies for growth and development in Sonora. COPRESON promotes activities of the state government and supports specific strategies of the private sector (COPRESON, 2012).

Table 5.2. Major public actors/agencies involved in the regional economic development of Sonora

Actors/agencies	Policy/Mechanism
Federal Government	National Development Plan 2007-2012 outlines general objectives & strategies; Science & Technology Act establishes principles for support of science and technology.
CONACYT	Mixed Funds (programme of mixed federal and state funds) supports science and technology capabilities.
State Government	Sonora's State Plan for Development 2009-2015 (*Programa Estatal de Desarrollo de Sonora*) outlines general objectives & strategies.
Ministry of Economy (SE)	Plan *Nuevo Sonora*; *Fondo Nuevo Sonora*; outlines the current state government's perspective on Sonora's economic development. It involves a shift to direct support for firms.
Economic Development Council of Sonora (COPRESON)	Provides assistance to entrepreneurs, small businesses and projects for productive SMEs (PyMEs), and access to financing.
Association of Maquila Industries of Sonora (AMS)	Mostly foreign-owned assembly industry factories are major employers of manufacturing labour force and investors in manufacturing infrastructure.
Sonora-Arizona Commission	Governor-chaired forum for cross-border economic development initiatives; *A shared vision for Arizona and Sonora 2011-2015* articulates principal goals of Arizona and Sonora on joint initiatives.
Municipal Governments/ Committees for Economic Development	Important role in attracting and promoting various infrastructure projects.

Sources: Gobierno de los Estados Unidos Mexicanos (2007), Plan Nacional de Desarrollo, 2007-2012, Talleres de Impresión de Estampillas y Valores, Distrito Federal, *www.oei.es/quipu/mexico/pnd_mexico_transformacion_educativa.pdf*.; CONACYT (Consejo Nacional de Ciencia y Tecnología) (2012), "Algunas cifras sobre la situación de la ciencia, la tecnología e innovación en Sonora," PowerPoint presented at OECD Review Visit, Hermosillo, 13 March 2012.; Gobierno del Estado de Sonora (2009), "Plan Estatal de Desarrollo, 2009-2015," Gobierno del Estado de Sonora, *http://portal.sonora.gob.mx/documentos/plandedesarrollo/libroPED.pdf*.; SE (Secretaría de Economía) (Ministry of the Economy) (2010), Fondo Nuevo Sonora, *http://fns.sonora.gob.mx/sitiopublico*.; COPRESON (Economic Development Council of Sonora) (2012), COPRESON*, http://copreson.sonora.org.mx*.; Maquila Portal (2012), Maquila Portal: Mexican Manufacturing Industry Information Center, *www.maquilaportal.com*, accessed 18 April 2012.; AMC/CSA (Arizona-Mexico Commission/Comision Sonora-Arizona) (2011), "A Shared Vision for Arizona and Sonora 2011-2015," ASU North American Center for Transborder Studies, *http://nacts.asu.edu/sites/default/files/A%20Shared%20Vision.pdf*.; Sonora's Regional Steering Committee (2012), Self-Evaluation Report, Gobierno del Estado de Sonora, Sonora.

A unique player in the economic development of Sonora is the Sonora-Arizona Commission (*Comisión Sonora-Arizona*), which, through its various committees, closely collaborates across the border with its

counterpart in Arizona, the Arizona-Mexico Commission. Composed of government, public and private sector representatives, the commission outlines the principal goals of joint initiatives, serves as a platform for proposals and provides encouragement for special projects.

Sonora's TE system

Sonora's TE system resembles the typical composition of state-level TE systems in Mexico: it is composed of federal autonomous TEIs, federal non-autonomous TEIs, state autonomous TEIs, state non-autonomous TEIs, and private TEIs (Table 5.3). Through the Ministry of Public Education (SEP), the federal government has direct influence on the federally-based institutions in each state and also significant influence in public autonomous universities, which are dependent on federal subsidies to support their operations.

Public federal universities and some state universities enjoy autonomy and self government according to their respective laws. Federal TEIs are approved by the national congress, whereas the state TEIs are approved by the Sonora State Congress. Within these institutions, governance is collegiate, with entities that define policies, approve development plans, institutional budgets and expenditures, and new academic units and programmes. The autonomous TEIs also appoint the rector and other leadership positions responsible for policy execution and institutional administration. Respective federal or state laws grant immediate official recognition to their study programmes.

The second group of public institutions – non-autonomous state universities; technological, polytechnic, and intercultural universities; and state and federal technological institutes – report directly to the federal and/or Sonora state government (through SEP and/or Sonora's Department of Education). However, these TEIs possess significant autonomy in matters of appointments, promotions and academic tenure.

Table 5.3. Tertiary education system governance in Sonora

Tertiary Education Institutions (TEIs)	Governance Framework
Autonomous Federal TEIs (Universities) (Currently none in Sonora)	National Congress approves self-governance laws; grants immediate official recognition to their study programs. TEIs define policies; approve development plans, institutional budgets and expenditures, new academic units and programmes. They appoint the Rector and other leadership positions responsible for policy execution and institutional administration.
Non-autonomous Federal TEIs (IT Hermosillo, IT Nogales, IT Agua Prieta, IT Huatabampo, IT Guaymas, IT of the Yaqui Valley)	Federal Government's Ministry of Public Education (SEP) alone establishes the governance rules for non-autonomous TEI; TEIs curricula – including those focused on regional development – are defined by federal authorities. TEIs decide appointments, promotions and academic tenure.
Autonomous State TEIs (UNISON, ITSON, COLSON, CIAD)	State Congress approves self-governance laws; grants immediate official recognition to their study programmes; TEI define policies; approve development plans, institutional budgets and expenditures, new academic units and programmes. They appoint the Rector and other leadership positions responsible for policy execution and institutional administration.
Non-autonomous state TEIs (CESUES, CEPES, ITESCA, ITESCAN, ITSPP, Uni de la Sierra, Uni Tecnologica de Hermosillo, Uni Tecnologica de Nogales, Uni Tecnologica del Sur de Sonora)	Governance rules established jointly between state and federal authorities. TEIs curricula – including those focused on regional development – are defined by state authorities. TEI report directly to state government (through state's Department of Education). TEIs decide appointments, promotions and academic tenure.
Private TEIs (ITESM Sonora Norte, ITESM Ciudad Obregon, Uni del Valle de Mexico, and others; total 32)	Federal government (through SEP) authorises and regulates (awards and withdraws) official recognition of studies undertaken at private institutions; TEI need official certification of studies (RVOE) approval for each study programme; SEP and authorised federal institutions can grant authorisations and the RVOE to study programmes in any state. Sonora state government authorities and state public higher education decentralised organisations can grant authorisation for study programmes in Sonora.

Source: OECD (2008), *OECD Reviews of Tertiary Education: Mexico 2008*, OECD Publishing. doi*: http://dx.doi.org/ 10.1787/9789264039247-en*; Sonora's Regional Steering Committee (2012), *Self-Evaluation Report*, Gobierno del Estado de Sonora, Sonora.

The federal Ministry of Public Education (SEP) alone establishes the governance rules for non-autonomous federal institutions in Sonora, while the governance rules for non-autonomous state institutions are agreed jointly between federal and Sonora state authorities. These institutions' curricula – including those that are focused on regional development – are defined by federal or Sonora state authorities. Representatives from business and social sectors, including regional and local councils can also get involved in their activities.

The governance of private institutions differs from that of federal and state institutions. The governance of these institutions reflects the purposes of the founders and the organisations to which they are related, and accordingly their management is subject to a different set of rules. Sonora's state government authorities and decentralised state public tertiary education organisations authorise and regulate (award and withdraw) official recognition of studies undertaken at private institutions through the Official Certification of Studies (*Reconocimiento de Validez Oficial de Estudios*, RVOE). If a private institution wishes that the respective degree becomes part of the national educational system and valid across Mexico, it needs official recognition for each study programme by SEP and authorised federal institutions. Both the authorisations and the RVOE are granted when private institutions meet the conditions established by law in relation to staff, infrastructure and study programmes. The granting authority is responsible for supervision and oversight of the educational services that they have authorised and recognised.

5.2 Sonora's TEIs and their regional engagement

This section provides a brief overview of Sonora's TEIs and outlines their engagement activities which encompass a wide range of activities including community service, technology transfer and leadership in regional development strategy development. Sonora's diverse range of TEIs, in terms of both their missions and funding structure, has pronounced implications for their ability to engage in regional development. The large number of TEIs (54) and their geographic distribution across the state represent both opportunities and challenges for their engagement with regional development. Challenges are associated to funding as well as human resources. This requires careful identification of regional priorities, effective co-ordination of activities and continuous monitoring of outcomes in order to sustain and improve regional engagement.

An overview of TEIs

Sonora's tertiary education sector is characterised by institutional and geographic diversity. In 2012, Sonora had 56 TEIs, of which 23 were public and 33 were private, with different missions, funding systems (federal, state and private), degrees of autonomy. Although smaller in number, public institutions account for about 80% of all enrolled students. Of the 54 TEIs, more than half (59%) are private institutions, about half are organised as universities, the rest are technological institutes.

UNISON (*Universidad de Sonora*) and ITSON (*Instituto Tecnológico de Sonora*) are two leading public autonomous institutions in Sonora. In 2011, they enrolled 25 895 and 16 818 students respectively at both undergraduate, graduate and PhD level.[2] COLSON (*Colegio de Sonora)*, which only enrols graduate students, had 68 students in 2011.

Among public TEIs, the largest number falls into the category of non-autonomous state institutions. The largest among non-autonomous state TEIs (in terms of student population) are UES (*Universidad Estatal de Sonora,* formerly known as CESUES) with more than 7 000 students; ICATSON (*Instituto de Capacitación para el Trabajo de Sonora*) with over 6 500 students; UTH (*Universidad Tecnológica de Hermosillo*) and ITESCA (*Instituto Tecnológico Superior de Cajeme*) each with between 3 000 to 3 600 students. With the exception of UTSS (*Unversidad del Sur de Sonora)* and UTN (*Universidad Tecnológico de Nogales*), with little over 1 000 students, all other state TEIs enrol between 200 and 600 students. Non-autonomous federal TEIs are even smaller; with the exception of ITG (*Instituto Tecnológico de Guaymas)* with 700 students, all other institutions enrolled less than 300 and even less than 50 students *(e.g. Instituto Tecnológico deAgua Prieta).*

Private TEIs also vary in size; the majority have rather small numbers of students. Two TEIs are a part of internationally well-known private systems, such as ITESM (*Tecnológico de Moterrey*) with 1 741 students at its Sonora Norte campus, and the UVM (*Universidad del Valle de México*) with approximately 6500 students in its campus in Hermosillo.

Geographical distribution of TEIs in Sonora reflects the distribution of population and economic activities in the state; the capital city of Hermosillo has the largest concentration of TEIs, including UNISON, COLSON, ITESM and UVM. Ciudad Obregon is the second most important concentration of TEIs, with ITSON's main campus and several other institutions. ITSON's five branch campuses serve different areas of southern Sonora, making it as the largest and most influential TEI in southern part of the state. Several technological institutes and universities were established in

northern border cities in response to population growth and expansion of the *maquila* industry since the 1980s.

TEIs engagement activities

Sonora's TEIs have developed many different ways in regional development, ranging from community-based social and economic development programmes to technology parks and incubators. Table 5.4 summarises major contributions of selected TEIs.

Table 5.4. Regional engagement by selected TEIs in Sonora

Tertiary education institution	Contribution
UNISON (*Universidad de Sonora*)	Technology Transfer Programme (*TxTEc*); Programme for education, training and research; Agreements with companies; Classes for continuing education in various areas; Professional practice in industry; Annual creativity fair; Annual seminar on connection with the productive sector.
ITSON (*Instituto Tecnológico de Sonora*)	Technology centre for integration and development of companies (CETIDE); Centre for software solutions (NOVUTEK); Software technology park (*Sonora Soft*); Tourist corridors of southern Sonora (*Corredores*); Experimental centre for technology transfer (CETT); Centre for research and innovation in biotechnology, cattle raising and environment (CIIBAA); Business incubator (*Incubadora ITSON*); Centre for research and development of water and energy (CRIDAE); International district of agricultural business for small and medium companies (DIAPYME); Park for articulation and transfer of technological education (Patte); University Centre for Community Development (CUDDEC).
ITH (*Instituto Tecnológico de Hermosillo*)	Programmes of connection with the region through conferences, seminars and other gatherings related to promotion and generation of technological innovation; Participation in institutional self-assessment process; External evaluation and accreditation of educational programmes.
ITESCA (Instituto Tecnológico de Cajeme)	Centre for advanced technology (CETA); Centre for research in water technology and environment (CITAA); Centre for marketing and urban development (CEMADU); Bi-annual meetings for identification of private sector needs; Agreements for collaboration with more than 30 companies and institutions in the region.

Table 5.4. Regional engagement by selected TEIs in Sonora (continued)

ITESM Campus Sonora Norte (*Instituto de Estudios Superiores de Monterrey*)	Centre for innovation and technological development; Programme of advisory services in the administrative area; Consulting services for companies; Business incubator; Automotive and aerospace technology site for the development and research of Sonora (STAADIS).

Source: Sonora's Regional Steering Committee (2012), Self-Evaluation Report, Gobierno del Estado de Sonora, Sonora; ITSON (Instituto Tecnológico de Sonora) (2012a), "Regional Center for Research and Development of Water and Energy. Strategic initiatives of ITSON to promote the Regional Development," PowerPoint presented at OECD Review Visit, Ciudad Obregón, 15 March 2012; ITSON (Instituto Tecnológico de Sonora) (2012b), Iniciativas Estratégicas, *www.itson.mx/iniciativas/Paginas/IniciativasEstrategicas.aspx*.; ITSEM (Tecnológico de Monterrey) (2011), "Technology Park opens in Puebla," SISTEMA Tecnológico de Monterrey, *www.itesm.edu/wps/wcm/connect/snc/portal+informativo/news/not(8feb11)puebla*, accessed 21 May.

Universities and other TEIs in Sonora engage with industry in many different ways. Of the many different forms of interaction between institutions and industry, informal contacts are the most prevalent, including well-established relationships between the private sector as well as individual researchers or groups of researchers. The administration of TEIs has made efforts to formalise such projects by channelling them through the respective offices and acquire some income for the institution in exchange for an "official" seal on research results. Companies also contact TEIs directly regarding their skills demands, which potentially increases competition for funding between TEIs. Technological institutes and private TEIs are in a better position to respond to such requests in a shorter time frame that other TEIs. Workforce training practices are likely to benefit the individual companies whereas the role of TEIs in a more comprehensive regional transformation would require long term collaborative action. Table 5.5 provides an overview of the modes of TEI-industry collaboration as well as the challenges.

Table 5.5. Modes of TEI–industry engagement in Sonora

Mode	Mechanisms	Challenges
Expansion and diversification of the educational supply in Sonora to align with regional needs	Investigation of regional labour market needs:COEPES' developmental plans; as part of the PIFI programme (*Programa Integral de Fortalecimiento Institucional*), encouraged to improve educational supply on the basis of graduate labour market outcomes, feedback from graduates and views of employers; State and regional COVES; connection councils and offices.	Assessment of a longer term regional needs vs. short-term needs of individual businesses; Inadequate and unstable funding;Lack of incentives;Inadequate staffing (number and specific profiles) in connection offices.
R&D	Contract(s) between individual researcher(s) – business organisation; Partnership(s) between TEI –business organisation(s).	Limited absorptive capacity of the industry and innovation system to use knowledge generated by TEIs; Research capacity.
Micro-level socio-economic development	Mandatory Student Social Service as a graduation requirement; Business incubators	Scarce and unreliable resources; Sustainability; Indicators for progress monitoring
Triple Helix model	Government-university-private sector partnership focussed on science, technology and innovation, *e.g.* bio-tech parks	Initial funding; Sustainability; Public-private relationship; TEIs entrepreneurial capacity; Impact assessment

Source: Rodriguez-Villanueva, G. and E. Lagarda-Leyva (2009), "Using Technology and Innovation for Planning Social and Economic Transformation in a Region of Mexico," Performance Improvement Quarterly, Vol. 22, No. 2, pp. 53-77.; Sonora's Regional Steering Committee (2012), *Self-Evaluation Report*, Gobierno del Estado de Sonora, Sonora; ITSON (Instituto Tecnológico de Sonora) (2012d), "Instituto Tecnológico de Sonora Business Incubator," PowerPoint presented at OECD Review Visit in Ciudad Obregón, 15 March 2012.; SE (Secretaría de Economía) (Ministry of the Economy) (2012), "Capital Humano en Sonora: El Sector Aerospacial," PowerPoint presented at OECD review visit, Hermosillo, 12 March 2012.; CONACYT (Consejo Nacional de Ciencia y Tecnología) (National Council of Science and Technology) (2012), "Algunas cifras sobre la situación de la ciencia, la tecnología e innovación en Sonora," PowerPoint presented at OECD Review Visit, Hermosillo, 13 March 2012.; Parque Tecnológico de Software PTSw (Sonora Soft Technology Park) (2012), "IT in Sonora," PowerPoint presented at OECD review visit, Ciudad Obregón, 15 March 2012.; ITESCA (Instituto Tecnológico Superior de Cajeme) (2012b), "Semblanza ITESCA: Actividades 2011-2012," PowerPoint presented at OECD review visit, Ciudad Obregón, 15 March 2012.

Overview of the efforts of individual TEIs

The University of Sonora – UNISON (*Universidad de Sonora*) is an autonomous state TEI located in Hermosillo. It is the largest TEI in Sonora and the eighth largest university in the Pacific region of Mexico (Sonora's Regional Steering Committee, 2012). It provides a broad range of study programmes to close to 26 000 students[3] and has significantly increased its research capacity in recent years: over the period from 2006-2011, the number of UNISON's nationally certified SNI research increased by 85% and they now represent 62% of Sonora's SNI researchers. UNISON is strong in arts and culture, and sustainable development. It offers programmes for education, training and research, as well as programmes in technology transfer (TxTEC). It operates the national lab for solar concentration and solar density. UNISON is known for its extension services, especially in rural areas and has been recognised as a socially responsible organisation by the Mexican Centre for Philanthropy. This recognition is granted to educational organisations that implement social responsibility beyond the obligations that are established for the implementation of programmes with positive impacts on the environment (UNISON, 2012). UNISON has several dozens of agreements with other TEIs, including cross-border collaboration with universities in Arizona, government agencies and the private sector. UNISON is committed to building stronger links with economic and social actors in the region.

Sonora Technological Institute – ITSON (*Instituto Tecnologico de Sonora*) is the second largest TEI in Sonora with 16 500 students and the first among Sonora's TEIs on the national ranking list (38th in 2010) two places ahead of UNISON because of its well targeted research. ITSON has clearly stated its mission as a three-part activity: education-research-outreach. Its funding comes from federal and state funds, as well as from student fees and fees for various services it provides to external agencies. ITSON stands out as an example of an entrepreneurial TEI, and as an engaged partner in social and economic development of vulnerable neighbourhoods and remote rural areas. ITSON has identified four major areas as its strategic initiatives: i) software and logistics; ii) biotechnology and agribusiness; iii) ecotourism and sustainable development, and iv) education and health. ITSON's focussed technology park houses a number of companies (*e.g.* Novutek, Sonora Soft) that offer software and business services to government and private organisations and generate income for ITSON. The park also serves as business incubator with partial support from the federal government and CONACYT. ITSON is also known for its services to the agribusiness community of southern Sonora. There is a general acknowledgement among the business community that ITSON is

connected with the private sector in the region: "They are very well connected with CEOs of firms in Sonora; they serve as technical mediators and are known for quality business services" (CONACYT, 2012). ITSON's eco-tourism project (Tourism corridors) and a world class example of a long term neighbourhood project CUDDEC are worth noting for their organisation and impact on the micro-economy (See Box 5.3. and 5.4.).

More than just an institutional plan, ITSON has built partnerships with municipal leaders and state /ministries of economy and education and culture in support of a Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*). This plan aims to use technology and innovation for the region's social and economic transformation. This plan has not only helped reconfigure the relationship between ITSON, and the social and productive sectors in southern Sonora, but could also provide a basis for the strategy development at the state level (Box 5.1. See also Chapter 3).

Box 5.1. Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*)

Faced with new globalisation challenges in Sonora, ITSON has redefined its socio-economic role in the community, identifying strategic sectors and designing high impact projects in collaboration with the government, private enterprises and social entities in order to increase the well-being and competency of organisations and individuals.

In 2008, municipal presidents of Guaymas, Empalme, Cajeme, Navojoa and Quiriego, together with state ministries of economy and education and culture, made a commitment to regional development of southern Sonora under ITSON's co-ordination. The long term plan for southern Sonora was based on the analysis of four high potential ecosystems: biotechnology and agribusiness, software and logistics, eco-tourism and sustainable development, and education and health. The plan targeted the southern Sonora corridor connecting four key cities – Ciudad Obregon, Guaymas, Empalme and Navojoa – by organising a "logistics backbone" of airports, railroad and Wi-Max broadband coverage, and developing the agriculture, aerospace and ecotourism clusters.

Box 5.1. Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (*Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación*) (continued)

The plan identified southern Sonora's strengths and opportunities as well threats and weaknesses. Its strengths and opportunities include: the Guaymas port; the *maquiladora* industry; ecotourism attractions; the export of high quality (clean) food products (pork, shrimp, and vegetables); an aerospace cluster; a strategic location (access to the US and emerging Asian markets and the CANAMEX corridor); a qualified workforce; the capacity to develop technological solutions for water and energy production; basic urban infrastructure; support from ITSON. Sonora's weaknesses: and threats are: population decrease in rural areas; reduced public services; water deficit; reduced productive diversification and low modernisation index; few university-company links; lack of modernisation and maintenance of communication; military checkpoints; growing consumerism, obesity and low life expectancy.

The programme has created 34 new organisations and 960 new sustainable jobs during the 2006-2008 period and aims to create 14 000 new jobs by 2014. (Estimated funding needs for the implementation was over USD 30 million in 2008 and an additional USD 96.5 million in 2012.)

Source: Rodríguez, G. and E.A. Lagarda (2009), "Using technology and innovation for planning social and economic transformation in a region of Mexico", *Performance Improvement Quarterly*, Vol. 22 No. 2, pp. 53-77.

ITSON faces major challenges in sustaining its strategic initiatives in a changing political climate and shifting priorities of external funding sources, most notably at the level of state government. Internally, the challenge is how to incentivise and reward faculty for outreach activity. ITSON has a formal connection office, but the actual connections with the private sector still occur within traditional practice of direct collaboration between the faculty/researcher and the private company.

UES (*Universidad Estatal de Sonora*) formerly CESUES, *Centro de Estudios Superiores de Sonora*) has 7 500 students on its five campuses and is the third largest TEI in Sonora after UNISON and ITSON. About 65% of all faculty members are full-time employees. UES has three fundamental focuses: student-centred education, sustainable development, and education for employment. The Centre is supported by combination of federal and state funding. One of the campuses, Benito Juarez, is particularly oriented towards indigenous communities dependent on the fishing business. Scholarships are provided to about 21% of all students, and flexibility is

required of faculty and administrators to accommodate students' needs during the shrimp harvest or other community or individual needs.

Sonora's six Technological Institutes (ITs) were established by the federal government and strategically located in border cities with manufacturing activity (primarily the FDI-based *maquila* industry) and in southern Sonora where fishing and agribusiness activities are an important economic base. The main mission of these TEIs is to educate the labour force in accordance with regional needs. These are small institutions; together they enrol less than 1 500 students ranging from as low as 23 students enrolled at IT Agua Prieta to almost 700 students at IT Guaymas. A common characteristic is the focus on engineering and technology, and close relationship with local companies. They claim to be more flexible than other TEIs in responding to immediate needs of local companies. While this flexibility is appreciated by the private sector, there is also concern that this creates *ad hoc* changes in curriculum while undermining long term skills development and a more comprehensive assessment of regional needs.

Sonora's non-autonomous federal technological institutes are closely connected with the industry, serving the *maquila* industries but also other regional needs in Hermosillo, Guyamas and Yaqui Valley. ITH (*Instituto Tecnológico de Hermosillo*) is the largest of the six federal institutions. Although it has long experience of working with local companies, the formal connection council was established only recently in 2011. ITH is an important source of graduates for the automotive industry of Hermosillo. ITN (*Instituto Tecnológico de Nogales*) and ITAP (*Instituto Tecnologico de Agua Prieta*) cater to local the *maquila* industry, which first developed in Sonora's border cities before the Mexican law allowed their spreading to the interior. Nogales is currently the major concentration of foreign-owned *maquila* plants specialised in electronics. While Hermosillo and Obregon offer better supply of qualified labour force, Nogales has the advantage of its proximity to the United States. ITG *(Instituto Tecnológico de Guaymas*) is located in Sonora's most important sea port Guyamas and in the vicinity of the city of Empalme, which has an expanding *maquila* industry under a so-called shelter plan – a sort of "*maquila* incubator" within an industrial park. ITG provides demand-led training to the *maquila* industry, but is also focused on support for the fishing industry and on design and production of fishing equipment. ITG has agreements with local organisations regarding student internships and to train specific profiles needed for these companies. The needs are identified and evaluated on an *ad hoc* basis through direct contacts with companies, rather than based on a comprehensive assessment of regional need. In the Yaqui Valley, the small ITYV (*Instituto Tecnológico del Valle del Yaqui*) has a pronounced impact on the local community. Approximately 30% of students are of indigenous origin (the

Yaqui Tribe) in a traditionally agricultural region that has undergone transformation through the 20th century irrigation and commercialisation of agriculture. ITYV focuses on "protected agriculture" techniques, collaborates with local agricultural businesses. The ITYV graduates find employment in the local economy.

State technological institutes were established by the Sonora state government in collaboration with local governments to focus on local industry needs with an emphasis on engineering. Larger than federal technological institutes, the state technological institutes collaborate closely especially with local *maquila* companies where students get experience through internships. State technological institutes need to focus on the professional development and competence building among teaching staff. In Ciudad Obregon, ITESCA (*Instituto Tecnológico Superior de Cajeme*) is the largest of state technological institute with more than 3 000 enrolled students, ITESCA's focus is on local needs in engineering and agriculture through research and technological development carried out in four research centres: Centre for Advanced Technology (CETA), Centre for Research in Water Technology and Environment (CITAA), Centre for Marketing Studies and Urban Development (CEMADU), and the Centre for Studies of Educational Quality (CECE) (ITESCA, 2012a). The operation of these centres is supported by institutional resources. Additional resources are obtained through collaboration with the private sector and funding by CONACYT and other programmes on a competitive basis. Other state technological institutes ITSPP (*Instituto Tecnológico Superior de Puerto Peñasco*) focuses on industrial engineering, while ITSC (*Instituto Tecnológico Superior de Cananea*) focuses on electro engineering.

The state of Sonora has also established technological universities (*Universidad Tecnólogico*) in Hermosillo, Nogales, Empalme, San Luis RC, Puerto Peñasco, one in southern Sonora (*Universidad del Sur de Sonora*) and one for the mountainous region (*Universidad de la Sierra*). Technological universities focus on engineering and are flexible in responding to the needs of the private sector. Each technological university has a connection office for creating links with external organisations. Recently, connection councils were established as forums for institutional representatives to meet with companies and other representatives from the community to discuss regional needs.

Sonora has a large number of private TEIs with high student fees, most of which enrol small numbers of students. Students attending private TEIs comprise about 20% of the total number of TE students (Sonora's Regional Steering Committee, 2012). ITESM (*Tecnológico de Monterrey*) is the most renowned private TEI in Mexico with two campuses in Sonora. The focus of its teaching and research is on architecture and design, administration and

finance, humanities and social sciences, and engineering. ITESM is renowned for close links with the private sector as well as a strong outreach function that utilises student community involvement. UVM (*Universidad del Valle de Mexico*), a national chain of private universities, has two campuses in Sonora, one in Hermosillo and one in Nogales. UVM offers programmes in four focus areas including health, engineering, tourism, and architecture. Courses are also offered on-line for distance and adult learning. UVM has no community outreach activity, but focused on the collaboration with private companies where UVM students acquire experience through working with engineers. Like other private TEIs in Sonora, percentage of teaching faculty with postgraduate degree is low; only about 40% have a Masters degree. UVM has initiated several proposals that will require collaboration with other sectors in the community, for example one with focus on public safety, modelled on Ciudad Juarez's "Possible City" model, and another that capitalises on a health and medical tourism approach.

5.3 Policy environment for TEIs

The experience in OECD countries indicates that the development of regionally engaged institutions is challenging if the tertiary education policy does not explicitly include a regional dimension. A basic question is whether policies that affect universities and TEIs in Sonora support them to play a local and regional role. This section will provide an overview of the policies and mechanisms at the federal, state and institutional level to drive the local and regional engagement of TEIs, including collaborative mechanisms, funding incentives and the tasks of the TE staff.

Federal and state policies

Government tertiary education policy strongly emphasises economic development and social integration (SEP, 2006; OECD, 2008). Several key documents at the federal and state level outline TEIs' role in regional economic development. These include the National Development Plan 2007-2012, the Strategy for Education (PRONAE) 2001-2006, and the Higher Education Co-ordination Law at the federal level. At the state level, the Sonora State Plan for Development 2009-2015 and the State Education Programme 2010-2015 outline the TEIs' role in economic development of Sonora.

The National Development Plan 2007-2012 (*Programa Nacional de Desarrollo,* PND) identifies the role of TEIs as an important force in Mexicos social and economic development. The plan addresses the creation of connections and linkages between the public, academic and commercial

sectors in resolving basic national problems, increasing growth and improving the welfare of the population.

The National Plan for Education 2001-2006 (*Programa Nacional de Educacion*, PRONAE) strongly emphasises TEIs' role in economic development and social integration. Two specific objectives are highlighted: *i)* the improvement of the relevance and quality of the provision of tertiary education; and *ii)* co-ordination of the tertiary education system and its greater integration (OECD, 2008). PRONAE also requires the expansion and diversification of the educational supply in states to be associated with state's developmental plans. This includes an investigation of overall regional labour market needs in both high-tech and low-tech fields.

According to the HE Coordination Law (*Ley para la Coordinación de la Educación Superior*), educational policies are centred on regional and local development but in reality institutions are left to their own devices to implement the programmes without funding incentives. The federal government, through the Ministry of Public Education (SEP), establishes guidelines in agreement with state governments and promotes TE resources and evaluation, supports agreements between national and sub-national levels, and encourages and co-ordinates tertiary education planning. While co-ordination between federal and state level government to support higher education is an explicit goal, there is, however, no mandate or policy initiative from the Ministry of Public Education that does more than merely encourage regional engagement (OECD, 2008; Sonora's Regional Steering Committee, 2012).

Sonora's State Plan for Development 2009-2015 (*Programa Estatal de Desarrollo de Sonora*) identifies "Educated Sonora" as one of the key directions in the midterm development. As a part of this general direction, the plan emphasises the promotion of linkages between the educational system and different actors and sectors of the Sonoran society.

Sonora's State Education Programme 2010-2015 (*Programa Estatal de Educacion*, PEE) identifies connections and linkages between education and different social, productive and governmental sectors as one of the key strategies. In relation to tertiary education, the State Education Programme identifies a number of specific action items which address TEIs regional engagement such as: i) promotion of the participation of representatives from the three levels of government and the productive and social sectors in linkage programmes; ii) stimulation of business incubators with TEIs; iii) consolidation of programmes that foster creativity and entrepreneurship as integral parts of study programmes; iv) strengthening the efficiency of linkages between TEIs and other sectors through increasing inter-institutional collaboration; and v) strengthening collaboration between all

levels of government, TEIs and the productive sector based on specific programmes based on the national and state development plans (SEC, 2010a). Following the recommendations in the national plan, the State Education Programme outlines general mechanisms for linking TEIs with various sectors of Sonora's society. The entity that is specifically charged with the promotion of the government, the private sector and TEI collaboration is the Connection Council of the State of Sonora (*Consejo de Vinculacion del Estato de Sonora*, COVES).

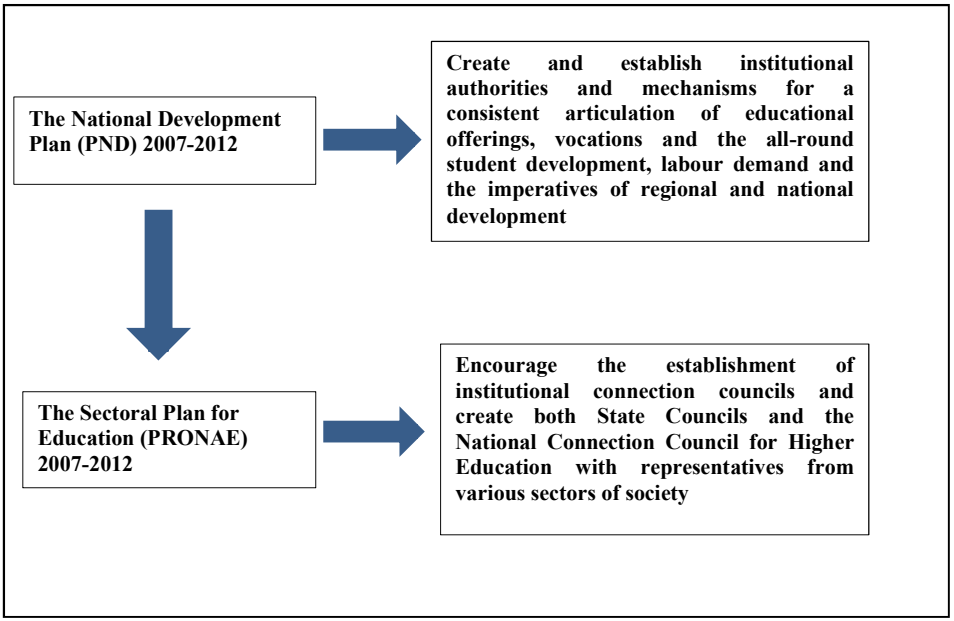
While Sonora's State Education Programme (PEE) is very specific about the importance and types of linkages that TEIs need to establish and strengthen, it is nevertheless short on funding mechanisms and incentives for TEIs' regional engagement. In the situation where a large number of Sonora's TEIs need to focus on improving quality of teaching and research, due to a high institutional priority for accreditation, it is unrealistic to expect significant improvements in regional engagement without more specific funding schemes.

Mechanisms to promote regional engagement of TEIs

In Mexico, TEIs' regional engagement has a strong focus on industry linkages, but in practice industry links remain weak. Linking TEIs with the productive sector is at the core of transformation of Mexican and Sonoran economy as it rapidly integrates into global economic system (Romero, 2005; Flores, 2006; Rodriguez-Villanueva and Lagarda-Leyva, 2009). The process of linking TEIs with industry production is a relatively recent phenomenon. During last decade, TEIs established a variety of links ranging from consultative connection councils, institutional connection units, technology-based firm incubators, and entrepreneur and consulting programmes to national or regional strategic research centres (SEP, 2006).

The National Development Plan 2007-2012 (PND) emphasised the importance of TEIs in regional development and the Sectoral Plan for Education (PRONAE) specifically encourages the formation of institutional connection councils between TEIs and different sectors of society at national and state level (Figure 5.1).

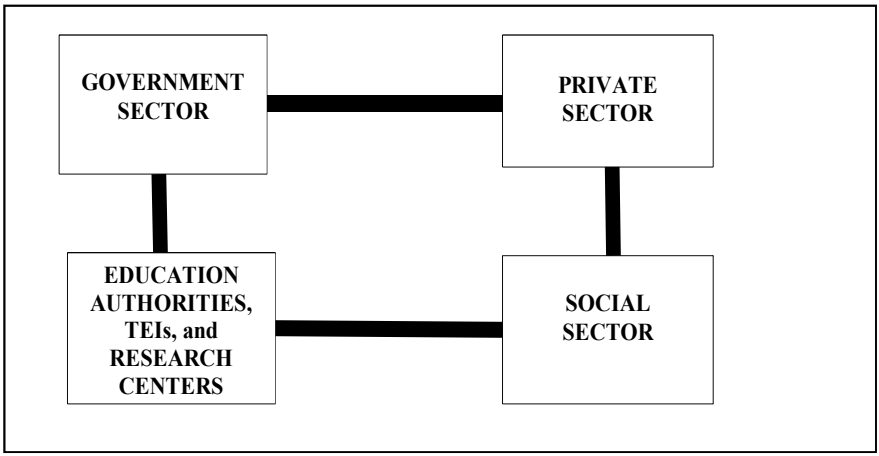
Figure 5.1. National strategy for engagement of TEIs with social and economic sectors



Source: SES (Subsecretaría de Educación Superior) (Sub-Secretariat of Higher Education (2009), "Agenda Nacional de Vinculación" (National Connection Agenda), Subsecretaría de Educación Superior, *www.vinculacion.ses.sep.gob.mx/jsp/general/Agenda_Nacional_Vinculacion.pdf*.

Specifically, the Sub-Ministry of Higher Education identified four key pillars of the connection model: i) the government sector, ii) the education sector authorities, TEIs and research centres, iii) the private sector, and iv) the social sector (Figure 5.2).

Figure 5.2. Key pillars of a state's connection council (Consejo Estatal de Vinculació)

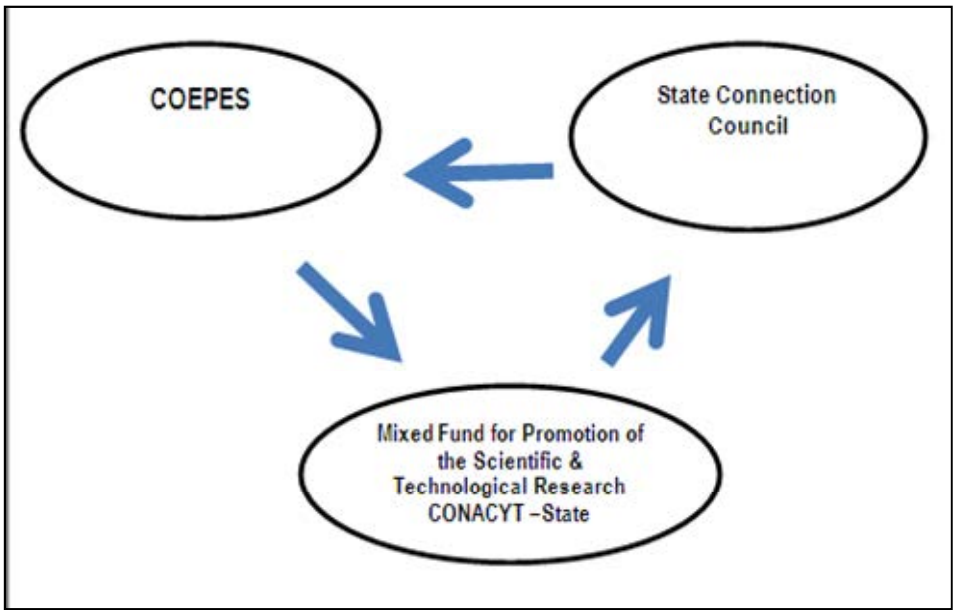


Source: SES (Subsecretaría de Educación Superior) (Sub-Secretariat of Higher Education (2009), "Agenda Nacional de Vinculación" (National Connection Agenda), Subsecretaría de Educación Superior, *www.vinculacion.ses.sep.gob.mx/jsp/general/Agenda_Nacional_Vinculacion.pdf*.

Furthermore, once established, the state level connection council is supposed to collaborate closely with the state's COEPES and CONACYT (Figure 5.3).

COEPES (the State Commission for Higher Education Planning) carries out the planning activities relevant for educational supply. COEPES is primarily responsible for the technical appraisal and approval of the new public institutions or programmes in existing institutions, through feasibility studies that take into account some of the following factors: macro-regional (needs of the region in the national framework); micro-regional (specific needs of the regions); labour market (needs of professional personnel in the respective regions); socio-economic needs and educational expectations, and supply and demand of educational services. COEPES is also responsible for ensuring that federal, state, autonomous and private TEIs are integrated into the different regions' economic and social development plans. COEPES membership is typically made up of rectors or directors of state public universities, technological universities, technological institutes, private institutions and teacher education institutions, as well as the head of the ministry of education in the states, a Ministry of Public Education representative from the federal government, and local representatives from the social and entrepreneurial sectors.

Figure 5.3. Coordination between state-level connection council, COEPES and CONACYT



Source: SES (Subsecretaría de Educación Superior) (Sub-Secretariat of Higher Education (2009), "Agenda Nacional de Vinculación" (National Connection Agenda), Subsecretaría de Educación Superior, *www.vinculacion.ses.sep.gob.mx/jsp/general/Agenda_Nacional_Vinculacion.pdf*.

CONACYT, the federal agency focused on science and technology development, provides funding through so-called mixed funds established in collaboration with states. Funds are limited, but open to a large number of applicants from a variety of programmes. FORDECYT is a special fund to stimulate collaboration between industry and TEIs.

Connection councils in Sonora

The state of Sonora was one of the first states in Mexico – next to Aguascalientes, Guerrero, Jalisco and Veracruz – that established a state-level connection council (*Consejo de Vinculación*) (Flores, 2006). Known in Sonora as COVES according to its Spanish acronym (*Consejo de Vinculación Estatal de Sonora*), the Council encompasses, at present, eight regional councils. COVES held its first annual general meeting in 2010. Its general purpose was identified as "seeking the greatest possible relevance of education to the requirements of the productive, social, political and cultural sectors of Sonora" (CIAD, 2010). COVES functions as an advisory

organisation; its activities include informing, disseminating, evaluating and proposing changes in curriculum and linking TEIs and research centres with the demands of the state and country. COVES promotes meetings, partnership agreements, funding for student placements, and information boards.

Almost all Sonora's TEIs have signed individual agreements of collaboration with representatives of the state and local government, businesses and social organisations with assistance from COVES. *Instituto Tecnológico de Hermosillo* (ITH), a federal non-autonomous institution, was one among the first to formally establish its connection council in June 2008 (ITH, 2008). Promoted as an effective, integrated and regionalised model of the education-business-government link (SEC, 2010b), the model has been inaugurated by other TEIs in Sonora, from *Universidad Tecnologica de Nogales*, CESUES, *Universidad de Sonora* (UNISON) and its regional campuses, ITSON and CIAD (UTN, 2010; CESUES, 2011; UNSON, 2011a; CIAD, 2010). At a recent meeting at CIAD in April 2012, it was reported that COVES had 53 members, including university presidents, directors of other TEIs, entrepreneurs, members of chambers of commerce, public officials, and representatives of the State Ministry of Education and Culture and members of public organisations.

Regional connection councils typically include the local mayor and directors of municipal economic development offices, as well as representatives of local industry. It is also common that the regional councils are chaired by business people. For example, the Regional Council of Guaymas-Emplame was chaired by the president of Offshore Group, a *maquiladora* shelter company, which is one of the major employers in the region (ITSON, 2011). In case of ITH, the council's top three positions – chairman, executive secretary and commissioner – were held by representatives of major companies in the Hermosillo region, including Vangtel, Ford Motor Company and Metrix SE (ITH, 2008).

At the TEI level, the composition and scope of councils follow the general guidelines developed by ANUIES in the *Higher Education in the XXI Century*, a document approved by its general assembly in 1999 (UNISON, 2011b). The specifics may vary from one TEI to another. For example, UNISON approved its first rules for the formation of a Council of Social Connection in 2002, and amended them in January 2011 (UNISON, 2011b). The council is composed of internal university members (including the rector, vice-chancellors of regional units, academic secretary general, director of liaison and outreach, and director of research and graduate studies) and external members including the business community (representatives of productive and trade sectors, and entrepreneurs), alumni, and community leaders (see Box 5.2).

Box 5.2. Formal structure of TEIs' Connection Council

Members of the Connection Council:

- [ex-officio]: Rector, Vice-chancellor(s) of regional unit(s), Academic secretary general, Director of liaison and outreach, Director of research and graduate studies;
- Three representatives of productive sector, trade and entrepreneurs;
- Three representatives of alumni;
- Three outstanding individuals from educational, cultural, and business community.

Standing Committees at regional units include: Vice president of the unit and One representative from each: manufacturing and service sector, government, social, educational and cultural community, and alumni

Special Committees: Representative of divisions and departments relevant to project or activities; and Technical secretary.

Tasks:

1. Link with the productive sector and services: expand partnerships; strengthen mechanisms for cooperation through actions and projects;
2. Link to government sector: strengthen relationships with federal, state and municipal government agencies through participation of researchers, teachers and students in projects;
3. Promote collaboration with social sector with specific focus on most vulnerable social groups.

Source: UNISON (Universidad de Sonora) (2011b), *Reglamento Interno del Consejo de Vinculación Social de la Universidad de Sonora*, *www.vinculacionsocial.uson.mx/queescvs/pdf/ReglamentoInternodelCVS.pdf*.

UNISON's connection council is supported by standing committees at each regional unit and an additional number of special committees formed around specific activities or projects. Special committees are charged with strengthening and widening the relations linking the institution with one of the three major sectors: *i)* the productive sector and services; *ii)* the government sector, and *iii)* social development.

As early as 2007, a set of indicators was developed by the UNISON faculty for Sonora's state congress to be applied in monitoring the progress in linkages carried out by COVES (Gómez, 2007). Four groups of indicators were proposed to monitor the following areas: *i)* relevance of education offerings and final efficiency; *ii)* development of entrepreneurs; *iii)* continuing education, and *iv)* technological and innovative projects. Other researchers (Borbón and Olea, 2009) addressed the methodology of monitoring specifically the interaction between TEIs and companies. It is not known if the indicators were further developed and refined, and most importantly, applied. It would be useful to revisit these indicators, revise them if necessary and make them available for application.

While the concept of COVES and regional councils is an innovative mechanism for regional engagement of TEIs, in practice they have a number of shortcomings. Some of them are common ills resulting from a short experience. There also is a problem of co-ordination and efficiency of a great number of TEI-associated councils. A major problem stems from the fact that the councils have been designed primarily as advisory organisations, with no state-supported funding nor clear incentives for TEIs to engage more substantially than placing their highest administrators as representatives on the councils. Furthermore, while regional councils were defined to better relate to specificities of each region, it does not seem that the scope of each region has been well-defined and understood. TEIs' have established their own connection councils (a group of elected administrators that represent individual TEIs in meetings, conferences and similar "focus groups") and connection offices, but no information and data on the number and capacity of people engaged in the connection (*vinculación)* activities at institutional level was available.

Through its regional councils and institutional connection councils at each TEI, COVES has identified a continuing analysis of regional needs as one of its major functions. However, during the OECD review visit, the team learned that it is Sonora's Ministry of Economy assesses the needs of the industry.

Funding of TEIs in Sonora

Funding policy is the most influential policy tool that governments can use to affect the behaviour of TEIs and their faculty. In Mexico, funding policy is not used to drive TEIs for regional engagements. In public universities the so called ordinary subsidy concentrates about 90% of the total public subsidy for TEIs and includes the basic funding for research. No quality-related indicator is used in determining the ordinary subsidy. Mexico's and Sonora's TE sector features considerable discrepancies in

public subsidies per student across institutions. Financial incentives are lacking for Mexico's universities to modernise themselves or to encourage universities to engage with business and the community.

Public funding, allocation, institutional and per student funding

The federal government is the primary funding source of Sonora's public TEIs. Through the Ministry of Education (SEP), federal funds support the operation of the autonomous federal TEIs, federal technological institutes, and jointly with state government, some state TEIs. The government of Sonora supports the state technological universities and institutes. Autonomous State TEIs, such as UNISON, ITSON, COLSON and CIAD are funded by both the federal and state money. These funds support mainly teaching and operational costs.

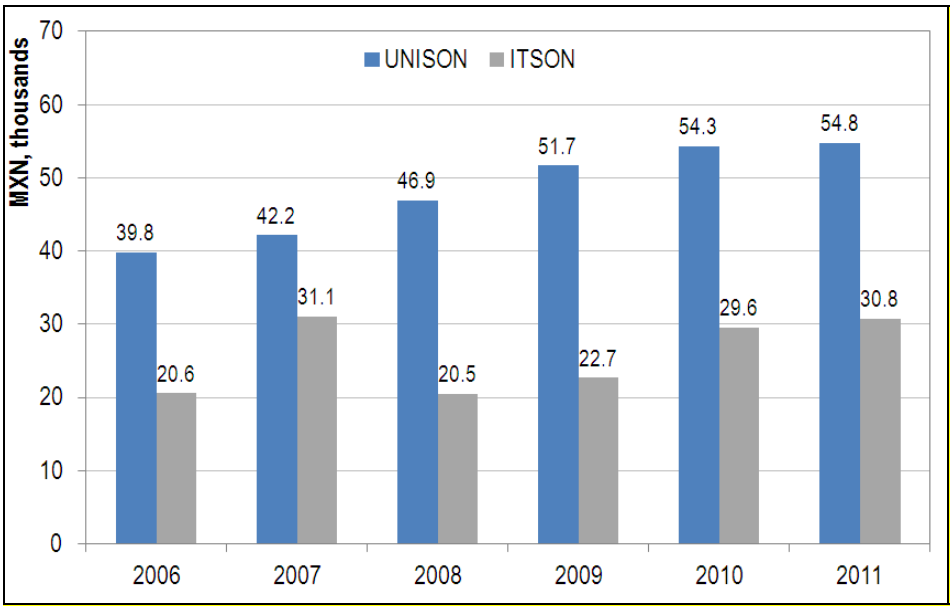
The federal subsidy consists of three components: i) ordinary subsidy; ii) extraordinary subsidy, i.e. targeted funding; and iii) a subsidy linked to the annual expansion and diversification of the educational supply. In turn, the state subsidy has two components: i) an ordinary subsidy and ii) a subsidy that is related to the expansion of the educational provision.

The ordinary subsidy covers current expenditure related to the regular activities of TEIs. It is based on the size of the academic body, but often reflects historical trends or the lobbying power of the institution. The ordinary subsidy concentrates about 90% of the total public subsidy for TEIs and includes the basic funding for research. No quality-related indicator is used in determining the ordinary subsidy. Also, the ordinary subsidy is adjusted for cost increments such as salary rises or newly-created social benefits. The size of the state ordinary subsidy relative to the federal subsidy is determined in the same manner (OECD, 2008).

Mexico's TE sector features considerable discrepancies in public subsidies per student across institutions. The OECD (2008) notes that in 2004-05, "the average annual subsidy per student in federal public universities was twice that received by state public universities, 2.6 times that received by technological universities and 3.4 times that received by technological institutes. There is also wide variation within the subsystems. For instance, in the subsystem of state public universities, the average annual subsidy per student varied between MXN 22 090 and MXN 79 120 for that same year. These differences can only partially be explained by the research role of individual institutions. On this basis, there must be a question about whether the allocations are equitable. Similarly, there is no rationale to explain the considerable variability in the relative contributions of the federal and the state governments to the public subsidy received by public universities." While no comprehensive data is available, the Self-

Evaluation Report (2012) provides data for some non-autonomous federal and state TEIs based on the SEP report of 2011. This data demonstrates large discrepancies in per-student funding among non-autonomous federal and state TEIs (see Annex Tables 5.A.1 and 5.A.2). Sonora's autonomous TEIs also receive significant, but disparate, funding from the state and federal governments. This situation is exemplified in Figure 5.4, which shows the development of public funding per student in the leading universities in Sonora – UNISON and ITSON.[4]

Figure 5.4. Annual public subsidy per student (Federal and State)



Source: Data taken from UNISON (Universidad de Sonora) (2006-2011), *Informe Anual*, UNISON, Hermosillo, *www.uson.mx/paginadelrector/informes.html*.; ITSON (Instituto Tecnológico de Sonora) (2006-2011), *Informe de Actividades del Rector*, ITSON, Ciudad Obregón, *www.itson.mx/rector/Paginas/InformesRector.aspx*.

Funding for science & technology and regional development

Federal government is the main source of funding for national and regional S&T research activity. The funds are administered through two types of institutional funds: the National Council of Science and Technology (*Consejo Nacional de Ciencia y Tecnología*, CONACYT) and sectoral ministries. CONACYT was established in the early 1990s with the purpose

of encouraging science and technology development through several programmes: *i)* training of S&T human resources (mainly postgraduate scholarship programmes); *ii)* financial support to R&D labs and specific, thematic areas such as biotechnology, nanotechnology, advanced computing, and alternative energies through the science institutional fund; *iii)* development of new science and technology through the New Science & Technology Fund and AVANCE programme; *iv)* regional development through *Fondos Mixtos*, the Mixed Funds (FOMIX), and *v)* international cooperation in S&T (Sonora's Regional Steering Committee, 2012).

Research activity in Sonora is concentrated in four TEIs, all autonomous: UNISON, ITSON, COLSON and CIAD. These institutions account for 99% of nationally certified researchers (SNI) and were awarded the majority of CONACYT funding for research. In terms of its ability to attract CONACYT funding, however, Sonora lags behind other Mexican states, partly because the research is concentrated in small group of researchers and partly because of the weak state support for S&T (CONACYT, 2012).

INNOVAPYME, PROINNOVA and INNOVATEC are support programmes aimed at fostering RDI with a focus on SMEs and micro-enterprises, and on the cooperation between enterprises and TEIs. Sonora receives a relatively small sum through these funds: USD 15 million.

Funding mechanisms geared to regional development include the Mixed Funds (FOMIX) and FORDECYT. The Mixed Funds (FOMIX) were initiated by the federal government as a joint CONACYT-state funds and were designed as the key instrument for the promotion of applied research and innovation at the state and municipal levels. The funds are distributed through calls for proposals responding to state-specific needs and benefit both enterprises and research institutions that are registered in the National Registry of Science and Technology Institutions and Businesses (RENIECYT). In 2011, about MEX 21.3 million (approximately USD 1.72 million) were allocated for various projects in Sonora. However, in the latest round of the Mixed Fund funding distribution, only private enterprises, no TEIs received funding.

FORDECYT is a special CONACYT programme for regional development through the promotion of science, technology and innovation. It was created to complement the FOMIX programme. The aim is to promote S&T activities and the training of human resources that contribute to regional development. It is not known to what extent the TEIs in Sonora have made use of this fund.

TEI staff, workload and incentives for regional development

The lack of well qualified TE faculty combined with the heavy teaching load, limited research output, mandatory community service for students and other demands from industry, government and civic society have resulted in a discrepancy between TEIs missions and visions and their actual capacities.

The rapid growth of both public and especially private TEIs in Sonora during last 10-15 years has not been accompanied with an adequate growth in postgraduate degrees awarded to teaching and research personnel. The number of faculty with PhD degrees remains low, and the same applies even to Masters degrees. As faculty has a heavy teaching load, improving the credentials presents a real challenge, coupled with weak reward and incentive policies.

There is also a shared impression that TEIs have inadequate numbers of faculty and staff to support the scheduled programmes. Each institution offers a broad range of programmes and the question arises as to whether there is enough qualified faculty to actually develop and sustain quality programmes. This is especially important because of the demands from the productive sector for new professional and vocational profiles that require the timely adaptation of curriculum to regional and industry needs.

Research in Sonora is concentrated in small groups of productive researchers. Research occurs mostly within institutions within very small research teams, while inter-institutional and inter-sectoral collaboration is limited. TEI representatives reported hundreds of agreements, but it was difficult to gain concrete indices of what they exactly entail in terms of personnel and outputs.

The mandatory requirement for community service for all TE students in Mexico (up to 500 hours) poses opportunities and challenges to regional and local engagement of TEIs. A well organised community service can provide TEIs with opportunities for long term ongoing collaboration with the labour market and wider society. Sonora features examples of successful models of community engagement in conditions of scarce financial sources (see for example CUDDEC, Box 4.5). However, because of a lack of supervision and coaching for students staff, limited knowledge of the community needs, the mandatory community service can lead to sub-optimal outcomes, even a waste of time.

At the institutional level, few incentives exist to encourage regional engagement of TEI staff. ITSON has developed an incentive programme for the university faculty, but there is no information how this works in practice. ITSON's teacher's performance incentive programme consists of 1 000 points which are allocated according to three main aspects: Permanence

(100 points), Dedication (200 points) and Quality (700 points). Within Quality, there is a set of items covering "Knowledge generation and application" (with 180 out of the 700 points) of which, 50% of the points (90) can be earned by "Research and development" activities, including "External funding obtained for projects" (38 points) (ITSON, 2010).

Despite the lack of well developed incentive systems, universities' regional engagement is driven by individual academics rather than institutions. Traditionally, individual researchers at Sonora's TEIs have participated in various state-level and regional plans and economic development proposals and studies. For example, researchers at CIAD's division of regional development have contributed over the years to numerous economic studies requested by the governor's office and other state government agencies. More recently, researchers from UNISON, COLSON, and ITESM provided inputs into the bi-national plan, *A Shared Vision for Arizona and Sonora* (AMC/CSA, 2011). While this continues to be a valuable contribution of TEIs' expertise to regional development, it is necessary to build capacity so that TEIs as institutions become real partners in regional economic development.

International experience in incentivising TEIs and TE staff

Sonora's TEIs could find inspiration from international experience on how to encouraged TEIs and TE staff to engage in regional and local development, whether technology transfer or community development. Experience in OECD countries shows that a variety of design mechanisms can be used to provide funding incentives for regionally relevant activities or engagement of higher education institutions, for example:

- Formulae for block grant funding could include higher weights for enrolment of students from within the region, from special populations, or for enrolment in academic programmes related to regional needs.
- Polices governing tuition fees could allow for lower fees for students from region and policies for financial aid to students can provide higher amounts for in-region students and special populations.
- Eligibility for special funding could be contingent on evidence of regional engagement and focus.
- Eligibility for special funding could be made contingent on inter-institutional collaboration. This could provide incentives for universities and further education and training colleges to facilitate mobility of students (credit transfer within the region) and share programmes and resources in efforts to serve the region.

- Special funding could be provided to match funding obtained by universities and further education and training colleges from contracts with regional employers for education and training services.

Federal government or state government of Sonora could consider introducing a funding and monitoring mechanism to support university business and community engagement. Such mechanisms include the Higher Education and Innovation Fund for England (HEIF) and the associated monitoring system the Higher Education and Business and the Community Interaction Survey (HEBCIS) (see Box 5.3). While HEIF funds are a small component of the budgets of English universities, their cumulative impact on the behaviour of English universities has been significant. (PACEC, 2012) Despite the economic situation, Higher Education Funding Council has maintained the HEIF funding at GBP 150 million per annum for the 2011-15 period.

Box 5.3. The Higher Education Innovation Fund in the UK

The Higher Education Funding Council (HEFCE) launched the Higher Education Innovation Fund (HEIF) in 2001 to support and develop a broad range of knowledge exchange activities that result in economic and social benefit to the UK. HEIF provides special funding to universities to support activities which increase their capability to respond to the needs of business (including companies of all sizes and sectors and a range of bodies within the wider community) where this will lead to identifiable economic benefits. Early rounds of HEIF built capacity and provided incentives for all English higher education institutions to work with business, public sector bodies and third sector partners, with a view to transferring knowledge and thereby improving products, goods and services. Following ten years of capacity building, from 2011 HEIF became performance based and was awarded to 99 English HEIs.

HEIF has gone through several iterations:

- Round 1 (AY2001-2003): 136 applications for funding from 128 HEIs including 34 proposals from thematic and regional consortia involving several HEIs. Funding of over GBP 77 million to 89 applicants.

- Round 2 (AY2004-2006): 183 applications for funding including 69 from consortia of HEIs. Funding of GBP 186 million allocated to 124 proposals, including 46 consortia, 22 new Centres for Knowledge Exchange established.

Box 5.3. The Higher Education Innovation Fund in the UK (continued)

- Round 3 (AY2006-2008): GBP 238 million allocated by combination of formula funding to all HEIs based on data collected via the mandatory Higher Education Business and the Community Interaction Survey (HEBCIS), and collaborative competitive projects. Three elements of the formula: *i)* potential and capacity building; *ii)* external income as a proxy for demand; and *iii)* activities not best measured by income. Allocation per institution GBP 200 000 to GBP 3 million. Accountability via submission of institutional plans and annual monitoring. 11 large scale projects including several HEIs and external partners from business and community organisations and continuation funding for Centres for Knowledge Exchange were also supported.

- Round 4: AY2008-2011: Move to formula only allocations of GBP 150 million per annum over period, maximum annual institutional allocation GBP 1.9 million per annum in AY 2010-11. Formula allocations moderated by assessments of institutional knowledge exchange strategies and annual monitoring.

- Round 5: AY2011-15: Funding maintained at GBP 150 million per annum for the four year period, despite economic situation, reflecting minimum return on investment of GBP 6 for each HEIF GBP 1. Allocations are now performance based: institutions are eligible to receive an allocation if they exceed GBP 250 000 allocation threshold related to their external income earnings and the performance of the sector over all (as captured in HE-BCI survey). 99 institutions received allocations, as previously accountable by submission of institutional knowledge exchange strategies and annual monitoring.

Higher Education and Business Interaction Survey (HE-BCI)

HE-BCI covers a range of activities, from the commercialisation of new knowledge, through the delivery of professional training, consultancy and services, to activities intended to have direct social benefits. "Business" in this context refers to private, public partners of all sizes and sectors, with which HEIs interact in a broad range of ways. "Community" in this context refers to society as a whole outside the HEI, including all social, community and cultural organisations, individuals and the third sector. Data collection moved to the Higher Education Statistics Agency (HESA) in 2011.

Source: HEFCE (Higher Education Funding Council for England) (2012a), Funding for knowledge exchange - Higher Education Innovation Funding (HEIF), *www.hefce.ac.uk/whatwedo/kes/heif*; HEFCE (Higher Education Funding Council for England) (2012b), Higher education-business and community interaction survey, *www.hefce.ac.uk/whatwedo/kes/measureke/hebci.*

Another source of funding for universities' regionally relevant work includes charitable donations, trusts, persons of wealth and alumni. TEIs in

Sonora have not yet taken action to diversify their funding streams through voluntary giving. The universities could make efforts in this domain, for example, by engaging with their alumni and developing other systematic mechanisms that support voluntary giving. The federal government could consider mobilising universities to raise private funds. Recognising that investment in the fundraising infrastructure can generate real rates of return, some countries, such as Finland, Singapore and the United Kingdom, have sought to stimulate this activity by matched funding schemes. The UK experience is particularly interesting, as it uses different weights for different types of TEIs (see Box 5.4).

Box 5.4. The UK matched funding scheme for charitable donations to universities

In April 2008, the UK Government launched a GBP 200 million matched funding scheme for voluntary giving. The matched funding scheme began in August 2008 for a three year period. Funding was available to match eligible gifts raised by English higher education institutions and directly funded further education colleges. There were three levels of funding:

- First Tier: 1:1 private to public: intended for the least-experienced fundraising institutions and those looking to build capacity from a low base. Every GBP 1 raised will be matched in full.
- Second Tier: 2:1 private to public: intended for the majority of institutions with existing development programmes. Every GBP 2 raised will be matched by GBP 1.
- Third Tier: 3:1 private to public: intended for the most experienced fundraisers. Every GBP 3 raised will be matched by GBP 1.

Higher education institutions were able to request their own tier, with the exception of the Universities of Oxford and Cambridge, which were included in the third tier. All directly funded further education colleges wishing to participate in the scheme were automatically included in first tier. Each institution's tier and cap level was confirmed by the Higher Education Funding Council (HEFCE) prior to the start of the scheme.

The following forms of giving were eligible for match funding: actual gifts of cash, gifts of shares, gifts from small/medium-sized charitable trusts and foundations, gifts through higher education institutions own non-consolidated development trusts, corporate gifts, and overseas gifts. Legacies and gifts in kind were not eligible for matching. Higher education institutions had the freedom to decide how match funding was spent.

Source: HEFCE (Higher Education Funding Council for England) (2008), "Matched Funding Scheme for Voluntary Giving 2008-2011", Circular Letter, No. 11/2008, HEFCE, Bristol, *www.hefce.ac.uk/pubs/circlets/2008/cl11_08/.*

In developing a state-level framework for regional engagement of TEIs, Sonora could learn from the Regional Stewardship Initiative of the Commonwealth of Kentucky (US), which illustrates a comprehensive

strategy to provide incentives for universities and other tertiary education institutions to support regional engagement (see Box 5.5). This approach could be applied in Sonora via the establishment of a special state investment fund (funded from public and private resources) to build capacity within universities for regional engagement. It could also provide incentive funds to institutions and individual faculty members for regional initiatives, such as engaging faculty members and students in teaching, learning and applied research projects related to regional priorities.

Box 5.5. Kentucky Regional Stewardship

The goal of the Regional Stewardship Program is to promote regional or state-wide economic development, liveable communities, social inclusion, improved P-12 schools, creative governance and civic participation through public engagement activities initiated by university faculty and staff. To help accomplish this goal, campus administrators are expected to design and implement programmes that align institutional resources and infrastructure to support their missions as "stewards of place", and to create partnerships and undertake engagement activities that address regional and state needs.

The programme provides three forms of funding incentives to institutions: i) infrastructure funds to support the development and maintenance of organisational structures, personnel, information systems and community relationships directed toward the identification of regional needs, opportunities and stewardship priorities; ii) regional grant funds to support comprehensive university efforts to build intellectual capacity in stewardship priority areas (to qualify for regional grant funds, each institution must submit a strategic plan for stewardship activities and a priority area proposal to the state Council on Postsecondary Education); and iii) the stewardship initiatives pool to support specific public engagement activities at the institutions that improve economic prosperity, quality of life, or civic participation in the region or state, while furthering the goals and mandates of the state's public agenda to increase the educational attainment of the state's population.

Source: Kentucky Council on Postsecondary Education (2009), Regional Stewardship Program, *http://cpe.ky.gov/policies/budget/reg_steward_program.htm*.

In developing incentives for staff, Sonora's TEIs could find inspiration in the work of the University Rovira i Virgili in Tarragona, Spain, which has developed a strong research base, but is also renowned for its broad outreach agenda, including technology transfer, skills development for industry and cultural outreach in communities. This university has not only created incentives to encourage faculty contributions beyond the conventional arenas of research and teaching, but also created methods to evaluate those contributions (see Box 5.6).

Box 5.6. University Rovira i Virgili: Creating incentives for faculty participation in third mission activities

The University Rovira i Virgili in Tarragona has an active third mission agenda, including entry points for small and medium-sized enterprises (SMEs) to the university knowledge base, social and cultural programming in 22 cities in southern Catalonia and active participation in fostering a knowledge based petro-chemical industry cluster in the sub-region.

Contracts for the university faculty emphasise the importance of and give value to faculty participation in these outreach efforts and allow for different staff profiles (i.e. facilitators in the learning process, knowledge generators, service providers) in order to ensure that high staff performance, collaboration with colleagues. The university faculty contract has been re-organised around a system with a ten-point base (Research and academic staff agreement) that direct faculty & administrative efforts to achieving mutually accepted individual, departmental, school and university goals, in line with the university mission. All faculty are expected to undertake research and to teach, with the minimum contractual obligations constituting six of the expected ten points. To reach the expected ten points, faculty can contribute in a variety of ways, according to their interests, expertise and position, by focusing on administrative tasks, research activities, innovative teaching or outreach. For some faculty, this may mean giving presentations in programmes in which the university is developing a presence. For others, it may mean working with a small and medium-sized enterprise (SME) to implement a technology transfer or technology commercialisation project. For other faculty, reaching the ten points may mean additional research and publication.

The goal of this governance strategy is to set a base expectation for faculty performance in core activities. This evaluation method also creates the flexibility to allow faculty to contribute in arenas related to the university's goals to expand its third mission activities. All of the criteria for performance constitute a unit contributing to the ten-point base are publicly available and the activities of each faculty member toward achieving the base standard are available to all members of the department. The goal of the university in developing this evaluation programme is to create a more transparent and accountable university. In future, it would be useful to give better visibility for the university expertise.

Source: OECD (2011), *Higher Education in Regional and City Development: Catalonia, Spain 2011*, OECD Publishing, *http://dx.doi.org/10.1787/9789264089006-en.*

Conclusions and recommendations

Sonora has a large and diverse tertiary education sector (federal, state and private). This is an asset for regional engagement but can also lead to the dilutions of resources and challenges for inter-institutional and intra-regional collaboration.

Regional role of Sonora's TEIs in economic, social and cultural development is framed by a combination of federal and state governmental policies and institutional responses. As in the rest of Mexico, federal government plays a major role. Being the primary source of funding for TEIs – not only for federal TEIs, but also state and autonomous TEIs – the federal government directly influences the capacity of TEIs for regional engagement. The three main documents at the federal level, the National Development Plan 2007-2012, the National Plan for Education 2001-2006, and the Higher Education Coordination Law formally identify regional engagement as the third key role of TEIs, in addition to teaching and research.

Connection councils at state and regional level have been conceptualised as an innovative mechanism through which TEIs would engage with regions and regional stakeholders. While connection councils are in principle a positive development, they have some shortcomings: i) there are no specific mandates for the regional engagement of TEIs; everything is at the level of "encouragement" or "suggestion"; ii) there are no specific plans on how to fund TEIs in order to promote and strengthen regional engagement; iii) there are no common incentives for TEIs to engage in this relatively new area of actively participating in regional economic development, and iv) there are no common measures to monitor outputs and outcomes of TEI regional engagement that could be used for more focused efforts on what works best as well as the basis for the distribution of funding.

The general situation at the state level mirrors the federal level. Sonora's State Plan for Development 2009-2015 identifies "Educated Sonora" as one of the key directions in mid-term development and emphasises the promotion of linkages between the education system and different actors and sectors of Sonoran society. Additionally, the State Education Programme 2010-2015 identifies connections between education and different social, productive and governmental sectors as one of the key strategies. As is the case with the federal plans, however, the state plans and programmes in Sonora are short on specifics, especially with regard to funding mechanisms, monitoring of progress and outcomes, and incentives for regional engagement of institutions and their faculty.

Funding incentives for third mission activities of Sonora's TEIs remain inadequate. Despite CONACYT's special programme in support of connecting TEIs with the private companies, there is no assessable data to show if they actually supported any of the Sonora's TEIs. Their connection activities as a formal mechanism for regional engagement are likely to be supported from institutional resources that are used in a less systematic way, are scarce, and as such unsustainable. At the state level, the shift of the state priorities towards direct support for the private sector (*e.g. Nueva Sonora* programme) has had a negative impact on university-industry collaboration: the support for university-industry collaboration had diminished or even vanished, affecting the efforts to improve quality of teaching, raise relevance of research, and connect with the region's social and economic sectors.

On the positive side, Sonora was one of the first states in Mexico that established state-level connection councils, known in Sonora as COVES (*Consejo de Vinculación del Estado de Sonora*), in accordance with the Ministry of Education's recommendations. COVES was created to build capacity among Sonora's TEIs to fulfil their roles as actors within Sonora's economic development infrastructure. COVES' main function is as an advisory organisation; its activities include informing, disseminating, evaluating and proposing changes in curriculum and linking TEIs and research centres with the demands of the state and country. With the advisory assistance of COVES, almost all of Sonora's TEIs signed individual collaboration agreements with representatives of state and local government, businesses and social organisations in their regions.

Operationally, the state level COVES also represents a co-ordinating body for eight regional councils, each of which incorporates linkages with institutional councils. Each council is composed of key representatives of academia, government, the productive and services sectors, and the social sector. This is an important strategy toward capacity building for TEIs' regional engagement.

"Connection" (*vinculación*) at the level of Sonora's TEIs remains an abstract concept than a real working mechanism. This is partially due to its novelty (some councils were established as recently as the end of 2011) and it may take some time to learn what works and what does not. The linkage mechanisms have major shortcomings such as: i) the lack of national and state funding, which places greater burden on institutions and other regional stakeholders; ii) the lack of focus on regional priorities; councils appear to be over-encompassing and thus less efficient; iii) inadequate capacity in terms of institutional council staffing due to a shortage of professionals with knowledge in regional development; and iv) non-existent indicators for assessment of outcomes and outputs of the linkage strategy for regional engagement.

Managing regional interface through external partnerships requires from TEIs not only time, but also commitment to the regional development. This includes making and sustaining strategic regional partnerships, the scale and scope of which pose new demands on TEIs leadership/management teams.

Regional engagement requires changes in institutional leadership approach as well as the mobilisation of TEI staff in support of this agenda. A change in behaviour, attitudes and values toward the "third task" calls for changes in rewards and incentives for staff, as well as new recruitment, hiring, reward and human resources development practices. One of the key factors of success in regional partnerships is the presence of facilitators between the different networks and organisations, and a team of staff with knowledge of regional development.

Successful partnerships between TEIs and the region depend on regional leadership and collaboration. In that respect, Sonora has made significant progress by establishing COVES, which could work as a regional steering committee composed of tertiary education institutions and a wide range of regional stakeholders. In practice, this is a challenge because of the multiplicity of regional agencies and partnership structures, which results in tensions between different parts of the region, or between different agencies with multiple objectives who are competing against each other for scarce resources and the lack of incentives. A way forward could be to develop COVES into the co-ordinating body for the Sonora's human capital and skills development system.

The OECD review team recommends that the following measures be taken to improve the capacity building for local and regional development:

Recommendations for the federal government

- Strengthen institutional capacity of TEIs to ensure relevance of education and application of knowledge to economic and social needs.
- Allocate a special budget of the federal government to promote specific linkages in addition to existing initiatives. The UK HEIF funding could provide inspiration.
- Promote a model of facilitators or managers and other personnel of connection councils and units responsible for translating business issues to the academic agenda and generating specific collaboration projects.
- Analyse existing regulations and propose improvements in legal and institutional framework that facilitate connection between academia and industry.

- Evaluate the National System of Connection continuously; establish indicators to measure performance and impact to ensure that the system functions properly.
- Establish and promote incentive schemes that give priority to research that serves the needs of the regional/local domestic industry.

Recommendations for the state government

- Strengthen the co-ordination function of the state-wide COVES in order to better identify regional priorities and more efficiently apply resources and expertise of regional connection councils.
- Develop incentives for TEIs to engage in regional development via regional connection councils. The Kentucky Stewardship programme could provide an inspiration.
- Conduct surveys of TEIs to assess their experiences and challenges participating in regional councils in order to improve collaboration and co-ordination with the productive, service and social sectors.
- Incentivise TEIs to develop a common set of measures to assess outputs and outcomes of their regional engagement.
- Provide incentives to TEIs to improve the connection council's professional capacity for regional engagement.
- Strengthen the engagement of TEIs as institutional partners in developing and implementing state plans and strategies.
- Encourage companies to work collaboratively with TEIs in areas of mid- and long-term labour needs planning, technology development and application.
- Building on the existing successful models, develop capacity in regional data gathering, and sharing regional data repositories as a basis for identifying regional priorities.

Recommendations for universities and other tertiary education institutions

- Develop internal incentives for faculty/researchers to engage in specific committees established under connection councils.

- Document the present linkages and publicise them within the region and within the institutions to raise the profile of tertiary education as a region builder.
- Assess needs for professional capacity building within the connection council and invest in strengthening its professional capacity building.
- Use regional connection councils as a platform to strengthen co-ordination among local and regional TEIs and promote a "common tertiary education vision" to policy makers.
- Utilise the experience of individuals and groups within TEIs who are actively involved in providing advice to regional agencies to assist the academic leadership in guiding institution's policy and practice as it pertains to regional engagement.
- Review existing efforts in developing methodology for evaluation of the TEIs-industry sector linkage, modify and adopt common measures.
- Design and implement tangible rewards and incentives, including new employment and human resources management practices, in support of individual and institutional regional engagement. Review staff recruitment, hiring and reward systems so as to include the regional development agenda. 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.
- Through feedback to COVES and regional councils, contribute to the improvement of co-ordination and management of regional links.
- Educate faculty/staff about benefits of regional engagement, and maintain pressure for mainstreaming of regional engagement into research, teaching and service functions
- Utilise existing expertise in regional economic analysis and modelling (e.g. ITSON's Strategic Plan for Regional Development in Southern Sonora based on Innovative Ecosystems (Plan estratégico para el Desarrollo regional basado en ecosistemas de innovación) as a basis for collaboration with government, productive and social sectors in assessing regional needs and development trajectories.

Annex 5.A.1. Federal funding for TEIs

Table 5.A.1. Federal funding for non-autonomous TEIs in Sonora (2011)

Institution	Number of students	Total federal funding (MXN)	Funding per student (MXN)
Instituto Tecnológico de Hermosillo	3 607	27 764 550	7 697
Instituto Tecnológico de Nogales	2 162	14 059 577	6 503
Instituto Tecnológico de Valle del Yaqui	1180	5 000	4
Instituto Tecnológico de Huatabampo	1 091	4 950 400	4 000
Instituto Tecnológico de Agua Prieta	985	534 614	543
Instituto Tecnológico de Guaymas	573	1 000 000	1 745
Total	**9 598**	**48 314 141**	**5 033 (average)**

Source: Sonora's Regional Steering Committee (2012), *Self-Evaluation Report*, Gobierno del Estado de Sonora, Sonora.

Table 5.A.2. Federal funding for select non-autonomous state TEIs in Sonora (2011)

Institution	Number of students	Total federal funding (MXN)	Funding per student (MXN)
ICATSON (Instituto de Capacitación para el Trabajo del Estado de Sonora)	6 503	37 958 419	5 837
Instituto Tecnológico Superior de Cajeme	3 631	32 522 427	8 957
UTH (Universidad Tecnológica de Hermosillo)	3 356	41 256 599	12 293
Universidad del Sur de Sonora	3 050	16 231 522	5 322
UTN (Universidad Tecnológica de Nogales)	1 043	23 951 279	22 964
Instituto Tecnológico Superior de Cananea	608	22 935 831	37 723
Instituto Tecnológico Superior de Puerto Peñasco	565	12 673 901	22 432
Universidad de la Sierra	538	9 080 326	16 878
UTE (Universidad Tecnológica de Etchojoa)	371	6 633 000	17 879
UTSLRC (Universidad Tecnológica de San Luis Rio Colorado)	232	5 407 288	23 307
UTPP (Universidad Tecnológica de Puerto Peñasco)	195	5 407 288	27 730
Total	**20 092**	**214 057 880**	**10 654 (average)**

Source: Sonora's Regional Steering Committee (2012), *Self-Evaluation Report*, Gobierno del Estado de Sonora, Sonora.

Notes

1. For example, a collaboration agreement was signed between AMS and Sonora SE's Programme to Support Companies Certification (Maquila Portal, 2012).
2. Enrolment figures for UNISON vary: 25 895 refers to degree seeking students, while a larger figure 36 382 students includes 10 487 non-degree-seeking students, of which 815 are enrolled in art workshops and 9 672 are enrolled in language courses (Grijalva Monteverde, 2011).
3. See note 2.
4. In 2011, UNISON received MXN 739.3 milllion from the federal government, plus an additional MXN 43.5 million in special federal funds and MXN 72 406 627 from PIFI (*Programa Integral de Fortalecimiento Institucional*). State funding for UNISON was MXN 679.4 million in 2011 (Grijalva Monteverde, 2011). ITSON received MXN 318.4 million from the federal government and MXN 199.3 million from the state government in 2011 (Rodriguez-Villanueva, 2011).

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Annex A. Review team

Jaana Puukka is an international higher education expert, currently serving the OECD Education Directorate as a project manager and analyst in the Policy Advice and Implementation Division. She joined the OECD Programme on Institutional Management in Higher Education in 2005 to lead the OECD multi-annum activity in Higher Education in Regional and City Development which has involved reviewing the impact and engagement of higher education institutions in more than 30 cities and regions in over 20 countries. She has coordinated three subsequent rounds of reviews and personally led more than 15 reviews – Andalusia (Spain), Berlin (Germany), Bio Bio Region (Chile), the Basque Country (Spain), Catalonia (Spain), the Free State (South Africa), the Galilee (Israel), Lombardy (Italy), the Paso del Norte region (US/MX), the State of Penang (Malaysia), Southern Arizona (US), the State of Victoria (Australia), Wroclaw (Poland) – and has been the lead author for these reviews as well as for the reviews of State of Parana (Brazil), the State of Veracruz (Mexico) and Antioquia (Colombia). Puukka has provided policy advice to national and sub-national governments and tertiary education institutions worldwide. She is the co-author and editor of the OECD publication "Higher Education and Regions – Globally Competitive, Locally Engaged" (OECD, 2007), the editor of the "Post-secondary Vocational Education and Training: Pathways and Partnerships" (OECD, 2012) and the forthcoming publication "Higher Education in Cities and Regions – For Stronger, Cleaner and Fairer Regions". Before joining the OECD, Puukka was engaged in higher education and local and regional development in Finland as a national and local government adviser, programme manager, practitioner and evaluator. She has held management, expert and advisory positions in the higher education sector, and has worked in university internationalisation, institutional evaluation, regional development, PR & communication and stakeholder management. Her corporate sector experience comes from the biomedical industry.

Bonifacio Agapin joined the OECD Education Directorate in January 2010 first as a trainee and later as a consultant, contributing to the Quality in Teaching Project, the Centre for Effective Learning Environments (CELE)

and reviews of Higher Education and Regional and City Development. Prior to joining the OECD, Agapin worked for several years in the US public education sector as a Foreign Credentials Evaluator and as a Postgraduate Student Counsellor in the UK.

Susan Christopherson is a Professor in the Department of City and Regional Planning at Cornell University. She is an economic geographer (PhD, U.C. Berkeley) whose research focuses on the spatial dimensions of economic policy and economic development. Her work in the field of economic development has focused recently on strategies for revitalising economies in manufacturing regions and on the economic development implications of natural gas development. In the past seven years, she has completed policy studies on economic development via targeted workforce development; a clusters strategy to build an advanced technology industry; and on the role of universities and colleges in revitalising regional economies. She is an expert on the film and television industries and particularly on work and the workforce in those industries. Her research in this field has focused on the way in which trends in media work foreshadow changes in work organisation across the economy. She served as a consultant to the OECD Working Party on the Role of Women in the Economy and the United Nations Conference on Trade and Development. She has participated in three regional reviews for the OECD IMHE project on how higher education institutions can positively affect regional economic development.

Patrick Dubarle, former Principal Administrator at the OECD Public Governance and Territorial Development Directorate (GOV), has co-ordinated and contributed to a number of OECD territorial reviews at the national and regional level and has also participated in case studies within the framework of the OECD programme on Higher Education Institutions and City and Regional Development. Patrick Dubarle joined the OECD in 1978 as an administrator in the Directorate for Science Technology and Industry. He was appointed Secretary of the OECD Working Party on regional development policies in 1992, where he was responsible for country regional policy reviews and horizontal programmes. He has worked with national governments in many OECD countries and has spoken at several international conferences. He is the author of documents on high technology policies and sectoral questions including space industry, technological change, technology fusion, innovation and higher education in regional development. He is presently a consultant for the European investment Bank, the OECD and the French Agency for Higher Education and Research Institutions' Assessment.

Jocelyne Gacel Ávila holds a PhD in Higher Education with honors specialised in internationalisation and a Master's degree at the University of Paris VII in English and German. She has been in charge of the internationalisation process at University of Guadalajara, Mexico, for more than 20 years, as General Director for Co-operation and Internationalisation. She is a tenured researcher, professor and director of thesis on higher education for postgraduate students. She is a member of the National System of Research of Mexico (SNI) and considered an expert in the theme of internationalisation and co-operation in higher education in Latin America on which she has written and co-ordinated more than nine books and more than fifty articles. She has collaborated in research projects with different international organisations such as the World Bank, the Ford Foundation, the European Commission, the Consortium for North American Collaboration in Higher Education (CONAHEC), the Observatory on Borderless Higher Education, the International Association of Universities, the Interamerican Higher Education Organisation and the Forum for Internationalisation in Brazilian Universities, among others. She was founding member of the Mexican Association for International Education (AMPEI) and elected its president for two periods and vice-president of CONAHEC 2005-2007 representing Mexico.

Vera Pavlakovich-Kochi is Senior Regional Scientist in the Eller College's Business Research Center and adjunct Associate Professor in the School of Geography and Development at The University of Arizona. Her research interest is focused on regional economic development with an emphasis on US-Mexico border and Southeast Europe. Articles on various aspects of Arizona's economy and US-Mexican border have been published in Arizona's Economy, Arizona's Review, Journal of Borderlands Studies, Revista de El Colegio de Sonora, Estudios Sociales and Geografski glasnik. She co-edited a book "Challenged Borderlands" (Ashgate, 2004) in collaboration with scholars from Mexico and Europe. Other research interests include the impact assessment of various agents on local and regional economy such as the maquiladora sector, fresh produce industry, border tourism, universities and research parks. Prior to her current position, she was Director of Regional Development in the University of Arizona's Office of Economic Development, where she developed an original set of cross-border regional economic indicators for the Arizona-Sonora Region and served as the principal author of the annual indicators report.

Annex B. The review visit agenda

OECD review visit to Sonora, Mexico, 11-16 March 2012

Sunday 11 March

18.00 OECD review team internal meeting

19.00 Meeting with José Manuel Ochoa-Alcántar, Regional Co-ordinator for the OECD review

Monday 12 March

09.00 – 10.30 **Ministry of Education and Culture, State of Sonora**
Higher Education in Sonora, DECIDE programme, COEPES
Vicente Pacheco-Castañeda, Secretary for Upper Secondary and Higher Education in Sonora
Rogelio Noriega-Vargas, Director for Upper Secondary and Higher Education in Sonora
Sandra Elena Gutiérrez-Preciado, General Director for Higher Education in Sonora
Gerardo Ochoa-Salcido, State of Sonora Commission for Higher Education Planning (COEPES)

10.30 – 11.00 **University of Sonora, UNISON**
Enrique Fernando Velázquez-Contreras, Academic Vice President
Francisco Javier Castillo-Yáñez, General Secretary

11.00 -13.00 **UNISON**
Heriberto Grijalva Monteverde, Rector
Enrique Velázquez Contreras, General Academic Secretary (Secretario General Académico)
Guadalupe García de León Peñuñuri, Vice-rector, Office of Central Region (Vicerrectora Unidad Regional Centro)
Benjamín Burgos-Flores, University Planning

Luz María Durán-Moreno, Academic Development and Innovation
Daniel González-Lomelí, Graduate Studies and Research
Samuel Galaviz-Moreno, Student Services
Manuel Ignacio Guerra-Robles, Outreach
José Luis García-Ruíz: Mobility, Academic Exchange and Co-operation
Ignacio Guerra Robles, Director of Partnerships and Diffusion (Director de Vinculación y Difusión)
Carlos Velázquez Contreras, Co-ordinator of the International Cancer Programme (Coordinador Programa Internacional del Cáncer)
Rafael Cabanillas López, Energy Commission (Comisión de Energía)
Luis Eduardo Velázquez Contreras, Speciality in Sustainable Development (Especialidad en Desarrollo Sustentable)

15.00 – 16.00 **Knowledge City (Ciudad del Conocimiento)**
Mario César Cuén-Aranda, Sonora State Treasurer

16.00 – 17.30 **Ministry of Economy, State of Sonora (Secretaría de Economía, Estado de Sonora)**
José Alfredo Gámez-Corrales, Director of Technology Sectors (including topics related to higher education, innovation and maquiladora industries in Sonora)

Tuesday 13 March

09.00 – 10.00 **National Council for Science and Tecnology, CONACYT**
Francisco Javier Cevallos-Rojas, Director

10.00 – 12.00 **Center for Research on Nutrition and Development, CIAD**
Angel Valdés-Cuervo: Scientific expertise of graduate students, its relation to innovation management in graduate studies

15.00 – 16.30 **CESUES (Sonora State Higher Education Center (now known as UES (State University of Sonora)**
Samuel Espinosa-Guillén, Rector
Rubén Irazoqui-Galaviz, Secretary
Ernestina Arabella Almada-Ruiz, Academic General Secretary
Brenda María Vega-Moreno, International Affairs
María Grethel Ramírez-Siqueiros, Research and Graduate Studies
María Ernestina Quintal-Berny, Planning

16.40 – 18.40 **Technological Higher Education in Sonora**

Federal Institutions of Technology
Jesús David Estrada-Ruiz, Instituto Tecnológico de Huatabampo (Huatabampo Technological Institute)
Adolfo Rivera-Castillo, Instituto Tecnológico de Hermosillo (Hermosillo Technological Institute)
José Escárcega-Castellanos, Instituto Tecnológico de Nogales (Nogales Technological Institute)
Victor García-Castellanos, Instituto Tecnológico de Agua Prieta (Agua Prieta Technological Institute)
Juan Alfredo Moncayo-López, Instituto Tecnológico de Guaymas (Guaymas Technological Institute)
Rafael García-Martínez, Instituto Tecnológico del Valle del Yaqui (Yaqui Valley Technological Institute)

Technological Universities
Miguel Ángel Salazar-Candia, Universidad Tecnológica de Hermosillo (Hermosillo University of Technology)
Marco Antonio García-Carrasco, Universidad Tecnológica de Nogales (Nogales University of Technology)
Hermenegildo Lagarda-Leyva, Universidad Tecnológica del Sur de Sonora (South Sonora University of Technology)

Higher technological institutes
Paulino Antonio Sánchez-López, Instituto Tecnológico Superior de Cajeme (Cajeme Higher Institute of Technology)
Rafael Lara-Mungarro, Instituto Tecnológico Superior de Puerto Peñasco (Puerto Peñasco Higher Institute of Technology)
Pablo Andrade-Gerardo, Instituto Tecnológico Superior de Cananea (Cananea Higher Institute of Technology)

Wednesday 14 March

09.00 – 11.30 **University of the Valley of Mexico (Universidad del Valle de México, UVM)**
María Luisa-Valdéz, Director
Christopher A. Young, Academic Director

13.30 – 15.30 **ITSON staff, San Carlos Bay**
Sonia Beatriz Echeverría-Castro, ITSON Director
Mario Alberto Vázquez García, ITSON Head of Department (Guaymas)

Luis Fernando Olachea-Parra, ITSON Head of Department (Empalme)

17.00 – 20.00 **Museum of the Yaquis**
Erika Shander Tamaura-Torres: ITSON Culture
Marina Arteaga: Sonora Culture Institute

Thursday 15 March

09.00 – 9.30 **Sonora's Institute of Technology, ITSON**
Javier Portugal-Vásquez, President
Luis Carlos Valdés, Academic Vice President
Javier Saucedo-Monarque, Administrative Vice President
María Mercedes Meza-Montenegro, General Secretary
Ernesto Alonso Lagarda-Leyva, University Planning Director
Imelda Lorena Vázquez-Jiménez, Economy and Administration Director
Juan José Padilla-Ybarra, Engineering and Technology Director
Luciano Castro-Espinoza, Natural Resources Director
Silvano Higuera-Hurtado, Social Sciences and Humanities Director
Sonia Beatriz Echeverría-Castro, Guaymas Director
Francisco Nabor Velazco-Bórquez, Navojoa Director
Reynaldo Pérez-Quiñonez, University Extension Director
Ruperto Reyes-Ramos, Information Technology Director
Lorenzo Pinzón-Compeán, Material Resources and General Services Director
María del Carmen Pérez-Gaxiola, Financial Resources Director
José Manuel Ochoa-Alcántar, Director of Services

09.30 – 11.30 **ITSON**

Pablo Gortáres-Moroyoqui: Center for Research and Innovation in Biotechnology: Agriculture and Environment
Irma Guadalupe Esparza-García: Alternative tourism corridors
Rodrigo González-Enríquez: Regional Center of Research and Development of Water and Energy
Mónica Gómez-Juraz: Internationalisation
José Manuel Ochoa-Alcántar: Asia-Pacific Economic Co-operation Digital Opportunity Centers (Centro de Oportunidades Digitales ADOC 2.0)

11.45 – 12.45 **University Center for Community Development (CUDDEC, ITSON)**

Reynaldo Pérez-Quiñonez, University Extension Director
Armando Alonso Murrieta-Osorio, University Outreach
Yanaki G. Ahumada-Carbajal, CUDDEC Co-ordinator
Ana Beatriz Martínez-Vizcaíno, PERAJ Adopt a Friend

13.00 – 14.30 **Students at ITSON Náinari**

Omar Alejandro Domínguez Pérez, Bachelor's degree in Economics and Finance (Licenciatura en Economía y Finanzas)
Andrés Avilez Trapero, Bachelor's degree in Graphic Design (Licenciatura en Diseño Gráfico)
Karen Aida Cervantes Sotomayor, Bachelor's degree in Economics and Finance (Licenciatura en Economía y Finanzas)
Rocío Guadalupe Cervantes Parra, Industrial and Systems Engineering (Ingeniería Industrial y de Sistemas)
Antonia Alarcón Escribano, Industrial Engineering (Ingeniería Civil), University of Castilla and La Mancha (Universidad de Castilla La Mancha), Spain (España)
Usue Turrillas Erkiaga, Bachelor's degree in Educational Sciences (Licenciatura en Ciencias de la Educación), University of the Basque Country (Universidad del País Vasco)

14.30 – 17.00 **Sonora Soft Technology Park (Parque Tecnológico de Software PTSw)**

Juan Pablo Jiménez-Sánchez, Technology Park
Manuel Montaño, Novutek
Juan Carlos Murrieta-Lee, Technology Center for Integration and Business Development
Manuel Ricardo Lugo-Cruz, Business Incubator

Bernardo Flores-Oliva, International Agribusiness District for Small and Medium Business

17.30 – 18.30 **Technological Institute of Higher Studies of Cajeme, ITESCA**
Paulino Antonio Sánchez-López, Director

Friday 16 March

08.00 – 10.00 **Chamber of Commerce and Chamber of Industry**
Carlos Enrique Lares-Ponce, National Chamber of Transformation Industry CANACINTRA
Gustavo Almada-Bórquez, National Chamber of Commerce CANACO
Marcel Alvarez-O'Donnal, Director at Trento Industrial Parks of Sonora
Rodolfo Rodríguez, President of USPRUSS
Antonio Gándara, President of PIEAES
Manuel Valenzuela, Director of PIEAES
Jesus Villaseñor, Director of AOASS
Ramon Romero, Director General of Riego District Manuel Cazares, National President of Tomato Product System (Presidente Nacional del Sistema Producto Tomate)
Gustavo Luders, Citrus Producer (Productor Citrícola)
Marco Antonio Fuerte Gaytán, Counsellor of the Cajeme Union
Luis A Cruz Carrillo, Counsellor of UCAY
Eduardo Pedroza, State President of the Potato Producer System
Miguel A. Gonzalez Hernández, Treasurer of the Directive Council of) COSAES
Miguel Angel Castro Cossío, Secretary of the Directive Council of COSAES
Arturo A Pérez Romero, President of Canirac

13.00 – 17.00 OECD review team internal meeting

17.00 – 18.00 **Feedback from the OECD review team**

Vicente Pacheco-Castañeda, Secretary for Upper Secondary and Higher Education in Sonora
Rogelio Noriega-Vargas, Director for Upper Secondary and Higher Education in Sonora
Sandra Elena Gutiérrez-Preciado, General Director for Higher Education in Sonora
Gerardo Ochoa-Salcido, State of Sonora Commission for Higher Education Planning
Mario César Cuen-Aranda, State Treasurer, Sonora Treasury Ministry
Samuel Espinoza-Guillén, President, CESUES
Miguel Ángel Salazar-Candia, President, Technological University of Hermosillo
Adolfo Rivera-Castillo, President, Technological Institute of Hermosillo

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