

**Higher Education in Regional and City
Development**

The Paso del Norte Region, Mexico and the United States



Higher Education in Regional and City Development

The Paso del Norte Region, Mexico and the United States



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ISBN 978-92-64-08888-7 (PDF)

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Foreword

Universities and other higher education institutions can play a key role in human capital development and innovation systems in their cities and regions. Reviews of Higher Education in Regional and City Development are the OECD's vehicle to mobilise higher education for economic, social and cultural development of cities and regions. They analyse how the higher education system impacts local and regional development and assist in improving this contribution. In addition to human capital and skills development, technology transfer and business innovation, the reviews also examine higher education's contribution to social, cultural and environmental development and regional capacity building. The review process facilitates partnership building in regions by drawing together higher education institutions and public and private agencies to identify strategic goals and work together towards them. To know more about the OECD review process and requirements visit the Higher Education and Regions website at www.oecd.org/edu/imhe/regionaldevelopment.

These reviews are part of a wider multi-annum work of higher education in cities and regions coordinated by the OECD Programme on Institutional Management of Higher Education (IMHE). In 2004-07, the OECD/IMHE conducted an extensive study with fourteen regional reviews across twelve countries. This resulted in the OECD flagship publication *Higher Education and Regions: Globally Competitive, Locally Engaged* (OECD, 2007) with recommendations to benefit both higher education institutions and national and regional governments. In 2008, the OECD/IMHE launched a second series of OECD Reviews of Higher Education in Regional and City Development to address the demand by national and regional governments for more responsive and active higher education institutions. As a result, 14 regions in eight OECD countries and three non-member economies underwent the OECD review process in 2008-10. The reviews were carried out by the OECD/IMHE in collaboration with international organisations and associations and other OECD programmes and directorates. This work also supports the OECD Innovation Strategy and OECD Green Growth Strategy.

This OECD review of the Paso del Norte Region in the United States and Mexico is part of the second round of OECD reviews of Higher Education in Regional and City Development. This bicultural and bilingual cross border region faces specific challenges to move away from the low-skill, low-wage economy towards knowledge-based economy.

Acknowledgements

Numerous regional stakeholders and representatives of higher education institutions provided valuable insights during the review visit and in the form of comments. The OECD would like to thank in particular to the Hunt Family Foundation, the lead coordinators and other active local counterparts for this review: Lisa Muñoz-Colquitt, Jorge A. Ramos, Eduardo A. Rodriguez, Richard Rhodes, Mario Blanco, Saul Candelas, Bob Cook, Jaime Farias, Vickie Galindo, Dolores Gross, Richard Jarvis, Robert Nachtmann, Lydia Nesbitt, Enrique Portillo and Joyce Ritchey. Additional thanks to the leadership and staff of the following institutions: The Autonomous University of Ciudad Juárez (UACJ), the Centre for High Tech Training (CENALTEC), Doña Ana Community College (DACC), El Paso Community College (EPCC), New Mexico State University (NMSU), Regional Economic Development Corporation (REDCo), Tecnológico de Monterrey (ITESM), Texas Tech Health Sciences Center and the University of Texas at El Paso (UTEP).

This publication draws on interviews carried out during a week-long review visit in 25-31 October 2009, on the findings of the Paso del Norte Region's Self-Evaluation Report and using additional information provided to the review team. The OECD Review Team had a full and intensive programme and was received openly by a wide range of stakeholders. The team had the benefit of an extensive and reflective Self-Evaluation Report. The report went beyond description to postulate a number of hypotheses about regional strengths and weaknesses, which the team members were able to test. The team was also able to rely on a range of other reports, including the NCHEMS Publication *Higher Education and the Economic Future of El Paso* (2007).

This publication was co-ordinated by Jaana Puukka (OECD Programme for Institutional Management in Higher Education, IMHE), with support from Ernesto Flores, a Mexican national who joined the OECD in 2009 on a 15-month secondment. The other members of the Peer Review Team were: Susan Christopherson (Cornell University, US), Carlos Baradello (University of San Francisco, US), Francisco Marmolejo (CONAHEC, Consortium for North American Higher Education Collaboration) and

Alessandra Proto (OECD/LEED Trento Centre for Local Development). Further details about the Review Team can be found in Annex 1 of this report. Rachel Linden supervised the publication process and Fionnuala Canning and Austin Delaney provided invaluable assistance in the editing phase.

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List of acronyms

ACE	American Council on Education
AERI	Alliances and Innovation Networks for Competitiveness
AES	Agricultural Experiment Station
ANUIES	Mexican Association of Universities
AMCDPE	<i>Asociación Mexicana de Centros para el Desarrollo de la Pequeña Empresa</i> Mexican Association of Small Business Development Centres
ASME	American Society of Mechanical Engineers
ATCP	Alternative Teacher Certification Program
ATI	Arrowhead Technology Incubator
ATP	Advanced Technology Program
BIEM	Brandenburg Institute for Entrepreneurship and SMEs
BNSL	Bi-National Sustainability Laboratory
BRIDGE	Bridging Rigorous Independence with Guidance to Higher Education
BTU Cottbus	<i>Brandenburgische Technische Universität Cottbus</i> Brandenburg University of Technology Cottbus
CDSR	Centre for Defense Systems Research
CENALTEC	Centre for High Tech Training
CENDE	Centre for Corporate Development
CERM	Centre for Environmental Resource Management (University of Texas at El Paso)
CES	Cooperative Extension Service
CETYS	<i>Centro de Enseñanza Técnica y Superior</i> Centre for Technical and Higher Studies
CEUR	The Centre for Urban and Regional Studies
CIDE	Centre for Economic Teaching and Research
CIDS	Centre for Inland Desalination Systems
CIMAV	Centre for Research of Advanced Materials
CINESTAV	Research and Advanced Studies Centre of the National Polytechnic Institute of Mexico
CODECH	Council for Economic Development for Chihuahua State
CODER	<i>Consejo de Desarrollo Económico Regional</i> Council for Regional Economic Development

COEPES	State Commission for Higher Education Planning
COLEF	<i>Colegio de la Frontera Norte</i> The College of the Northern Border
CONAHEC	Consortium for North American Higher Education Collaboration
CONACYT	National Council for Science and Technology
CONAGUA	National Commission for Water Resources
CONAPO	<i>Consejo Nacional de Población</i> National Population Centre
CONEVAL	<i>Consejo Nacional de Evaluación de la Política de Desarrollo Social</i> National Centre for the Evaluation of Social Development Policies
COVAP	Consejo de Vinculación Académico-Productiva
CREIE	Centre for Research, Entrepreneurship and Innovative Enterprises
DACC	Doña Ana Community College
DECJ	Ciudad Juárez Economic Development Corporation
DOE	United States Department of Energy
EDA	Economic Development Administration
EPA	US Department of Commerce Environmental Protection Agency
EPCC	El Paso Community College
ESPCoR	Experimental Program to Stimulate Competitive Research
ETF	Texas Emerging Technology Fund
EUR	Euro
FAA	Federal Aviation Administration
FAST	Future Aerospace & Technology Centre
FDI	Foreign Direct Investment
FECHAC	<i>Fundación del Empresariado Chihuahuense</i> Chihuahua's Businesspeople Foundation
FIAC	<i>Fondo de Innovación Académica</i> Academic Innovation Fund
FIPSE	Fund for the Improvement of Postsecondary Education
FOMIX	<i>Fondos Mixtos</i> Mixed Funds Programme
FORDECYT	Institutional Fund for Regional Development through the promotion of Science, Technology and Innovation
FUMEC	US – Mexico Science Foundation
GAESD	Group on Applied Engineering for Sustainable Development
GAO	US Government General Accounting Office
GBP	British pound
GDP	Gross Domestic Product
GED	Graduate Education Development Diploma
GIS	Geographic Information Systems
HACU	Hispanic Association of Colleges and Universities
HEFCE	Higher Education Funding Council for England

HEI	Higher Education Institution
HERD	Higher Education Expenditure on Research and Development
HRSDC	Canadian Human Resources and Skills Development
ICEED	International Consortium for Education and Economic Development
ICHEA	Chihuahua Institute for Adult Education
ICT	Information and Communication Technologies
IDE	<i>Instituto para el Desarrollo de Emprendedores</i> Institute for Entrepreneurial Development
IDEAL	Innovative Digital Education and Learning
IGER	Institute for Grassland and Environmental Research
IMHE	OECD Programme on Institutional Management in Higher Education
IMPI	Mexican Institute of Industrial Property
INADET	Instituto de Apoyo al Desarrollo Tecnológico Technological Development Support Institute
IOED	Research for Development of Strategic Opportunities
IP	Intellectual Property
IPED	Institute for Policy and Economic Development
IPN	National Polytechnic University
ITCJ	Technological Institute of Ciudad Juárez
ITESM	Tecnológico de Monterrey Monterrey Tech
JAC	Joint Advisory Committee
K-12	Kindergarten through 12th Grade
KENTEQ	Metal-mechanics Training Centre
KTN	Knowledge Transfer Networks
LANL	Los Alamos National Labs
LEED	Leadership in Engineering and Environmental Design
MEMS	Micro-Electro-Mechanical System
MEP	Manufacturing Extension Partnership
MIT	Massachusetts Institute of Technology
MSA	Metropolitan Statistical Area
MVEDA	Mesilla Valley Economic Development Alliance
NAFTA	North American Free Trade Agreement
NAMP	North American Mobility Programme
NASA	National Aeronautics and Space Administration
NCACS	North Central Association of Colleges and Schools
NCHEMS	National Center for Higher Education Management Systems
NEC	US National Economic Council
NGO	Non-Governmental Organisation
NIH	National Institute of Health
NIMS	US Institute for Metalworking Skills

NIST	National Institute for Science and Technology
NMHED	New Mexico Higher Education Department
NMSU	New Mexico State University
NCPSO	New Mexico/Chihuahua Programme Support Office, New Mexico State University
OCR	Office of Corporate Relations (University of Wisconsin)
OECD	Organisation for Economic Cooperation and Development
OPIE	Office for the Promotion of Innovation and Entrepreneurship
ORSP	Office of Research and Sponsored Projects
OSI	Office of the Strategic Initiatives
PACES	Pan-American Center for Earth and Environmental Studies
PAHO	Pan American Health Organization
PBL	Problem Based Learning
PIADET	Applied Research and Technological Development Program for Small Business
PISA	OECD Programme for International Student Assessment
PNP	National Registry of Graduate Students
POL	Project Oriented Learning
PPP	Purchasing Power Parity
PROMEP	Faculty Enhancement Programme
PYME	Pequeña y Mediana Empresa Small and Medium-sized Enterprises
RBL	Research Based Learning
RCIC	Regional Center of Innovation and Commercialization
REDCo	Regional Economic Development Corporation
RIMES	Research Institute for Manufacturing and Systems Engineering
RITTS	Regional Innovation and Technology Transfer Strategy
RMAERA	Rocky Mountain Area Educational Research Association
ROC	Regional Training Centre
RSC	Regional Stakeholders Committee
SA	Spaceport America, New Mexico
SACS	Southern Association of Colleges and Schools
SATOP	NASA's Space Alliance Technology Outreach Program
SBDC	Small Business Development Center
SBIC	Small Business Investment Company program
SBIR	Small Business Innovation Research program
SDSU	San Diego State University
SEMARNAT	Ministry of Marine Life & Natural Resources
SEP	Secretaría de Educación Pública Mexican Ministry of Public Education
SME	Small and Medium-sized Enterprises
SNTE	Sindicato Nacional de Trabajadores de la Educación National Union of Education Workers

SNI	Sistema Nacional de Investigadores National System of Researchers
SNL	Sandia National Labs
STEM	Science, Technology, Engineering and Math
STI	Science, Technology and Innovation
STTR	Small Business Technology Transfer Program
SUT	Swinburne University of Technology (Australia)
SWC	Southwestern College
TAAC	Technical Analysis and Applications Centre
TEF	Texas Enterprise Fund
THECB	Texas Higher Education Coordinating Board
TIES	Training, Internships, Exchanges and Scholarships Programme (known as TIES-Partnership Programme)
TRADOC	US Army Training and Doctrine Command
TSB	Technology Strategy Board
TSU	Técnico Superior Universitario University Technician degree
TTHSC	Texas Tech Health Sciences Center
TTO	Technology Transfer Office
TxDOT	Texas Department of Transportation
UABC	Autonomous University of Baja California
UACH	Autonomous University of Chihuahua
UACJ	Autonomous University of Ciudad Juárez
UAM	Autonomous Metropolitan University
UAS	Unmanned Aerial Systems
UILO	University-Industry Liaison Office (University of British Columbia)
UNAM	Universidad Nacional Autónoma de México National Autonomous University of Mexico
UNM	University of New Mexico
URGWDB	Upper Rio Grande Workforce Development Board
USAID	US Agency for International Development
USDE	US Department of Education
USDOC	US Department of Commerce
USMBHA	US-Mexico Border Health Association
UTCJ	Technological University of Ciudad Juárez
UT	The University of Texas
UTEP	The University of Texas at El Paso
UTEP-SON	The University of Texas at El Paso School of Nursing
WARF	Wisconsin Alumni Research Foundation
WF/ED	Workforce Education
WICHE	Western Interstate Commission for Higher Education
WSMR	White Sands Mission Range

Assessment and recommendations

The Paso del Norte Region: moving from low wages towards a knowledge based economy

With a population of 2.4 million, the metropolitan area of Paso del Norte is one of the largest international cross border regions in the world and the largest metropolitan area on the border between the United States and Mexico. This region is also a major economic centre with three important urban areas: the City of El Paso in Texas, the City of Las Cruces in New Mexico and Ciudad Juárez in Chihuahua. The region provides a “preview” of the future for the United States: the Hispanic population in the US is projected to grow from 15% to approximately 30% by 2050.

The Paso del Norte Region features considerable intra-regional differences in its industrial make-up. 60% of the Ciudad Juárez labour force is employed in manufacturing, and the city constitutes one of the largest manufacturing centres in the world. Other sectors of the economy, including business services, trade, and transportation, support the dominant manufacturing sector. On the US side, the El Paso economy is more diversified, with a relatively large public sector. El Paso’s hospitality sector, trade and business services are interconnected with the manufacturing strength of Ciudad Juárez. There are also supplier linkages between the manufacturing industries in the two cities. Las Cruces in New Mexico is smaller in size but has a higher proportion of knowledge workers because of government defence and research facilities in Doña Ana and Otero Counties.

Since the implementation of the North American Free Trade Agreement (NAFTA), and in connection with the recent recession, the Paso del Norte Region has experienced fast population growth. The total population increased from 1 568 571 in 1990, to 2 385 695 in 2008, a growth rate of 52%. On the Mexican side the growth has been spectacular –73% compared to 37% for the US side. In large part, this growth reflects population migration in search of employment. Because of the influx of a low skilled population, the Paso del Norte Region continues to be characterised by structural weaknesses and remains primarily in a low skills equilibrium. The

economic performance on both sides of the border region is considerably below the OECD averages. Poverty remains a widespread problem both on the Mexican and US sides of the border and is a drag on the region's competitiveness. Health problems related to a low-income population, environmental degradation, and continuing violence jeopardise the long-term competitiveness of the region.

The major challenge for the Paso del Norte Region and its higher education institutions is to develop effective human capital development and innovation systems that can operate across the bi-national, tri-state region. The two larger cities, Ciudad Juárez and El Paso, are building the resources and institutions that can form the basis of future growth and development. However, to date, the regional innovation and human capital development system remains under-developed. The current drug-related violence on the Mexican side and the US focus on border security undermine the impetus to build a cohesive bi-national region.

The current extent of regionally relevant activities by higher education institutions in the Paso del Norte Region, including industry collaboration, widening access initiatives and entrepreneurship activities, are limited to sub-regional levels and not fully reflected at the regional cross border level. There are also gaps in important areas such as lifelong learning, entrepreneurship education and support for small and medium-sized enterprises. In this context, the key challenges for the Paso del Norte Region and its higher education institutions are the following:

- How to improve the overall educational attainment levels and increase the flexibility of the population to face rapid changes in the labour market?
- How to develop the HE knowledge base and collaboration within and between institutions that promote regional development?
- How to promote new business formation?
- How to leverage the current economic base and focus on a few world class competencies?
- How to address the considerable health and environmental challenges in the cross border region?

To address these challenges, the Paso del Norte Region needs more concerted efforts on cross border regional development, including a master plan with vision, goals, milestones, co-ordination measures and a robust evidence base. A more enabling environment needs to be created for new business formation and for upgrading the current low skilled economy. The good practice examples currently seen within the region – in widening

access to higher education and educational retention as well and industry-university collaboration – should be disseminated, extended and scaled up. Enhanced employability, job creation and access to employment opportunities should be seen as the primary goals of innovation and human capital development. In addition, higher education institutions should view the region as a “laboratory” for challenge-driven research and community outreach.

Human capital development in the Paso del Norte Region

The ability to fuel local growth by cultivating relevant skills is the best guarantee that the region will thrive in future. A region that wants to be globally competitive needs to have a highly skilled workforce and knowledge-based economy In order to break out of the low wage equilibrium The Paso del Norte Region needs to improve the educational attainment levels and widen access to higher education ...

There are considerable disparities across the Paso del Norte Region, which may narrow over time with the wages in El Paso levelling out or decreasing and the wages on the Mexican side increasing. On the US side the tendency in the past has been to attract low skill/low-wage jobs that do not do enough to diversify the region’s job skills level. The low skill/low wage propensity is, however, a self-defeating strategy not only to El Paso and Las Cruces, but also to the entire cross border region.

However, educational attainment levels limit the region’s ability to develop and attract high value economic opportunities. On the US side of the border the higher education attainment levels (associates degree and above) lag behind that of New Mexico (33.5%), Texas (31.7% and the United States 35.5%) as only 27.5% of the region’s population (aged 25 years and older) have an associates degree or higher in 2008. In the State of Chihuahua and Ciudad Juárez in Mexico, educational attainment levels are improving rapidly, and while higher than in many Mexican states, remain considerably below that of the US side of the region. Tertiary education attainment rates in Mexico are generally low: in 2007, only 15.9% of the population aged 25-64 had completed post-secondary education compared to the OECD average of 27.5% (OECD, 2009a).

... the El Paso Collaborative for Academic Excellence has achieved measurable improvements in school retention and widening access. This model of long-term multi-stakeholder collaboration needs to be underpinned with sustainable funding and extended across the region ...

The El Paso Collaborative for Academic Excellence has brought together educational institutions and the public and private sector stakeholders in a long-term concerted effort to improve retention and widen access in El Paso. The collaborative has made systematic changes in educational policy and curriculum to decrease the achievement gap across ethnic and socioeconomic groups. It has embraced all the twelve El Paso School Districts and produced measurable improvements in the performance of Hispanic students that make up 89% of the student population in El Paso. As a result, the educational attainment of the regional workforce significantly improved between 2000 and 2009. The proportion of the population with a high school (secondary) degree increased from 66% to 72% of the population and the proportion of the population with a bachelor's degree or higher increased from 17% to 20%. While this progress is commendable, higher education attainment still remains below the national average and also that of the States of Texas and New Mexico. There is a need to scale up the efforts of the Collaborative and support them up with sustainable funding to ensure long term impact. Programmes to widen access to higher education are also present in Las Cruces and at New Mexico State University (NMSU) but they play a less prominent role than in El Paso.

On the Mexican side of the border, higher education institutions have a more limited approach to widening access. For example the leading higher education institution, the Autonomous University of Ciudad Juárez (UACJ), maintains that its capacity to move forward in this area is limited by space constraints. Increasing and widening access to higher education in Ciudad Juárez is, however, necessary in order to make improvements in the local and regional economy. They are also necessary to enhance the flexibility of the population to adjust to changes in the labour market. Strong efforts should be made to extend the existing good practice examples in the region across the border.

...Despite the progress made, the region continues to lose educated workforce, particularly engineers and scientist. Strong

efforts should be made to link students with the local industry and to improve entrepreneurship education...

The Paso del Norte Region faces difficulties in retaining an educated workforce. El Paso is a net exporter of educated workers, particularly in the fields of engineering and computer sciences. A large number of the graduates of the University of Texas at El Paso (UTEP) in science, technology, engineering and mathematics are recruited by national and international companies outside the region. Renowned for its ability to educate Hispanic engineers, 75% of UTEP engineering graduates leave the region. Similarly the graduates of the New Mexico State University (NMSU) are recruited by business across the world. Ciudad Juárez is experiencing a significant brain drain as graduates are finding employment outside the region.

To improve graduate retention and the quality and attractiveness of local jobs, the region should consider better alignment of their educational programmes with the regional needs. Stronger efforts should be made to establish programmes to link all students, graduates and post-graduates with the local industry. Creating stronger ties between students and regional employers through internships and co-operative programmes should be made a priority. Higher education institutions have established various forms of work-based learning opportunities and entrepreneurship training for their students. However, only a portion of the students have exposure to this type of learning opportunities.

Las Cruces has a strong focus on industry skill development. The approach to human capital development in the higher education institutions in New Mexico has focused specifically on training for knowledge intensive jobs influenced in part by the labour demand in near-by defence establishments such as The White Sands Missile Range. The Arrowhead Center focuses on building new firms related to industry strengths in the region and provides a wide the range of services available to entrepreneurs and small firms. The Doña Ana Community College (DACC), adjacent to the New Mexico State University campus, provides technical training in skills related to industries in the region including automotive technology, digital graphics technology, electronics technology and welding. This industry skill development orientation is unusual in the US context and reflects both the high demand for medium-skilled labour in the defence facilities and suppliers in the Las Cruces area and a cooperative approach between employers and technical training providers.

On the Mexican side, the Chihuahua State has invested in “triple helix” collaboration bringing together the government, academia and industry. It

has also developed a range of mechanisms to improve human capital development in the state, including the establishment of training institutions. For example COVAP, an industry-academia liaison council helps match the supply and demand for highly skilled labour in selected enabling industries. CENALTEC focuses on sector-based skilled workforce training and provides process improvements in small businesses. It responds directly to the demand for more skilled workers in the *maquila* sector and in the regional economy. It contributes to localised learning and overall human capital development in the region and exemplifies best practice in skilled workforce training because it is organised around specifically defined industry skill needs and engages firms and trade groups directly and over time to ensure that training programmes change as firm skill needs change. Both CENALTEC and the Autonomous University of Ciudad Juárez are involved in “triple helix” type sectoral strategies in which a higher education institution and technical training institutes work in close interaction with industry to provide a technically skilled workforce and continuous improvements in productivity.

While the focus on continuous skills development in Ciudad Juárez for the benefit of the industry is commendable, too narrow skills development will not serve the population and the region 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. Considerable efforts should be made by the state and local government and educational institutions to raise the levels of education attainment. There is a need for comprehensive long-term efforts to increase completion rates in secondary education and the preparation of both youth and adult population for further education. Widening access to higher education will require multi-stakeholder collaboration between higher education institutions, schools and government.

The following measures would promote human capital development in the Paso del Norte Region:

- A wider portfolio of robust data related to the regional context and the situation of individual higher education institutions should be developed in the Paso del Norte Region to support evidence-based decision making and targeted efforts to address human capital development needs. The most effective region-wide graduate labour market systems are based on the collection of comprehensive labour market intelligence, on-line publication of the data in a single place to improve students’ ability to make rational choices about their studies and to help graduates and employers come together and

move students into employment. Efficient systems also use data strategically to identify regional priorities and at an institutional level, to respond to the data in terms of course provision and the provision of employer specified skills.

- The Paso del Norte Group, higher education institutions, other educational institutions and key stakeholders of the economy and society should work together to establish a Strategic Plan for Regional Human Capital Development which outlines region-wide goals, policies and priorities extending from primary to tertiary education and beyond. To form the basis for regional comparative advantage this strategy should build on the strengths of the higher education institutions *i.e.* the widening access agenda in El Paso, industry skill development in Las Cruces and “triple helix” collaboration to improve productivity in industry in Ciudad Juárez. Regional policy makers should draw on the experiences from each “model” and identify ways to extend these activities to the region as a whole. The challenge is to selectively build on these strengths in order to disseminate the knowledge they represent across the region and to select projects for cooperative efforts that take advantage of the strengths of the higher education institutions, while recognising limits and barriers inherent in different institutional contexts. As part of this strategic plan, a higher education coordinating body should be established to define goals, policies and priorities.
- Higher education institutions should continue and expand efforts to increase the enrolment and success of first generation students. These efforts should build upon existing successful models of widening access, effective support services for students, including both academic and social supports and learner-centred teaching methods. Higher education institutions and governments on both sides of the border should increase financial assistance to low income students, including both institutional aid and state aid. The Paso del Norte Region should replicate the El Paso model for improving performance and widening access to higher education throughout the region. Higher education institutions’ lifelong learning activities should be strengthened and they should improve their capacity to provide up-skilling and re-skilling for the adult population who combine work and study or are unemployed.
- Ciudad Juárez needs to develop a comprehensive long-term strategy to increase completion rates in secondary education and the preparation of both youth and adult population for further education. Widening access to higher education will require multi-stakeholder

collaboration between higher education institutions, primary and secondary schools and government. 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.

- Significant multi-stakeholder public-private efforts should be made to boost entrepreneurship, business formation and business development. Higher education institutions should focus on strengthening the regional employability and entrepreneurial skills of all graduates. Creating ties between students in fields of critical importance to the region and regional employers through internships and co-op programmes should be made a priority. Experiential, work- and problem-based learning methods embedded in learning programmes to build entrepreneurship skills should be developed to improve graduate retention in the region. Similarly, efforts in dual language learning should be stepped up to assist the region in its internationalisation efforts.
- Incentive structures could be strengthened to encourage higher education institutions and their staff to engage in activities benefiting regional and local development and entrepreneurship activities. Discretionary funds should be established for supporting projects of various kinds of teaching-related activities that include interaction between the higher education system and the community.
- The industry or sectoral orientation should be extended to human capital development in order to galvanise technical training in Ciudad Juárez, El Paso and Las Cruces around cluster-based manufacturing and manufacturing services. The workforce development system should be adapted to the needs of small firms and to the development of companies in place. The Workforce Investment Board Report for El Paso (2008) focuses on cluster development, for example, an approach that when applied to human capital development is consistent with the sectoral approach being undertaken in Ciudad Juárez through CENALTEC. The Arrowhead Center appears to have made the most progress in working on an industry-based, small firm-oriented human capital development strategy.

Innovation in the Paso del Norte Region

... The United States provides favourable framework conditions for business formation, innovation and small business development. Faced with global financial crisis, the government has taken on a stronger role to support innovation ...

The universities in the Paso del Norte region have both advantages and challenges arising from the national context in which they operate and the character of their national innovation systems. The United States has led the way in developing pro-innovation policies and small business development. It was the first country in the world to offer companies a R&D tax credit and, through the 1980 Bayh-Dole Act, the first to allow universities to patent products originating from federal R&D funds. The technology licensing offices of the Massachusetts Institute of Technology (MIT) and Stanford University are global leaders in commercialising university research. The totemic examples of the Silicon Valley or Route 128 continue to inspire many regions and their higher education institutions worldwide.

Despite the favourable conditions, most US university technology licensing/transfer offices generate less licensing revenue for the university than the cost of their operations. Many universities have focused on technology transfer or developing revenue streams from products that have limited or no relation to the regional economy. As a result, most second-tier universities have not been successful in building regional clusters and innovation systems.

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

While many US state and local governments have established technology-based economic development programmes to promote innovation, these programmes often remain focused on the same high-technology industries regardless of whether they are suited to the regional and local economies (Wial, 2009). The Texas Emerging Technology Fund (ETF) provides financial support that boosts innovation for example through industry-university partnerships. The regional economic development agencies on the US side of the Paso del Norte Region – the El Paso Regional Economic Development Corporation (REDCo) and the Mesilla Valley Economic Development Alliance (MVEDA) – see their main role as attracting inward investment and serving industry that is relocating or expanding in their respective sub-regions.

In Mexico, national policies do not yet sufficiently support regional innovation systems or clusters. While programmes are in place to improve knowledge transfer and university-industry collaboration, there is a need for co-ordinated regional development policy approach ...

In Mexico, current efforts for regional development focus on poverty and infrastructure rather than competitiveness. Only a few enterprise-related policies take regional specificities into account while most sectoral programmes are place-blind, that is they do not build on comparative advantage. Although Science, Technology and Innovation (STI) Policy is increasingly recognising the importance of regional innovation systems, the concentration of resources in the capital slows down capacity building at the state and sub-national levels. The National Science and Technology Council (CONACYT) has taken measures to foster knowledge transfer and university-industry collaboration through different programmes, including the Mixed Funds Programme (Fondos Mixtos), Alliances and Innovation Networks for Competitiveness (AERIs), the Institutional Fund for Regional Development (FORDECYT) and a programme with the Mexican Institute for Intellectual Property (IMPI) to support technology transfer offices. In the State of Chihuahua, the Chihuahua Council for Economic Development (Consejo de Desarrollo Económico de Chihuahua), CODECH, leads the “triple helix” collaboration between academia, government and private sector.

The United States has a strong focus on small business development and effective programmes such as the Small Business Innovation Research Program. Mexico is also building its capacity in business development through support programmes...

Entrepreneurship plays an important role in generating innovation and stimulating growth. The US Small Business Development Centers (SBDCs) have a 30-year track record as an SME service network, with 1 100 centres located in higher education institutions, which annually serve 750 000 SMEs. The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programmes award USD 2 billion to small high-tech businesses every year. Established in 1982, SBIR is today the largest US innovation partnership and benefits from a stable budget: 2.5% of federal agencies' R&D budget has been set aside for grants or contracts with small businesses. It has helped new firms cross the “valley of death” and created a “demand pull” within SMEs by encouraging them to evaluate the commercial potential of research results. In El Paso, the Small Business Development Center is administered by the El Paso Community College.

Compared to the United States, new business formation in Mexico faces more difficult challenges. The Mexican Small and Medium-sized Enterprise Policy includes programmes that encourage university-industry collaboration and innovation, for example through the Fondo PYME (SME Fund) and the Programme for Innovation and Technology Development that funds business accelerators and innovation laboratories, often housed in higher education institutions. The State of Chihuahua has launched the Applied Research and Technological Development Program for Small Businesses (PIADET) to promote collaboration between small businesses and local or national research institutes and higher education institutions. Following the US model, Small Business Development Centers (SBDCs) have been created in Mexico. Currently there are no SBDCs belonging to the Mexican Association of Small Business Development Centres' network in Ciudad Juárez whereas the City of Chihuahua has four.

Despite favourable framework conditions, particularly on the US side, the innovation outcomes in the Paso del Norte Region remain modest...

The Paso del Norte Region combines many of the characteristics of peripheral and old industrial regions, which have been identified as being less innovative when compared with more central and agglomerated regions. The key challenges are a lack of dynamic clusters, a low level of R&D and innovation, and small and medium-sized enterprises (SMEs) in traditional sectors and/or branch plants with limited absorptive capacity. There is also a low level of networking and idea circulation and the innovation support institutions have limited infrastructure and capacity.

The US side of the region is a home to a number of defence-oriented organisations that could potentially play an important role in the regional innovation system by generating or using R&D and offering employment opportunities to high skilled personnel. While Fort Bliss has taken steps to reach out to the community, the economic impact of military related activities remains low due to the limited interaction with the regional community. In addition, the projected mix of military forces at Fort Bliss, increase in combat troops and decrease in the number of officers, makes it harder to attract more highly educated people to the region.

The research programmes in the US universities of the Paso del Norte Region support the defence and border security industry, but also have a wider emphasis, embracing border health and environmental sustainability. The universities have defined research fields that facilitate multidisciplinary work, respond to the regional needs and provide advantages in seeking state or federal funding. There is considerable overlap and potential for synergies. For example while the New Mexico State University (NMSU) has defined five research clusters, including biosciences; information sciences and security systems; natural resources sustainability and renewal; the Southwest border region's health, education, culture; and the development of 21st century aerospace, the University of Texas at El Paso (UTEP) has a focus on the environment, particularly air and water quality, Hispanic health disparities, border security and immigration, transportation and community health. In the future it will be important to enhance the regional focus of NMSU and UTEP research and mobilise the universities' collaborative efforts for regional development.

Currently, the universities have a tendency to measure success in innovation by the amount of (public) investment made, not the amount of commercial return generated or jobs created. This could be remedied by constructing efficiency/performance indicators for public agencies including

higher education institutions, such as time to process project applications and administrative costs for the programmes.

The development in the US side of the Paso del Norte Region is increasingly dependent on the investments from federal government on border security, defence, health and environment. The large public role in the regional innovation system could move the idea of innovation away from “commercially useful knowledge” towards a broader definition of generating “new knowledge.” Special consideration should be given to ensure that publicly-driven innovation system will not negatively impact entrepreneurship attitudes and delay the emergence of private sources of capital for innovation. Until recently El Paso was one of the few cities of its size in the United States without a venture capital group. The launch of Cottonwood in November 2009 is particularly welcome as it bridges the “valley of death” for innovative start ups by focusing on seed money in the range of USD 500 000 to USD 1 million.

Broadening the sectoral orientation and the disciplines that underpin engagement could be beneficial for large and growing clusters in the service sector. At the moment, industrial engagement is seen by the university faculty as a science and engineering pursuit rather than a role that could be embraced by the entire university community including business schools, social sciences and the humanities. For example border security could be seen in broader terms in order to ensure sustainable border conditions and cross border collaboration. A sector such as tourism is rarely seen as a focus for university activity but could be a focus for research, work-based learning and outreach.

... Ciudad Juárez and the State of Chihuahua have excelled in “Triple Helix” collaboration to upgrade and develop industry skills. Higher education institutions have focused their research on leading edge R&D and collaboration with big companies. The “City of Knowledge” aims to develop a high-tech knowledge hub with the capacity to draw foreign investment and impact regional development. Care should be taken to ensure that it will benefit not only big companies, but also small and medium sized enterprises and new business formation ...

Ciudad Juárez, the largest manufacturing region in North America and the leading *maquila* city in Latin America, has approximately 345 *maquila*

facilities that were owned and operated by more than 200 multinational corporations, which focus primarily on the automotive and ICT/software industry. As global operations, they can purchase the R&D anywhere in the world and do not rely on obtaining it from the local higher education institutions. Many plants are also driven exclusively by cost competition. In order to maintain plant loyalty to the region, the regional government aims to ensure that opportunities for skills development and labour market training are in place to produce continuous productivity increases.

The Chihuahua State has invested in “triple helix” collaboration between the government, academia and industry. It has developed multiple mechanisms to facilitate cluster development mainly through targeted skills improvement. The higher education institutions support the state government’s ambitions by focusing on high-end research. The Monterrey Tech is working towards the diversification of the regional economy and collaborates in close partnership with manufacturing centres and *maquiladoras*, with the aim of bringing leading edge R&D to the region. The Autonomous University of Ciudad Juárez (UACJ) has a focus on collaborating with the leading industries in the region through R&D and provision of co-operative work-based learning opportunities, mainly in the field of engineering. There is a growing understanding among the higher education institutions of the opportunities for “bespoke” industry courses and the contribution of university research to addressing industry and business problems. While focus on the “high end” of R&D is important, it is not a sufficient approach to economic development and should not be carried out at the expense of strong undergraduate programmes.

The development of the new campus “Ciudad del Conocimiento” (the City of Knowledge) for the Autonomous University of Ciudad Juárez will bring together the key higher education institutions in Mexico and state government in order to form a major knowledge hub with the capacity to draw foreign direct investment and to impact regional economic development. The City of Knowledge will provide an opportunity to widen the access to the university. The challenge is to ensure that the investments in real estate will underpin enhanced knowledge exchange and innovation for the benefit of regional development and integrate and sustain the wider effort over time. There is also scope to expand the collaboration with the higher education institutions on the other side of the Rio Grande, in view of the broader development needs of the region. Future challenges include ensuring that both students and graduates are engaged in entrepreneurial activities, that a pipeline of spin-off firms and graduate start-ups is developed and that effective support is delivered to small and medium-sized enterprises and not only larger firms.

Higher education institutions have each developed their own mechanisms for engaging with business and industry, and the US universities have gone down the route of having dedicated offices for technology transfer and intellectual property. Stronger impacts could be achieved through concerted efforts of universities....

The existing technology transfer or licensing offices (TTOs and TLOs) in the Paso del Norte US universities lack the economies of scale or scope to optimally commercialise faculty innovations and the scale of commercialisation activity remains relatively low. As with TTOs and TLOs in the United States, it can be expected that the existing technology licensing offices actually may lose money. It can also be expected that much of the current activity involves commercialisation outside the region. On the Mexican side, the legal basis for intellectual property protection is not yet fully developed. As a consequence, internal procedures or policies to address intellectual property rights as well as incubation programmes are at early stages of development in many Mexican higher education institutions.

Given the limited scope of the revenues generated by the technology transfer offices, broadening the understanding of knowledge transfer, knowledge utilisation and exploitation would be useful. By focusing on how the university research can support jobs, industry productivity and innovation in the region, the university technology transfer offices could move to a system that is based on developing continuous partnerships with regional industry, government and other partners. The new approach should embrace working to further develop open access/open source systems and inventions that have low revenue potential but high societal return.

In the United States small businesses employ 30% of high tech workers such as scientists, engineers and information technology workers. Spin-off companies are also often likely to be locally based and have a local economic benefit. The current rate of business formation in the Paso del Norte Region appears to be modest and the Paso del Norte universities are not prominent in fostering new enterprises in the region. Efforts in entrepreneurial activities and entrepreneurship education are in an early phase of development. This is reflected in the limited breadth and refinement of entrepreneurship education activities in the higher education institutions and the small proportion of students benefiting from them.

Collaborative mechanisms between the higher education institutions in the Paso del Norte Region to boost innovation, business incubation and development remain limited, with the exception of the Bi-National

Sustainability Laboratory (BNSL) that brings together Sandia National Laboratories, the US-Mexico Foundation for Science, the University of Texas at El Paso and the New Mexico State University and other regional organisations to help new technology driven start-ups. The Paso del Norte Region would benefit from concerted efforts to support entrepreneurship activities and share good practices among the higher education institutions, business and government. For example, a joint centre in entrepreneurship and small and medium-sized enterprises (SMEs) could be set up in collaboration with the regional development agencies in order to pool resources and gain critical mass. Furthermore, university programmes in business development and incubation should be extended and tied more closely to regional efforts, such as those being undertaken by regional development agencies. The focus should be on industries rather than on individual firms. Learning from the experiences of the Monterrey Tech, one of the leading entrepreneurial universities in Latin America would also be useful. Monterrey Tech has a broad approach to entrepreneurship that ranges from a wide portfolio of high-tech spin-offs to support for social entrepreneurship, including work in remote and rural areas.

There is currently no mechanism for pooling the knowledge and expertise of all higher education institutions to deliver support to industry. While setting up a joint front office for higher education institutions in a bi-national, tri-state context is a challenge, modern technology could facilitate collaboration in this area. For example, in North East England, the Knowledge House provides a single point of contact for five universities in the region as well the North East branch of the Open University in England. By using virtual and face-to-face collaboration, the Knowledge House has overcome barriers in collaborating with small and medium-sized enterprises (SMEs) and with industries, and increased the amount of technology transfer taking place between universities and local firms.

The following measures would promote regional innovation in the Paso del Norte Region:

- A systemic perspective should be applied to construct a regional development strategy by improving the connectivity in the regional innovation system through stronger collaboration and networking, focusing on consensus building for economic development and more efficient division of labour between the educational institutions and their partnering industries. The goal is to encourage collaboration across higher education, research and industry, and particularly small and medium-sized enterprises. Consistent innovation indicators should be developed and monitored over time.

- The state and local governments should ensure that research on clusters and the demands of industry extend into the service sector. Clusters should also be conceptualised as cutting across the manufacturing-service divide. For example manufacturing innovations increasingly incorporate service components. Higher education institutions should be encouraged to draw upon business schools, the humanities and social sciences in providing assistance to businesses.
- To upgrade existing industry and to improve graduate retention, the region should consider establishing specific “people-based” mobility programmes to link the students, graduates and post-graduates with the local business and industry in a more systematic way. Models for linking postgraduate students with the local industry include the Knowledge Transfer Partnership Scheme in the United Kingdom that has improved the competitiveness of the participating companies through introduction of some form of innovation or new technology and helped retain 75% of the postgraduate associates which participate in the projects.
- The Paso del Norte Region, its higher education institutions and the public and private sector should make systematic concerted efforts to support new business formation, minimise the administrative burden and build an environment and mechanisms that support start-up and entrepreneurial companies through aligning incentives for a sustained period of time. The higher education institutions should strive to match global levels of excellence in supporting entrepreneurship throughout the curriculum. This curriculum should build comprehensive support programmes encompassing entrepreneurship training and provide practical experiences in creating new businesses. It should support incubation facilities along with seed funds for new graduate ventures. Consideration should be given to establishment of a regional resource centre supporting entrepreneurship and small and medium-sized enterprises in order to pool resources and gain critical mass. Private funding sources willing to invest in “ideas” rather than real estate should be strengthened.
- To support the revitalised entrepreneurship agenda, public authorities should construct efficiency/performance indicators for public agencies including higher education institutions involved in innovation to reduce the tendency to measure success in innovation by the amount of (public) investment made, rather than the amount of commercial return generated or jobs created. Indicators could

include: *i*) time to process project applications; *ii*) cost to the proponent (in time and resources) of applying to various public programmes; *iii*) administrative costs for the programmes, etc. The indicators should be benchmarked against a set of credible comparators that include good private sector actors as well as top public sector agencies.

- The universities in the Paso del Norte Region should focus their joint efforts on challenge-driven innovation addressing the key issues in the cross border region, such as water, Hispanic/border health and border security in its broader sense and use the region as a “laboratory” for research, knowledge transfer and outreach to reach global levels of excellence. Job creation should be seen as the focus of innovation activities.
- The universities in the Paso del Norte Region should broaden their understanding of knowledge transfer, utilisation and exploitation and place less emphasis on financial return to the university. By focusing on how university research can support jobs, industry productivity and innovation in the region, the university technology transfer offices could move towards continuous collaboration with industry, government and other partners. There should be stronger emphasis on the development of open access/open source systems (e.g. Digital Commons at UTEP) and interventions with high potential to yield societal returns in order to build support among broader segments within higher education institutions (beyond business and engineering faculties) and within non-profit sectors in the cross border region.
- The Paso del Norte higher education institutions should develop a hands-on engagement with business and a more collaborative way of handling enquiries from business and industry with the use of virtual collaboration. This service should be proactive rather than introducing a stand-alone portal. The states should provide additional funding to encourage greater involvement by the small and medium-sized enterprises (SMEs). Knowledge House in the North East of England demonstrates a well functioning model linking five universities and Open University. Each higher education institution should consider establishing a single office to manage the institution’s external interface including regional collaboration in order to improve communication within and between the higher education institutions, generate cost savings and create more approachable structure from the perspective of external stakeholders.

- State government and higher education institutions in Ciudad Juárez should balance the current focus on industry skills development and high end R&D with considerable efforts to develop small and medium-sized enterprises and new business formation.
- El Paso and Las Cruces should continue their efforts to expand higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bi-lingual and bi-cultural environment and the ability to reach markets across NAFTA countries and Latin America. The higher education institutions on the US side should play a more active role in helping the Paso del Norte Region build a more robust economy based on knowledge and innovation.
- Incentives for higher education institutions should be strengthened in order to advance their capacity to act as technology transfer “agents” to bring non-local knowledge to the region and to create community partnerships. Incentives for higher education institutions and their staff to engage in local and regional development should be developed. The state governments could seek to encourage greater collaboration between higher education institutions through joint investments in research facilities and incentive programmes.

Environment, social development and border health in the Paso del Norte Region

The Paso del Norte Region faces difficult environmental challenges including climate change, persistent drought and the lack of water. These factors are exacerbated because of the fragility and limits of the desert environment, poverty and rapid population growth. Higher education institutions have taken steps to contribute to sustainable development in the region...

The air quality in the Paso del Norte Region remains a serious issue on the US-Mexico border. Climate model experiments indicate that the South-western part of the United States and Mexico will experience progressive drought during the 21st century. Ciudad Juárez, the largest and most rapidly growing city in the Paso del Norte, faces a near-term crisis due to severe depletion of fresh ground water. Further industrial expansion and many

economic development interests work to attract more industry into the region, thus increasing population growth and water demand. A comprehensive, regional approach to water planning and growth management is a challenge due to the political and institutional fragmentation in the bi-national, tri-state region. As a consequence of the jurisdictional divisions and differences in water laws, water planning in the region remains decentralised while more progress has been made in the cross border collaboration for air quality improvement.

Faced with the considerable challenges of environmental sustainability, the Paso del Norte higher education institutions have engaged in on-campus good practice and research activities. The New Mexico State University and the University of Texas at El Paso integrate sustainability guidelines in new construction and capital improvement projects. In Mexico, the new campus of the Autonomous University of Ciudad Juárez “the City of Knowledge” will be powered by wind and solar energy and will contain energy efficient buildings.

There are also a number of research centres in place to address environmental challenges in the region. The University of Texas at El Paso has several centres that focus on environmental sustainability, such as the Centre for Inland Desalination Systems (CIDS) and the Centre for Environmental Resource Management (CERM), which collaborates on a long-term basis with the City of El Paso and reaches out to neighbourhoods to provide energy efficient technologies 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. The New Mexico State University (NMSU) has the Water Resources Research Institute as well as the Institute for Energy and Environment that combines expertise in environmental education and technology development and renewable energy resource development. The Autonomous University of Ciudad Juárez collaborates with the federal government through the National Water Commission, CONAGUA, in a multidisciplinary research programme on water resources. The Monterrey Tech has a three-tier action plan to promote sustainability through curricula, awareness raising among university community and collaboration with private and governmental agencies, for example through research on wind and solar energies and the development of sustainable low-income housing.

... furthermore, ongoing cross border initiatives raise hope of concerted efforts to address the challenges and to underpin a more comprehensive approach to natural resource management...

The Bi-national Water Program was established in 1992 by the University of Texas at El Paso 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 non-governmental organisations. The programme has been extended and expanded over the years with the help of federal grants and foundation funding and culminated in the establishment of the Paso del Norte Water Task Force, which has provided 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. Other regional initiatives of importance include the collaboration of UTEP and the co-operative extension at New Mexico State University to conduct research on increasing irrigation efficiency in the Rio Grande Basin, the collaboration between the New Mexico State University and farmers in Chihuahua to develop and implement water conserving agricultural production methods and the participation of the region's higher education institutions in the educational and research programmes being undertaken by the Paso del Norte Watershed Council.

An important opportunity for cross border planning capacity lies in the above mentioned joint initiative to develop Geographic Information Systems (GIS) that can provide spatial data for the region as a whole. 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. A comprehensive data system should be created to combine environmental and social-demographic data and present a picture of the region as an integrated eco-system in order to galvanise regional leadership and on policy makers.

Cross border, cross-state collaboration for sustainable development is a challenge in water resource planning and air quality control and has implications to higher education institutions' work who often limit their collaboration in their immediate surroundings. The universities in the Paso del Norte Region have played a brokerage role in addressing the challenges linked to water resources and air quality, initiated data gathering

and participated in collaborative efforts which have begun the process of addressing environmental problems on a regional scale and in an integrated manner. These can underpin governmental efforts to provide a more comprehensive approach to natural resource management.

Environmental challenges can be turned into opportunities by scaling up research efforts in water management and alternative energy sources. The development of a “green” economy in the Paso del Norte however depends on the availability of skilled labour...

Environmental challenges can provide an opportunity to develop a more resilient and sustainable economy. They can encourage positive developments for the region, including increased efficiency in energy management, industrial production, spatial development, public and private transport, construction and operation of buildings and water management. Jobs related to renewable energy and energy efficiency are projected to increase to several millions worldwide by 2030, many of them in a small number of innovative regions. In addition, despite the current financial crisis, venture capitalists anticipate a continuous increase in their investments to boost clean technologies.

Up-scaling the research and innovation effort in sustainability could yield significant returns in local and regional development. Positive outcomes would require concrete action to identify opportunities for change, to create innovations in water management, to make low-carbon technologies more attractive and to develop skills to make wider use of green technologies.

The development of a “greener” economy in the Paso del Norte Region will depend on the availability of skilled labour to fill the new jobs related to renewable energy and energy efficiency. Extensive retraining and up-skilling as well as developing a diverse set of new skills will be necessary. Skill creation for “green” jobs could be more efficiently organised by pooling learning resources of educational institutions and industries at the regional level. This requires transparent pathways between different levels of education and also between higher education institutions.

The Paso del Norte population has a high incidence of poverty-related health problems and limited access to health care services.

Despite the range of health services available, the region remains under-served by health professionals given the size and needs of its population. Cross border collaboration could help the situation

The Paso del Norte Region is home to a low-income population, many without access to any form of health care insurance and unable to afford health care provision. Because of poverty, a lack of access to preventive health care and exposure to environmental hazards, the population has a high incidence of tuberculosis, chronic diseases such as Type II Diabetes and diseases, such as typhoid fever, that have been virtually eliminated in many countries. Many of these diseases are transmittable and raise risks for the regional population as a whole.

The Paso del Norte Region has a chronic shortage of medical and health care professionals. The development of joint medical and health care programmes by the higher education institutions in the cross border region remains a challenge because of the significant differences in the organisation of training, scope and practice of health professions and licensing of practitioners in Mexico and the United States. However, while physicians and nurses may be limited in their ability to practice across the regional border, cross border utilisation of medical services are common in dentistry, vision care and pharmaceutical services.

There are also examples of successful co-operative projects to train health care personnel between higher education institutions in Mexico the United States. Bi-national programmes are being pursued between California and Baja California where bi-lingual nurses are being sent to Mexico to receive a portion of their training because of the lack of capacity in US nursing schools. Furthermore, the University of Arizona and the *Colegio de Sonora*, a private postgraduate training and research institute in the State of Sonora in Mexico have established a joint Master's degree programme in Border Public Health. The University of Arizona and the University of Sonora also have in place a summer training programme that provides intensive clinical and language training to medical students from both institutions. Model cross border programmes should be developed in the Paso del Norte Region building on the high quality of nursing and medical education and commitment to lifelong education and career development in El Paso which will assist the development in the region as a whole.

...The Paso del Norte Region has considerable scale and expertise in the clinical health care programmes and border health issues. This should be applied to develop strategies to increase the quantity and quality of health care provision across the region. Existing research programmes on health issues specific to a low-income population should be scaled up and extended across the border in order to develop the region into a world class centre of expertise in border health ...

The higher education institutions in the Paso del Norte Region are developing challenge driven research expertise in the specific sources of health problems that show a high incidence in border communities such as low-income population health (Texas Tech's Paul Foster School of Medicine), regional genetic disease profiles (Autonomous University of Ciudad Juárez) and low cost bio-medical devices to improve preventive health care and bio-information (across all higher education institutions in the region). The research projects that focus on health problems in border communities have a strong potential for co-operative research efforts that could serve the needs of the Paso del Norte Region for more effective health care. They have the capacity to position the region as a whole as an international centre of expertise and innovation on health care practices and technical innovations that improve health care outcomes in particularly health care disadvantaged populations.

The Paso del Norte higher education institutions also have a tradition of serving their communities to improve their health outcomes. For example the Texas Tech at El Paso's clinics located in East, West, Central and Northeast El Paso provide care to underserved areas lacking adequate healthcare. The University of Texas at El Paso has partnerships with clinics, hospitals, schools, non-profit organisations and governmental agencies through 400 formal agreements. The New Mexico State University's partnerships in the health and medical services include internships in clinical nursing where students are placed in local schools, hospitals and nursing care programmes. Its Co-operative Extension Services provide health-related services to the individuals and families around the state. The Ciudad Juárez, the autonomous university of provides medical and dental care through *Brigadas Médicas*. This commitment, combined with the scale and scope of training programmes in health care, should form the basis for a broader regional effort.

Higher education institutions in the Paso del Norte Region have a tradition in community service and outreach. Mexican higher education institutions follow the national requirement that all university students must complete social service, while on the US side community service is on a voluntary basis. Despite commendable examples in this field, there is a need to improve the co-ordination, monitoring of results and to move towards community development ...

In Mexico, the national requirement of mandatory student social service for at least 240 hours as a graduation requirement has generated good results in mainstreaming community service activities into the core business of the higher education institutions. For example the Autonomous University of Ciudad Juárez (UACJ) has instituted a minimum of 300 hours of social service in the curricula. The university's service learning/internship programme has on average per semester 1 680 students working in companies and 1 300 students working at the university. Similarly, Monterrey Tech's campus in Ciudad Juárez has a community service programme that engages students in programmes that generate social, economic and education development in marginalised communities and social assistance organisations. Collaboration is often organised through The *Fundación del Empresariado Chihuahuense (FECHAC)*, a pioneering intermediary organisation in Mexico between the business community and the over 100 non-profit organisations that serve the community. A total of 38 000 local business people from Chihuahua contribute through FECHAC toward social and development projects throughout the state of Chihuahua.

The university graduates of the New Mexico State University (NMSU) and the University of Texas at El Paso (UTEP) participate in community service and volunteer activities at or above the national rates. UTEP contributes to the quality of life in El Paso by providing public access to a variety of social and cultural programmes relevant to Latin populations. Its Center for Civic Engagement, recruits students into service learning opportunities on a volunteer basis. The centre has engaged thousands of university students in public service learning. The voluntary participation of students is notable because the vast majority are working part-time or full-time. The projects at their apex connected with 100 community organisations in communities in the United States and Mexico.

The New Mexico State University (NMSU) has, as a land-grant institution, a special mission to serve the State of New Mexico and has

cooperative extension offices in all 33 counties of New Mexico. The university is home to a Heritage Center that preserves and protects the histories and cultures of different ethnic groups in the region. The university's Office of International & Border Programs includes an office in the capital of the neighbouring Mexican state of Chihuahua. About 500 students and faculty are involved in mobility programmes and programmes with extensive collaboration in civil engineering, aerospace, management, agribusiness and special education, between NMSU and Autonomous University of Ciudad Juárez and Autonomous University of Chihuahua. It also sponsors about 40 joint R&D projects with partners in Mexico and therefore provides an excellent opportunity to scale up cross border collaboration.

The programmes developed by individual higher education institutions are notable for their partnerships with external stakeholders and capacity to work across all sectors in sustained commitment. However, there is limited evidence of collaboration between all higher education institutions in the region and systematic monitoring of results, which would help evaluate the outcomes of outreach activities as a whole. Furthermore, despite the obvious benefits of these programmes there is less evidence of long-term community development programmes that would build capacity within these communities to help themselves. The scope and impact of the activities are constrained by the transiency of the population in many poor communities as well as short term project funding. Finally, the activities of the community serving organisations in Ciudad Juárez and El Paso, including those assisted by the regional higher education institutions, have been significantly curtailed by the recent violence in Ciudad Juárez.

The following measures would enhance the contribution of higher education institutions to the social, cultural and environmental development in the Paso del Norte Region:

- A systematic exchange of information and experience should be put in place through the establishment of a forum between higher education institutions in social, cultural and environmental matters facilitated by the Paso del Norte Group in order to bring about greater efficiency in these areas. Such a forum should organise thematic events, with regular information retrieval and exchange facilitated by a dedicated website. As a first step, higher education institutions' current connections, initiatives and projects involving stakeholder collaboration, community development and/or outreach should be mapped and published in the collaboration platform.

- Higher education institutions in collaboration with the public and private sector in the Paso del Norte Region should increase their conjoint efforts to support sustainable environmental and economic development through a comprehensive regional approach to water planning and growth management bringing together diverse regional actors to sustainability process. Higher education institutions should scale up their efforts to provide learning and further education programmes for “green” jobs and act as a source of expertise through research, consultancy and demonstration. Major areas of concern in the region are drought, scarce water supplies and air quality. The cross-border climate observation networking should be improved and expanded due to convergence of natural and man-made drought. In addition, drought planning and water conservation efforts should be enhanced. There should be an analysis of the benefits and costs of controlling emissions from the wide variety of sources, for example, foundries, brick kilns, airborne particulate matter from unpaved roads, and the *maquiladora* plants with data on abatement costs. Further, there should be a review of vehicular emission controls to reduce vehicle emissions.
- Building on existing successful models, capacity should be developed in regional data gathering, and sharing regional data repositories and technical skills associated with using regional data. Successful models in the area of natural resource management should be extended to the field of health. For example the Paul Foster Texas Tech Health Sciences Centre research agenda to document and learn about the incidence of health problems in the region could benefit by intersecting with the programmes undertaken in environmental science and resource management. The economic, social, and environmental analysis undertaken by the Institute for Policy and Economic Development at the University of Texas at El Paso should be used to lay the groundwork for a cooperative regional and analytical capacity, inclusive of all higher education institutions in the region. In addition, higher education institutions should engage students in gathering data on health problems and socio-economic and environmental conditions. With this effort, they would learn about survey research, the intersection between environmental conditions, socio-economic status, and health problems, and methods for analysing data.
- The region should take steps to develop a world-class programme that improves health outcomes in the region and has an impact on global knowledge about methods to improve health care provision and outcomes for low-income populations. This opportunity could

be enhanced through cooperation with the higher education institutions in the region in providing the regional data to contribute to the design of research and innovative health care provision programmes. Regional expertise in health should be applied to develop strategies to increase the quantity and quality of health care provision across the Paso del Norte Region. This expertise should be used to develop the region as a whole as an internationally recognised centre of expertise and innovation on health care practices and technical innovations that improve health outcomes in particularly health care disadvantaged populations. It should especially address the health needs of the *colonias* settlements, which are sizable in the exurban areas on both sides of the border.

- The Paso del Norte Region should focus on health occupations that offer significant potential for building human capital assets and regional research programmes that can set the region apart. The training of medical and health care personnel should be scaled up to the critical needs of the low income population across the region. Possibilities should be explored to increase access to Mexican health services by the US residents. Model cross border programmes in health and medicine should be developed building on the high quality of nursing education and commitment to lifelong education and career development in El Paso. Collaboration should be enhanced across the region in clinical trials and the development of low cost bio-medical technology. In addition, the region should focus on nursing training to improve overall quality of life.
- Cross-border interactions between higher education institutions and non-governmental organisations should be strengthened and further developed in order to maintain and enhance regional civic cooperation. The role of non-governmental organisations in the bi-national Paso del Norte Region is critical and the higher education institutions are already in collaboration with non-governmental organisations in connecting students with service learning opportunities.
- In addition to providing services to various communities, higher education institutions should 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. They should consider ways to balance the current approach, which has a focus on combating poverty, with fostering wealth and job creation through social entrepreneurship. The region should be seen as a

“laboratory” for developing research, students’ work-based and experiential learning and development projects in many different fields.

- The knowledge base about regional issues should be expended through stronger involvement of students and faculty. For example, local cable television affiliates have a weekly programme, whose goal is to report on subjects that affect the residents of El Paso, Ciudad Juárez and Las Cruces. A weekly programme *Nuestra Frontera* primarily covers education and health. The higher education institutions in the region should be conduits for content for this programme and for other media that attempt to reach and report on the region as a whole.

Chapter 1: Paso del Norte region – national and regional contexts

The Paso del Norte Region expands over two sovereign countries, the United States and Mexico, and constitutes the largest bi-lingual metropolitan area in the western hemisphere. It also offers a preview of the emerging Hispanicisation process in the United States, where the Hispanic population is projected to grow from 15% to approximately 30% by 2050. This chapter presents the profile of the cross border region, its economic and social base as well as higher education system considering the national and bi-national contexts to which it belongs. The Paso del Norte Region’s unique cross border position presents many opportunities and challenges associated with an increasingly global and interconnected society. The current drug-related violence in the Mexican side and the US effort to protect its border provides a “disintegration” impetus to a cohesive bi-national region.

Introduction

The United States and Mexico share increasingly integrated¹ but asymmetrical economies. Since the passage of the North American Free Trade Agreement (NAFTA) in 1994, which primarily focused on removing barriers for trade of goods and services, the economic integration process has been dramatically accelerated. Today, Mexico is the third largest trading partner of the United States, surpassed only by Canada and China, while the United States is by far the largest trading partner of Mexico (see Figures 1.1 and 1.2). The total level of trade between the two countries has increased about 300% since the signing of NAFTA (Selee, 2009).

Table 1.1. Comparative perspective of US and Mexico, selected indicators

Indicator	United States	Mexico	OECD average	Unit	Year
Gross Domestic Product (GDP)	13 741	1 480		USD	2007
GDP per capita	45 489	14 004	32 664	USD. Current prices and purchasing power parity (PPP)	2007
Median income	26 990	4 615	19 755	USD at PPP rates	Mid-2000s
Trade in goods and services	14.7	29.2	27.8	Percentage of GDP	2007
Triadic patent families	15 942	17	-	Number of set of patents taken in patent offices of Japan, Europe and the United States	2006
Households with access to the Internet	61.7	12.0	-	Percentage of household with access	2007
Population	301 621	105 791	-	Total population, thousands	2007
Total fertility rates	2.10	2.17	-	Number of children born to women aged 15-49	2006
Elderly population	12.4	5.2	13.8	65's and over as percentage of total population	2005
Tertiary education attainment	40.3	15.9	27.5	Percentage of the population for age group 25-64	2006
Expenditures per student in tertiary education ¹	24 370	6 402	11 512	USD 2000 constant prices and PPPs	2005
Expenditures on all levels of education	7.1	6.5	5.8	Percentage of GDP	2005

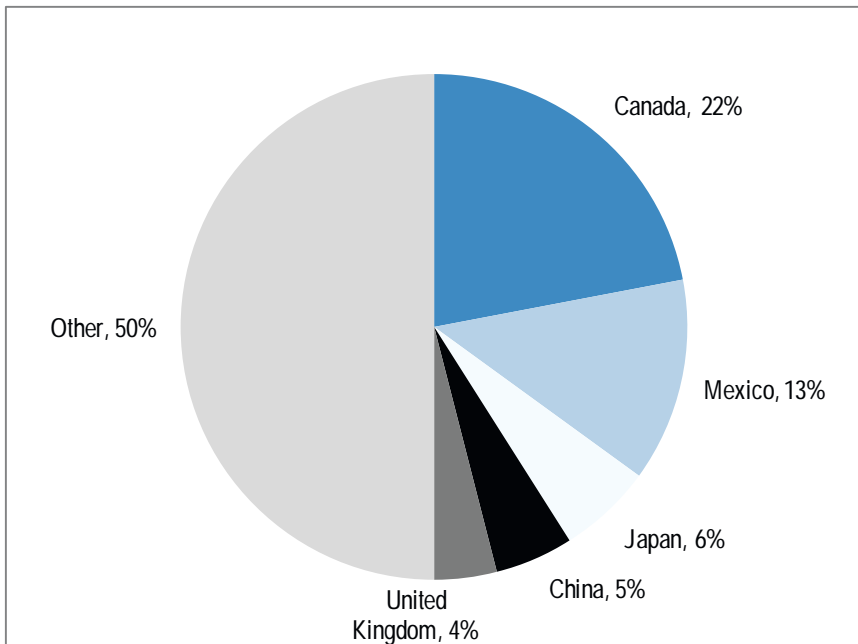
1. The indicator shows direct public and private expenditure on educational institutions in relation to the number of fulltime equivalent students enrolled in these institutions. Public subsidies for students' living expenses have been excluded to ensure international comparability of the data.

Source: OECD (2009a) Factbook: Economic, Environmental and Social Statistics, OECD Publishing, Paris.

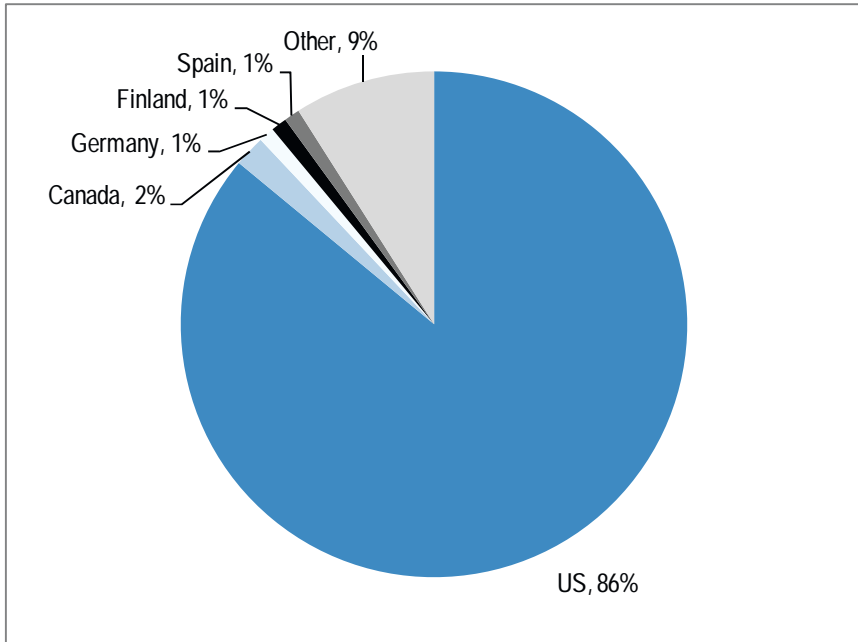
The progressive integration of the Mexican and US economies has come with both positive and negative impacts. Important asymmetries remain between the two countries in terms of economic, demographic, scientific, technological and educational development. These differences are particularly visible in the border region (see Table 1.1).

Despite these asymmetries, the high level of interconnectedness between the two countries is a fact that should not be downplayed. It is a bilateral relationship with significant domestic and international economic, social and political implications. The complexity of such an intertwined relationship has important ramifications not only in economic and political circles in Mexico City and Washington, DC, but also in the US-Mexico border region, which is considered the world's longest border between a developed and developing country.

Figure 1.1. Top markets for US exports, 2006



Source: US Census Bureau

Figure 1.2. Top markets for Mexican exports

Source: Mexican Ministry of Economy

1.1 The Paso del Norte Region

The Paso del Norte Region is characterised by a unique geopolitical location. Located in the mid-point of the 3 141 km (1 952 miles) long US-Mexico border, the region is comprised by three counties in south-western Texas and southern New Mexico, both in the United States, and the Mexican municipality of Ciudad Juárez in the northern part of the state of Chihuahua (see Figure 3). With an area of 34 581 km² (13 352 square miles) and a population of 2.4 million inhabitants, the metropolitan area of Paso del Norte constitutes one of the largest international cross border Metroplexes in the world and the largest metropolitan area on the border between the United States and Mexico. This “Border-plex” is also a major economic centre with three important urban areas: the City of El Paso, Texas,² the City of Las Cruces, New Mexico³ and Ciudad Juárez, Chihuahua.⁴ The two largest cities, El Paso and Ciudad Juárez are separated by a redirected Rio Grande and connected by five land bridges.

When NAFTA (North American Free Trade Association) was implemented in 1994 it was expected that the US-Mexico border region, and, in particular, its cross border metropolitan areas would experience fast growth and integration. Growth has been experienced on many fronts. In the region as a whole, the total number of inhabitants increased from 1 568 571 in 1990, to 2 385 695 in 2008 (52% growth). While the population grew quickly on both sides of the border, there was spectacular growth on the Mexican side: 73% compared to 37% for the US side (RSC, 2009). In both cases, the population growth was considerably higher than the respective national averages.

Due to its unique geographic location and transportation infrastructure, the Paso del Norte Region is the second most important trade corridor between Mexico and the United States, after the one which connects both countries in Laredo, Texas and Nuevo Laredo, Tamaulipas, Mexico. This is the principal reason which led Ciudad Juárez to experience its initial wave of growth in the 1980s – before NAFTA was in place – when a special tax regime and industrial park development by the Mexican government induced US companies to establish highly labour intensive manufacturing plants, *maquiladoras*, along the Mexican border⁵. The availability of jobs attracted massive migration from other regions of Mexico, which rapidly exceeded the local capacity in terms of adequate provision of housing, health, and education. Despite important investment in infrastructure and services, such deficiencies continued to increase after the passage of NAFTA because rapid population growth continued in connection with the establishment of more manufacturers in the region. In summary, the spectacular population growth in the last two decades has not been properly paired with similar development in infrastructure and support services, especially on the Mexican side.

Nevertheless, due to the asymmetric relationship between Mexico and the United States, the Paso del Norte Region should be analysed not only from a regional standpoint but also in relationship to the respective national contexts. Notwithstanding the obvious disparities in economic development and infrastructure, the US border counties belonging to the Paso del Norte region are less developed in comparison with US state and national averages, while on the Mexican side, the economic and infrastructure capacity in the Ciudad Juárez municipality is more developed relative to its respective state and national averages. The overall level of poverty in the three counties on the US side of the Paso del Norte Region is much higher than the national and state averages. In contrast, levels of economic poverty and social wellbeing in Ciudad Juárez are below the national averages (see Tables 1.2 to 1.4).

Figure 1.3. The Paso del Norte Region



Table 1.2. Poverty estimates on the US side of the region, 2007

		Estimated population below poverty level	Population (%) below poverty level	Estimated range of population below poverty level (90% confidence interval)		% range of population below poverty level (90% confidence interval)
				Low	High	
All ages in poverty, 2007	United States	38 052 247	13.0	37 829 283	38 275 211	12.9-13.0
	Texas	3 787 071	16.3	3 749 400	3 824 743	16.1-16.4
	El Paso County	204 927	28.4	192 849	217 004	26.7-30.1
	Doña Ana County	46 007	23.9	40 786	51 229	21.2-26.7
	Region - US side	250 934	27.5	233 635	268 233	25.6-29.3
Under age 18 in poverty, 2007	United States	13 097 100	18.0	12 981 173	13 213 027	17.9-18.2
	Texas	1 508 771	23.1	1 484 382	1 533 160	22.8-23.5
	El Paso County	89 010	39.4	82 676	95 344	36.6-42.2
	Doña Ana County	18 523	34.6	16 061	20 985	30.0-39.2
	Region - US side	107 533	38.5	98 737	116 329	35.3-41.6

Source: RSC (Regional Stakeholders Committee) (2009), “The Paso del Norte Region, US-Mexico: Self-Evaluation Report”, OECD Reviews of Higher Education in Regional and City Development, IMHE, www.oecd.org/dataoecd/48/2/44210876.pdf

Table 1.3. Poverty and social estimates on Mexican side of the region

	Population	Economic poverty (%)			Social backwardness (SB)		
		Food	Capacity	Patrimonial	SB Index ¹	SB degree	National Ranking ²
Mexico	103 263 388	18.2	24.7	47.0			
Chihuahua State	3 241 444	8.6	13.3	34.2	-0.60645	Low	24 out of 32
Ciudad Juárez	1 313 338	4.9	9.7	33.4	-1.36492	Very Low	2 298 out of 2 454

1. Value 0.0 corresponds to the national average.

2. Ranking # 1 corresponds to the poorest state/municipality at the national level

Source: CONEVAL (2007), Los Mapas de Pobreza en México, CONEVAL, Mexico City.

Table 1.4. Social indicators on the Mexican side of the region

	Mexico	Chihuahua State	Ciudad Juárez
% population 15 years and over illiterate	8.35	4.41	2.36
% population 6-14 years not attending school	5.29	5.83	4.40
% population 15 years and over with incomplete basic education	45.98	47.45	44.79
% population without medical insurance	49.78	35.96	30.63
% houses with members 15-29 years old in which at least one has less than 9 years of education	36.12	36.45	37.70
% houses without floor	9.93	5.21	2.18
% houses without toilets	9.90	9.67	9.14
% houses without running water	11.05	6.11	2.02
% houses without sewer system	11.67	7.73	1.49
% houses without electricity	6.12	9.04	7.95
% houses without washing machine	39.04	23.73	23.70
% houses without refrigerator	23.22	13.64	10.91
Average number of inhabitants per room	1.12	0.95	0.02

Source: CONEVAL (2007), *Los Mapas de Pobreza en México*, CONEVAL, Mexico City.

In industrial terms, the level of integration from both sides of the border is evident. Ciudad Juárez is home to the largest concentration of *maquila* employment and payroll in Mexico, and, as a result, it has built itself into a major provider of manufacturing components that are distributed throughout North America. El Paso has evolved into a service-oriented economy⁶ over the past two decades, while still keeping manufacturing jobs, including those that are linked to the production sharing, economies of scale practiced between US/foreign multinationals and Ciudad Juárez *maquiladoras* (Olmedo *et al*, 2008). The integration and economic dependence between El Paso and Ciudad Juárez has occurred spontaneously, rather than by design. Recently, more systematic efforts have been made to overcome improvised growth, including the development around the Santa Teresa port of entry opened in 1992 south of Las Cruces (GAO, 2003).

The significance of the *maquiladora* industry makes the region highly vulnerable to the cyclical economic changes in the US market. During the recent economic crisis, *maquiladoras* on the US-Mexico border were impacted by the decline of US manufacturing in late 2008, which heavily affected the automobile and consumer electronics sectors (Cañas & Gilmer, 2009).

In trade terms, the Paso del Norte constitutes the second busiest and second largest corridor of trade between Mexico and the United States.

However, in recent years the flow of goods, service and people crossing the border has been more strictly regulated. The intended harmonic integration of the region abruptly stopped as a consequence of the sudden change in US security foreign policy in the aftermath of the events of 11 September 2001. More recently, the interconnectedness of the region has been limited due to increasing violence in Ciudad Juárez, linked with drug trafficking activity. These events have deterred many forms of cross border interchange, including academic collaboration between higher education institutions on both sides of the border.

1.2 Higher education

Higher education in Mexico

Mexico's diverse range of higher education institutions, in terms of both their mission and funding structure, has implications for their ability to engage in regional development. The traditional public universities, which train almost half of the tertiary student population, are reported to have difficulties in meeting local labour market demands. Technical universities have been successful in linking with the business sector (OECD, 2009b).

The higher education institutions range from universities and technical universities to technological institutes and teacher training schools known as normal schools. In terms of governance, there are three types of institutions (see Annex 1.1, Table 1.1 for more detailed information):

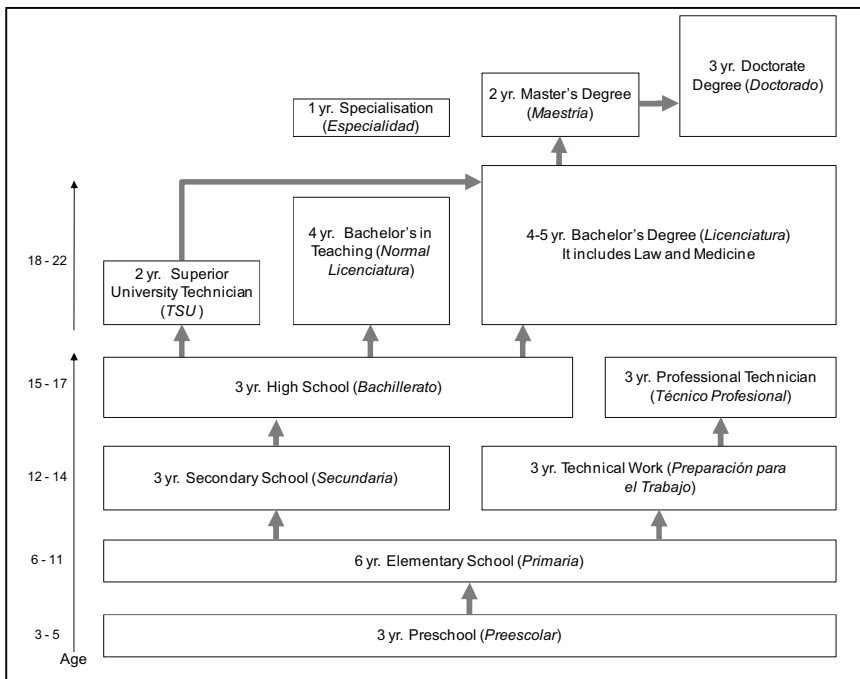
- Public autonomous universities. These can be federal or state level universities that have self governance. In most cases, autonomous universities offer both graduate and undergraduate programmes. In some cases, these institutions also offer a High school diploma. Federal public universities are funded by the federal government while autonomous state public universities receive mixed public funding from both the federal and the state governments.
- Federally or state-controlled institutions. These types of institutions include federal and state technological institutes, polytechnic universities, intercultural universities, teacher training schools (Normal Schools) and two-year technological universities.
- Private institutions. These include non-profit and proprietary institutions, which range from universities and technological institutes to teacher training schools and specialised schools. By 2005, Mexico had 2 807 higher education institutions, of which 60% were private. Private higher education institutions attracted nearly 32% undergraduate and 42% of postgraduate students in 2006. The

proportion of students attending private higher education institutions has increased from 18.5% of the undergraduate total in 1990 to 32% in 2006 (OECD, 2009b).

Academic programmes offered in Mexico include:

- Undergraduate programmes including 2-year *Técnico Superior Universitario*, TSU (which is somewhat equivalent to the US Associate Degree), 4-year *Licenciatura* degree in Education, and 4-5 year *Licenciatura* degree in most of the academic disciplines and professions.
- Graduate programmes including *Especialización* (1 year specialisation programmes), *Maestría* (2-3 year Masters degree) and *Doctorado* (3-4 year Doctorate).

Figure 1.4. Educational system in Mexico



Source: Elaborated with information from the Mexican Ministry of Education

Mexico witnessed a considerable expansion in higher education enrolment during 2000-05 with a 20% increase. Despite this expansion, the

tertiary education enrolment rate remains among the lowest in the OECD area and was 31% in 2006, compared to the OECD average of 56%. The 20% increase in enrolments was backed up by a modest increase of expenditure per student at the tertiary level. However, private spending increased by 106% with the result that the private share of funding in tertiary education in Mexico increased from 21% to 31%.

Mexico has introduced the principle of cost-sharing between government and individual beneficiaries of tertiary education, but the current system of tertiary education continues to rely heavily on public funding. Furthermore, Mexico has the largest gap among the OECD countries between per-student expenditure for tertiary education (USD 6 462) and for lower levels of education (USD 2 165 for secondary education, USD 2 003 for primary education). The per-student expenditure for tertiary education is 3.22 times that of the primary education. As a result, there is growing pressure to shift resources from tertiary education to school education (OECD, 2009c).

National higher education policy in Mexico focuses on access and quality but offers limited formal incentives for regional engagement. According to the Higher Education Co-ordination Law, the Federal Government promotes tertiary education through: resources, evaluation, support of agreements between national and sub-national levels, by encouraging and co-ordinating tertiary education planning, The Ministry of Education is responsible for supporting evaluation, quality, statistics collection, administration of several higher education funds and co-ordination across institutions and with states. There is a goal of co-ordinating between federal and state levels to support higher education, and national policy can encourage state action. There is, however, no mandate or policy initiative out of the Ministry of Education on regional engagement beyond the encouragement of the State Commission for Higher Education Planning (COEPES).

Higher education in the United States

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

- Associate's colleges. Includes institutions where all degrees are at the associate's level, or where bachelor's degrees account for less than 10% of all undergraduate degrees. Excludes institutions eligible for classification as tribal colleges or special focus institutions.

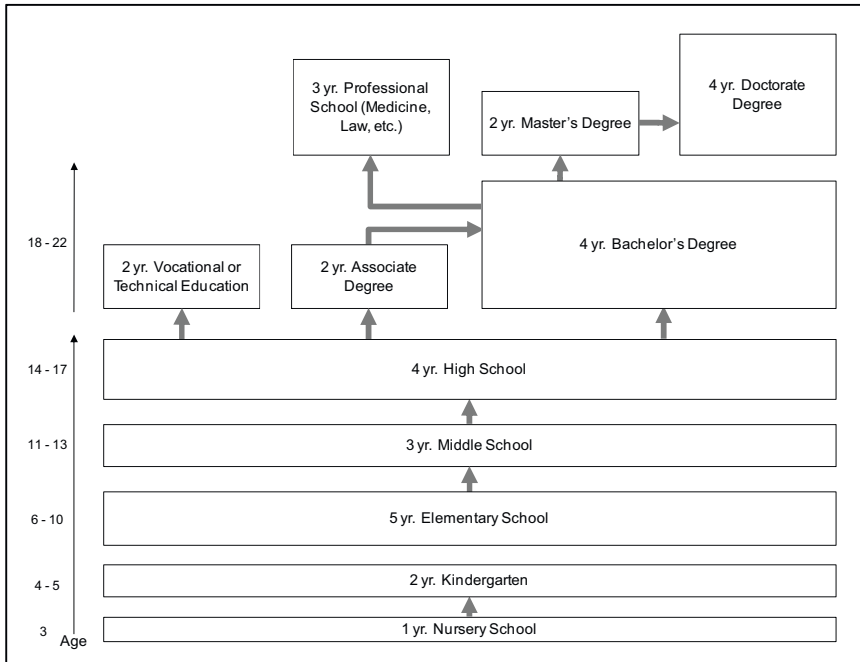
- Doctorate-granting universities. Includes institutions that award at least 20 doctoral degrees per year (excluding doctoral-level degrees that qualify recipients for entry into professional practice; and also excludes special focus institutions and tribal colleges).
- Master's colleges and universities. Generally includes institutions that award at least 50 master's degrees and fewer than 20 doctoral degrees per year. Excludes special focus institutions and tribal colleges.
- Baccalaureate colleges. Includes institutions where baccalaureate degrees represent at least 10% of all undergraduate degrees and that award fewer than 50 master's degrees or 20 doctoral degrees per year. Excludes special focus institutions and tribal colleges.
- Special focus institutions. Institutions awarding baccalaureate or higher-level degrees where a high concentration of degrees is in a single field or set of related fields. Excludes tribal colleges. It includes religious seminaries and colleges, medical schools and medical centres, schools of engineering and schools of law.
- Tribal colleges. Colleges and universities that are members of the American Indian Higher Education Consortium.

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

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

minority students were enrolled in community colleges (Ryu, 2008). An important difference between the United States and Mexico is the relative importance of enrolment in community colleges in the United States. They represent 36% of the total enrolment in higher education, while its equivalent in Mexico only accounts for 3%.

Figure 1.5. Educational system in the United States



Source: Elaborated with information from US Department of Education

The US Constitution does not include education as a federal responsibility; the states provide direct funding to public institutions and policy coordination. However, the US government provides major support for higher education through approximately USD 20 billion in needs assessed financial aid to students in the form of grants and loans. It is also the primary funder of scientific research. Market forces play an important role in higher education; institutions compete for resources, faculty, students, and prestige.

1.3 Higher education attainment

Higher education attainment in the United States

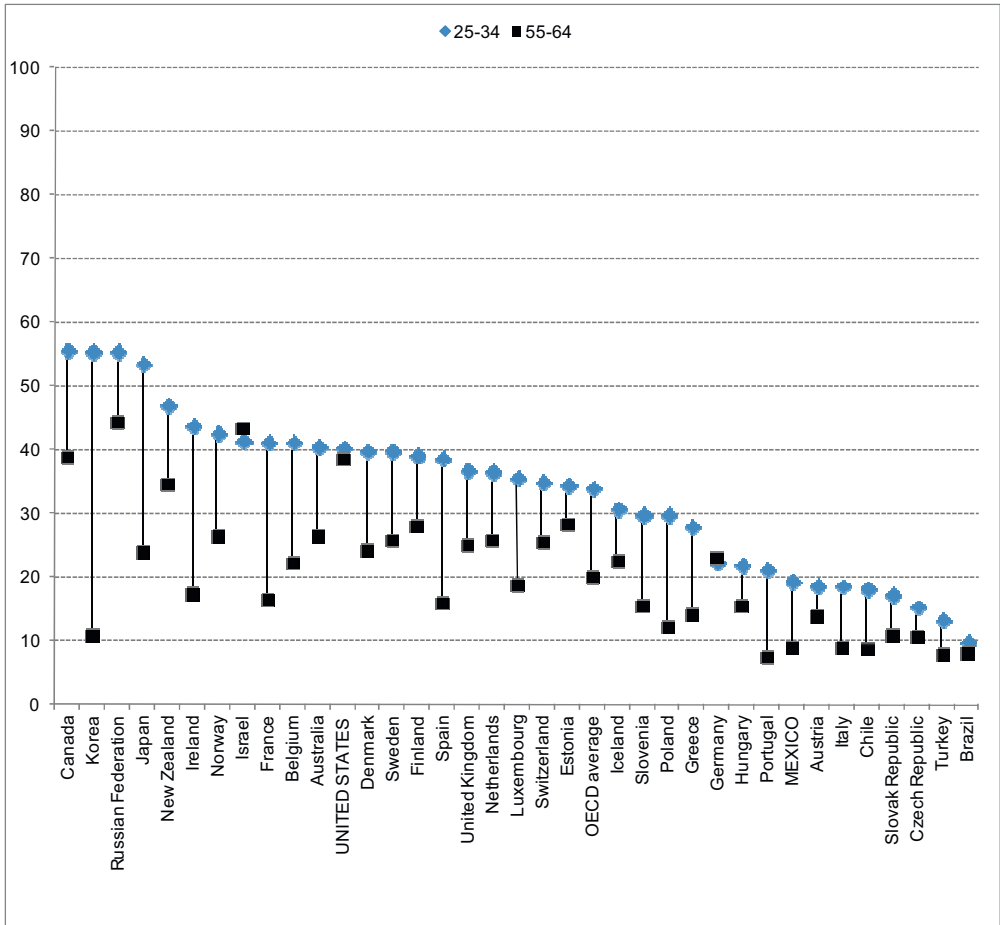
In 2007, 40.27% of the US population aged 25-64 had a tertiary education degree compared to 15.86% in Mexico and the OECD average of 27.53% (OECD, 2009d). The United States ranked fourth among the OECD countries in the rate of postsecondary attainment among adults aged 25-64, with Canada, Japan and New Zealand in first, second and third place respectively. Mexico was the 25th (OECD, 2009d).

However, when educational attainment is disaggregated by age group, it becomes clear that in educating young people the United States is falling behind the best performing OECD countries which have made rapid progress during the last few years. In 2007, the United States was ranked tenth among the OECD countries in the postsecondary attainment rate of young adults: 40.39% of US population aged 25-34 had tertiary education (OECD average was 34.15%). Mexico ranked 23rd with 19.46% (OECD, 2009d; see also Figure 6).

As a result, the American young adults aged 25-34 are no more likely to have a degree than older Americans aged 55-64, whereas in most other top-ranked nations, postsecondary attainment rates have considerably improved among the younger generation. Furthermore, certain key groups in the United States are falling behind their older peers. In particular, young Hispanics, African Americans, and American Indians have slightly lower rates of postsecondary attainment than their older peers (Ryu, 2008). These data suggest that without significant intervention, future generations of Americans will have less education than those who came before them (see Figure 6).


Figure 1.6. OECD population with at least tertiary education (2007)

Percentage, by age group



Note 1: The year of reference for Chile is 2002 and for the Russian Federation is 2004.

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

Source: OECD (2009), *Education at a Glance 2009*, OECD Publishing, Paris.
 StatLink <http://dx.doi.org/10.1787/664024334566>

In 2009, the US government declared the “bold goal” of restoring the United States to its position as the world leader of higher education graduates by 2020 (American Graduation Initiative). A range of policy

changes have been pursued including: USD 10 billion competitive grant funding through the “Race to the Top Fund” and other programmes to accelerate the reformation of elementary/secondary education; redesigning the higher education financial aid application process and student loan programmes, devoting additional funds to the federal need-based Pell Grant programme; leveraging an increased focus on degree completion at community colleges via new competitive grants. In addition to Federal Government initiatives, also major education foundations have targeted their resources toward increasing postsecondary education attainment, most notably the Bill & Melinda Gates Foundation and Lumina Foundation for Education.

Under the current financial crisis it may be challenging to achieve these “bold goals”. By March 2010, 34 US states had made cuts to spending on their colleges and universities, imposing measures such as furloughs, layoffs and tuition increases. The projected cumulative budget deficit for all 50 US states and Washington DC in 2011 is USD 142 billion (Douglass, 2010).

Higher education attainment in Mexico

In Mexico, over the last half century, participation in higher education has increased from 1% to one-quarter of the 19-23 age group. In 2006, approximately 380 000 students gained a tertiary education qualification. 61% of those who enter undergraduate degree programmes successfully complete their studies, compared to the OECD average of 69% (OECD, 2008).

Therefore Mexico has seen impressive growth in tertiary qualifications during the last decades, rising from 8.97% among 55-to-64-year olds to 19.46% among 25-to-34-year-olds, but still remains among the lowest achievers in the OECD area in terms of post-secondary education attainment (OECD, 2009d). Rapidly increasing participation rates, however, suggest that the attainment levels will continue to increase. The increase in tertiary enrolment between 1995 and 2004, which will influence graduation rates, was, at 53%, considerably above the OECD average of 41%. This trend is strengthened by Mexico’s increasing entry rates to higher education. The proportion of Mexico’s age cohort entering tertiary-type A programmes increased from 27% in 2000 to 30% in 2005. Mexico also compares favourably to other OECD countries in terms of the proportion of graduates gaining degrees in science and engineering. However, an area in need of attention is the lack of emphasis on vocational tertiary education (tertiary-type B programmes) that provide practical and technical skills that can enhance the performance of Mexican enterprises: during the last two

decades these programmes had an entry rate of 2%, compared to the OECD average of 15% (OECD, 2009d).

The current financial crisis is likely to also have an impact on higher education participation in Mexico. Early 2010, the Ministry of Public Education (SEP) announced a reduction of MXN 1 500 million (USD 119.6 million) in the competitive funds for higher education institutions⁷ for 2010. The final figures will be announced by the end of April 2010. Considerable reduction in competitive funding in terms of expansion of infrastructure is likely to constrain access to higher education (Milenio, 2010).

Table 1.5. National enrolment in HE in the US and Mexico

Level	United States ¹	%	Mexico ²	%
Associate Degree/TSU	6 617	36	96	3
Bachelor's/ <i>Licenciatura</i>	8 986	49	2 623	89
First Professional ³	351	2	-	
Graduate	2 294	13	212	8
Total	18 248	100	2 931	100

1. Data from 2007. Source: Snyder, T.D., S.A. Dillow and C.M. Hoffman (2009), Digest of Education Statistics 2008, National Center for Education Statistics, Institute of Education Sciences, US Department of Education, Washington, DC.

2. Data from 2008. Source: Ortega, S. (2009), “Cinco Desafíos para la Educación Superior en México y las Respuestas de la Política Educativa Actual”, proceedings of the TIES Partnership 2009 Conference, HED, Washington, DC.

3. Similar programmes in Mexico are considered part of the *Licenciatura* level.

Higher education in the United States and Mexico: key differences

Policy domains in both countries are significantly different (see Annex 1.1, Table 1.1). In the United States, a central role is played by state authorities in higher education. Such is the case of Texas and New Mexico, where the Texas Higher Education Coordinating Board and the New Mexico Higher Education Department, respectively, oversee the higher education systems and are involved in decisions related to funding and governance. In Mexico, the federal government, through the Ministry of Public Education (SEP for its acronym in Spanish), has direct influence in the federally based institutions, including technological institutes and technological universities and also significant influence in public autonomous universities, which are

dependent on federal subsidies to support their operations. At the same time, public autonomous universities, although relying mostly on public funding, are highly independent in matters related to internal governance. Typically, a university council, composed of deans, elected faculty members and elected students, makes key institutional decisions including authorisation of academic programmes, election of Rector, and approval of institutional budgets. In contrast, governance in the US higher education institutions is based on governing boards made up of individuals unaffiliated with the institution, which make decisions related to appointment of the President, authorisation of academic programmes and approval of budgets.

The differences between the two national higher education systems constitute an important factor that constrains more active levels of cross border collaboration. At the same time, such differentiation makes it difficult for governments to engage in developing and implementing policies which could accelerate levels of cooperation between both countries. For instance, in Mexico the federal government, through the Ministry of Public Education (SEP), has a central role to play in shaping higher education policy. No similar role can be assumed by the US Department of Education (USDE).

Despite these differences, both governments have been able to establish a series of cross border collaborative programmes such as the North American Mobility Programme (NAMP), which provides funding for consortia made up of six higher education institutions willing to exchange students and recognise academic credits from partner institutions. In this particular case, funding is provided to Mexican institutions by the Ministry of Public Education (SEP), while funding to the US institutions is provided by US Department of Education. Another successful initiative is the TIES-Partnership Programme, which supports joint US-Mexico efforts in research, intensive training, technology transfer, student exchanges and public service. In this particular case, most of the funding is provided by the US Agency for International Development (USAID).

1.4 Higher education in the Paso del Norte Region

The fact that the Paso del Norte Region is composed of two counties on the US side and one municipality on the Mexican side of the border makes the regional system of higher education a complex one in which three different governments and regulatory frameworks are clustered. However, interconnectedness among higher education institutions in the region and inter-institutional collaboration remains limited or marginal. Despite the physical proximity between institutions, their respective mode of operation is sometimes radically different (Marmolejo and Leon, 2000). More

recently, cross border interaction has been severely limited due to the wave of violence in the area. As a result, some US institutions have explicitly prohibited their faculty members and students from travelling to Ciudad Juárez on official business (Mangan, 2010). Institutional collaboration between local institutions, both on the US and Mexican side of the border, is also limited and usually confined to specific faculty-led initiatives.

There are ten principal higher education institutions in the Paso del Norte Region: three in El Paso, two in Las Cruces and five in Ciudad Juárez.

Institutions in El Paso, Texas (US)

El Paso is an educationally isolated region. A significant number of students from the region stay in the region to pursue postsecondary education. Few leave the region to attend college elsewhere and few from elsewhere in Texas or other states come to the region to study. In contrast, a substantial number of students from Ciudad Juárez cross the border to attend schools and colleges in El Paso (NCHEMS, 2007).

Founded in 1969, El Paso Community College (EPCC) is one of the fastest growing community colleges with 33 929 students (2008) in Texas and the United States. It is nationally recognised for its educational excellence. It houses a local branch office of the Small Business Administration (SBA), the federal programme of incubation type services.

The University of Texas at El Paso (UTEP) is a public university and a component of the University of Texas System. UTEP was founded in 1914 as a mining and engineering school to serve US companies operating in the northern region of Mexico. Today, UTEP has 21 011 students (2009) and enrolls the largest number of Mexican students of any US university. These students come primarily from the neighbouring state of Chihuahua. UTEP also has one of the largest enrolments of Hispanic students in the United States with 76.1% in 2009. It is ranked in the Carnegie Classification as a Research University with High Research Activity. Its research budget was over USD 56 million in 2009, with a total budget of about USD 334 million (2010). UTEP is expanding programmes in support of the regional public investments in the areas of aerospace, sustainability, defence and border security.

The Texas Tech University Health Sciences Center - Paul L. Foster School of Medicine (TTUHSC-SOM) received its first cohort of 40 medical students during the autumn of 2009. It offers nine residency programmes with approximately 205 residents. In addition, the institution serves as a

major participating institution for the orthopaedic surgery residency programme at the William Beaumont Army Medical Center. Its current focus is on education, while research is a future goal. The creation of this school of medicine is a response to the shortage of medical doctors, nurses and allied medical professions in the region.

Institutions in Las Cruces, New Mexico (US)

The Doña Ana Community College (DACC) offers over thirty two-year Associate Degree programmes and a wide variety of continuing education programmes for 8 706 students (2009). It houses the local office of the Small Business Administration, the federal programme of business incubation type services. DACC is part of the New Mexico State University (NMSU) system.

The New Mexico State University (NMSU), NMSU is the second largest university system in the state of New Mexico with 29 468 students (2009) out of which 18 497 are enrolled in the main campus in Las Cruces. A comprehensive land-grant institution, NMSU was founded in 1888 as an agricultural college and preparatory school. NMSU has an annual operating budget of USD 552 million (2008-09) and an externally funded research budget of over USD 165 million per year which is the highest in the region. Along with research, NMSU has created economic development programmes to promote the commercialisation of intellectual property. Five research clusters compose the majority of the research, including biosciences, aerospace, natural resources, information sciences and border issues. The NMSU system has campuses in Alamogordo, Carlsbad, Doña Ana (DACC), Grants and the main campus in Las Cruces. NMSU has an active Office of International & Border Programs, which includes an office in the capital of the neighbouring Mexican state of Chihuahua. Under the auspices of this office about 500 students and faculty are involved in mobility programmes (mostly unidirectional South/North) with programmes of joint or dual degrees programmes in civil engineering, aerospace, management, agribusiness and special education, between NMSU and the Autonomous University of Ciudad Juárez and the Autonomous University of Chihuahua. Furthermore, this office sponsors about 40 joint R&D projects with partners in Mexico. The Arrowhead Centre within NMSU is a driving force for business incubation, providing an outlet for commercialisation of NMSU innovations in defence and non-defence areas.

Institutions in Ciudad Juárez (MX)

A local public institution founded in 1973, the Universidad Autónoma de Ciudad Juárez (the Autonomous University of Ciudad Juárez), UACJ, is by far the largest higher education institution in Ciudad Juárez with 21 308 students and 68% of the total higher education enrolment in the Ciudad Juárez and 25.7% in the State of Chihuahua. It has been rated in Mexico as one of the top five public universities in the country. It has an autonomous local governing body. The University offers 4 PhD programmes, 41 masters and over 54 undergraduate degrees. It has continuing educational programmes oriented to local industry needs. UACJ has its main campus in Ciudad Juárez and a second campus in Nuevo Casas Grandes, approximately 260 km (161 miles) south of Ciudad Juárez. In 2009 UACJ opened a third campus in Cuauhtemoc, south of the state capital. This campus offers three undergraduate degrees. UACJ is in the midst of developing a massive new campus complex at about 15 km (9.3 miles) of its current location. It is establishing a flexible organisational structure based on horizontal areas of competencies that combine different degree programmes.

Founded in 1964, the Instituto Tecnológico de Ciudad Juárez (the Technological Institute of Ciudad Juárez), ITCJ, is the oldest higher education institution in the city. With its strong focus on engineering education, ITCJ played an important role in the development of the manufacturing industry in the 1970s and the 1980s. Today the institution is offering new degrees also in business studies for 5 200 students to respond to needs of the 21st Century.

The Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) (or Monterrey Tech) is a national private non-profit higher education institution composed of a network of 33 campuses and 25 sites across Mexico. Nationwide 96 649 students study at ITESM in 2009. The Ciudad Juárez branch was founded in 1983 and has 900 students.

Established in 1999, the Universidad Tecnológica de Ciudad Juárez (Technological University of Ciudad Juárez), UTCJ, belongs to the federally-controlled two-year technological universities' system along with 66 other institutions. UTCJ has 1 554 students (2008) that 2-year and 4-year degrees.

The Centro de Entrenamiento en Alta Tecnología (CENALTEC), founded in 2000, is a technical training school with programmes adapted to industry needs. Although in a traditional sense CENALTEC is not considered a higher education institution, the type of academic programmes it offers responds to specific needs of the industrial sector and are relevant for the development of the region. CENALTEC is seen as a national model

for its flexibility and successful outreach because it develops specific offerings based on concrete needs of industry. The programmes are federally accredited and the administration is overseen locally by the Industrial Development Secretariat. There are about 900 students.

1.5 Higher education and regional development in Paso del Norte

The Paso del Norte higher education institutions perceive regional engagement as part of their mission. There are, however, limited incentives for higher education institutions and their staff to engage with the region. In addition, there is no consensus as to the scope of the region, and the institutions define their region as the geo-politically relevant zone that surrounds them. This prevents higher education institutions from addressing issues from a meta-regional standpoint.

Some mechanisms have been established to bring together higher education institutions in the Paso del Norte Region. Formal, inter-institutional agreements have been signed among higher education institutions on both sides of the border, and funded projects supported by both governments or bi-national private agencies have helped institutions to launch collaborative, bi-national initiatives. On the US side of the border, there are articulation agreements in place aimed at transferring students from the 2-year Associate Degree level to the 4-year bachelor's degree between community colleges and universities both in New Mexico and Texas. No similar mechanism is in place on the Mexican side. A more effective outcome at the cross border level is prevented, in part, by the fact that there is no regional development authority with the capacity to identify areas of common work to foster involvement of institutions from both sides of the border.

In order to improve the collaboration among higher education institutions and between higher education institutions and their external stakeholders for the benefit of the cross border regional development, a Regional Strategic Plan is needed that involves key stakeholders from both sides of the border. This would lead to the creation of a regional authority or agency with sufficient authority, credibility and incentive mechanisms to mobilise higher education institutions towards more active work on a regional scale.

Notes

1. Using the typology developed by Martinez (1994) the US-Mexico border has experienced different stages of development and interrelationship during contemporary history going from alienation to co-existence, and more recently from interdependence to integration.
2. According to the 2005 US census data, the population of El Paso was of 708 319 inhabitants.
3. According to the 2005 US census data, the population of Las Cruces was of 184 089 inhabitants.
4. According to the Conteo de Población y Vivienda 2005 of the Mexican Institute of Statistics, Geography and Informatics (INEGI) the population of the Municipality of Juárez in 2005 was of 1 313 313 inhabitants, however, the projections of the National Population Council (Consejo Nacional de Población) estimates a population of 1 420 262.
5. *Maquiladora* is derived from the Spanish word *maquilar* meaning “to process ore for a fee”. It is commonly used to describe a foreign or domestic-owned factory in Mexico at which imported parts are assembled into products for re-export into the US market. The tariff charged on those re-imports is based on the value-added in Mexico calculated on the basis of wages paid to workers in the *maquilas*.
6. A service-oriented economy is made up primarily of service industries (e.g. banking, financial services, tourism).
7. The Mexican Ministry of Public Education (SEP) has seven competitive funds (*fondos extraordinarios*) for the 2010 budget. These funds: (i) support structural reforms (e.g. retirement schemes), (ii) provide performance-based additional funds or Fórmula CUPIA (Council of Public Universities and Similar Institutions, Consejo de Universidades Públicas e Instituciones Afines), (iii) provide support for the financial reorganisation of public state universities, (iv) provide support for increasing university enrolment, (v) formalise the employment of casual staff in public state universities, (vi) foster capacity building within public state universities, and (vii) expand educational programmes offered by the universities.

Annex 1.1. US and Mexico higher education systems

Table A.1.1. Types of HEIs in Mexico

Institution type	#	%	Student enrolment	%	Public subsidies	Description
Public federal universities	4	0.2	307 778	12.1	100% federal	Large public HEIs including the National University UNAM and the Instituto Politécnico Nacional (IPN, the main polytechnic) covering the vast majority of disciplines. Next to their teaching activities, these institutions develop a wide array of programmes and research projects aimed at generating and applying knowledge (GAK), and at expanding and promoting culture.
Public state universities	46	2.4	785 917	31.0	Split federal/state negotiated per institution	Decentralised agencies of state governments. Most of them are autonomous and tend to be the largest institutions within each state. They usually offer the vast majority of disciplines in different fields and conduct relevant research activities.
Public technological institutes	211	11.2	325 081	12.8	50% federal/50% state	Focused on engineering studies and professional studies in administrative areas. In addition to teaching activities, they develop programmes and projects aimed at GAK, and expand and promote culture. Most of these institutes are of federal nature while others are state level. The curricula are closely linked with labour market requirements and regional development, facilitating graduate access to the labour market.

Institution type	#	%	Student enrolment	%	Public subsidies	Description
Public technological universities	60	3.2	52 726	2.5	50% federal/ 50% state	Federal system co-ordinated from the Federal Ministry of Education since 1990 based on the French model for two-year programmes leading to certificate of university level technician. Their purpose is to ease student access to the labour market; the academic programmes are based on 70% practical and 30% theoretical curriculum; closely linked with industry. Most students are first generation in HEI (90%). Decentralised agencies of state governments, which conduct teaching activities, carry out programmes and projects aimed at GAK, and expand and promote technological services.
Public polytechnic universities	18	1.0	5 190	0.2	50% federal/ 50% state	Created in 2001, these universities are decentralised state government agencies. The emphasis of study programmes is based upon professional skills and on a learning-centred approach.
Public intercultural universities	4	0.2	1 281	0.05	50% federal/ 50% state	Created in 2001, these universities are decentralised agencies of the state governments, and are located in regions with high densities of indigenous population, albeit open to students of all origins. Under a cross-cultural concept, these institutions offer higher education options aimed mainly at satisfying the needs and intensifying the development potential of the regions they serve.
Public teacher education institutions	249	13.2	92 041	3.6	NA	These institutions offer higher education programmes in pre-primary, primary, bilingual intercultural primary, secondary, special, initial, technological and physical education among others for preparing and training teachers at different levels.

Institution type	#	%	Student enrolment	%	Public subsidies	Description
Private institutions (universities, institutes, centres and academics)	995	52.6	776 555	30.6	None for basic operations, eligible for programme funds	Includes universities of world-class stature as well as all other non-public institutions. In most of these institutions, teaching is the primary activity, however, the strongest also carry out activities aimed at GAK.
Private teacher education institutions	184	9.7	54 267	2.1	NA	NA
Public research centres	27	1.4	2 801	0.1	Principally federal funding	Their main objectives include diffusion of S&T; generating and applying knowledge in different areas; linking S&T with the productive sector to address problems and develop mechanisms and incentives that promote the contribution of the private sector to S&T activities. Co-ordination of most of the 27 centres is under the responsibility of the National Council for Science and Technology (CONACYT). Others, such as CINVESTAV (one of the main public research centres) are under supervision of sectoral ministries or affiliated with universities.
Other public institutions	94	5.0	124 609	4.9	NA	NA
Total	1 892	100	2 538 256	100		

Source: Adapted from OECD (2009), OECD Reviews of Innovation Policy: Mexico 2009, OECD Publishing, Paris.

Table A.1.2. Comparison of main features of US and Mexico HE systems

Item	United States	Mexico
Historical roots	German, English	Spanish, French, US
Institutional diversification	2-year Associate Degree (Community College) 4-year Bachelor's Degree (College or University) 2-3 year Profession e.g. in medicine and law (University, Specialised School) 2-3 year Master's (College or University) 4-5 year Doctorate (University)	2-year Technical Degree (TSU) (Technological University) 4-5 year <i>Licenciatura</i> incl. degrees in medicine and law (University, Polytechnic University, Technological Institute (IT)) 1-year Specialty (University, Technological Institute) 2-3 year Master's (University, Technological Institute) 4-5 year Doctorate (University, Technological Institute)
Ownership / Control	39% of HEIs are public either local (community colleges) or state institutions (universities). Enrolment: 74%. 61% of HEIs are private institutions (non for profit and for profit). Enrolment: 26%.	35% of HEIs are public institutions: mostly federal (Technological Universities, Polytechnic universities and institutes of technology) and independent public (autonomous universities). Enrolment: 66%. 65% of HEIs are private institutions (non for profit and for profit). Enrolment: 34%.
Prevailing philosophy of education	Education as an individual goal: Medium to high level flexibility for students in terms of choosing subjects. At the undergraduate level, focus on general education. Medium level dependency on government subsidies (public institutions) coupled with significant tuition paid by students or their families to the cost of their education. Non mandatory community service for students usually inked to in-service training.	Education as a societal goal: Low level flexibility for students in terms of choosing subjects. At the undergraduate level, focus on professional education. High dependency on government subsidies (public institutions) coupled with modest or nonexistent tuition paid by students or their families. Mandatory 240 hours community service for students.
Role of the government	Marginal role of federal government (apart from student financial aid and research funding). Significant role of state government (appropriations, and governance).	Significant role of federal government (institutional subsidies, regulation of private institutions, administrative control of universities of technologies and technological institutes). Marginal role of state government (contribution to subsidies for public universities, regulation of private institutions).

Item	United States	Mexico
Institutional governance	<p>Institutional authorities appointed by externally based governing boards (in public institutions usually named by the state government).</p> <p>Academic senate confined to academic decisions including initial approval of academic programmes.</p> <p>Budget and final decision of academic programmes under the authority of governing board.</p>	<p>Autonomous universities: Institutional authorities elected by an internally based University Council which also decides on academic programmes and institutional budget.</p> <p>Universities of technology, technological institutes and polytechnic universities: Institutional authorities appointed by federal or state government. Offering of academic programmes and budget approved by government.</p>
Funding	<p>Public institutions: Direct appropriations from state and local governments. Funding for research mostly from federal government. Additional revenues from student tuition and fees, provision of services, and private donations.</p> <p>Private institutions: No appropriations from government, but granted access to funding for research and to government funded student financial aid. Significant revenues from student's tuition and fees, provision of services and private donations.</p>	<p>Public institutions: Modest or nonexistent tuition paid by students. Funding for research mostly from federal government.</p> <p>Universities of technology, technological institutes and polytechnic universities: Direct funding is provided by the federal and state government.</p> <p>Public autonomous universities: Direct subsidies mostly from the federal government with match funding from state governments.</p> <p>Private HEIs: No direct subsidies from government, but eligibility to tax benefits. High dependency on student tuition. Limited access to research funds from the federal government.</p>
Undergraduate Academic programmes	<p>Bachelor's: Average of 40 subjects. 30% of subjects related to General Education.</p>	<p><i>Licenciatura</i>: Average of 52 subjects. 10% of subjects related to General Education.</p>
Admission criteria for undergraduate programmes	<p>Bachelor's: Decisions made by HEIs mostly based on nationwide standardised tests (SAT and ACT Tests) combined with performance in high school.</p> <p>2 year degrees: Automatic admission for graduates of high school or its equivalent (GED Test).</p>	<p><i>Licenciatura</i>: Decisions made by HEIs mostly based on a combination of in-house entrance tests and results from a nationwide standardised test (CENEVAL Test).</p> <p>2 yr. degrees: Decisions made by HEIs mostly based on an in-house entrance tests.</p>
Graduation criteria for undergraduate programmes	<p>Graduation granted once a certain number of academic credits are fulfilled.</p>	<p>Graduation granted once the full roster of subjects is approved and the mandatory community service has been completed. Other requirements may include writing a thesis, taking extra courses or appearing before the institution's Graduation Panel.</p>

Item	United States	Mexico
Quality Assurance	<p>Public and private HEIs: Independent institutional accreditation system based on peer review and handled by regional accrediting agencies. HEIs are subject to periodic evaluation based on a series of commonly accepted accreditation criteria. Additionally, they may opt for discipline-based accreditation offered by specialised agencies. Accreditation is voluntary, but only accredited institutions have access to federal based student loans and research funds.</p>	<p>Public HEIs: Voluntary accreditation system based on review of academic programmes made by specialised independent accrediting agencies approved by a semi-government entity COPAES.</p> <p>Private HEIs: Voluntary accreditation of academic programmes offered by accrediting agencies (as with public HEIs). A voluntary institutional accreditation system developed by the Mexican Association of Private Universities (FIMPES).</p>
Internationalisation	<p>Limited. Emphasis on fee paying international students. Low outbound mobility of students. Limited emphasis on second language.</p>	<p>Limited. Emphasis on temporary exchange of students. Low outbound mobility of students. Growing emphasis on second language acquisition.</p>

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Chapter 2: Contribution of higher education to human capital development

This chapter considers higher education institutions' role in regional human capital formation and development in the Paso del Norte Region. It highlights sub-regional differences in labour market demand and implications for human capital and skills development needed to aid economic development. It identifies good practice examples such as El Paso's long-term multi-stakeholder action for widening access to higher education and improving retention in educational institutions; Mexican educational institutions' involvement in sectoral strategies to improve productivity and New Mexico's industry skill development orientation. Finally, it suggests directions for further steps to improve human capital development and regional learning. These steps recognise the differences among the sub-regions in Paso del Norte but emphasise arenas where intersection and regional co-operation is feasible.

The key message of this chapter is that the ability to fuel local growth by cultivating relevant skills is the best guarantee that the region will thrive in future. A region that wants to be globally competitive needs to have a highly skilled workforce and knowledge-based economy than can absorb this workforce. Considerable efforts should be made to improve the educational attainment levels of the regional population on both sides of the border and to foster new business formation as well as employability and entrepreneurial skills of higher education graduates and the rest of the population. While Ciudad Juárez will need to raise the levels of education attainment and enhance the flexibility of its population through skills diversification in order to help adjustments to rapid changes in the labour market, El Paso and Las Cruces will need to continue their efforts to expand with higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bi-lingua and bi-cultural environment. Opting for low skill / low-wage jobs will not benefit either side of the region.

Introduction

The Paso del Norte Region has expanded economically since the 1990s, largely as a consequence of population growth and the spending it stimulated in retail, service and construction industries. Population growth has stimulated job growth in the region but job growth has not been able to keep pace with population growth. The significant increase in the region's population in the 2000s has been driven by migration from the interior of Mexico and composed of low skilled people seeking employment. According to the Paso del Norte Self-evaluation Report, population growth is likely to continue since the population of the region is young, with half the regional population estimated to be 25 year-old or younger (RSC, 2009).

Due to the considerable growth in regional manufacturing capacity in Ciudad Juárez and of governmental activities related to the defence sector in El Paso and Las Cruces, regional demand has increased for higher skilled workers and for middle skilled workers with technical skills. In addition, with population increasing, there has also been a concomitant demand for a higher skilled workforce in health services, financial services and consumer and business services. However, at the same time the region is unable to absorb a highly educated workforce and loses talent, particularly in engineering and computer sciences.

The Paso del Norte Region historically has high levels of poverty and low educational attainment and therefore this demand for a higher skilled workforce creates a significant challenge. While a high proportion of the regional population has limited access to educational opportunities, there are some prominent regional examples of successful efforts to increase access to education. There is, however, less evidence of successful efforts to transform the economy into a high wage/high skill base.

The bi-cultural character of the Paso del Norte Region, including a history of family and institutional ties, means innovative bi-national efforts to meet the regional needs for labour force development, widening access to education and job creation are possible. The ability of efforts to move forward, however, is significantly dependent on capacity of the region to speak with one voice, and on the restoration of civic order in Ciudad Juárez and an end to the violence that has afflicted the city. The threat of violence has disrupted the ordinary commerce that has knit together the cities on both sides of the border. It has also disrupted co-operative efforts among higher education faculty and students and acts as a disincentive for closer institutional collaboration.

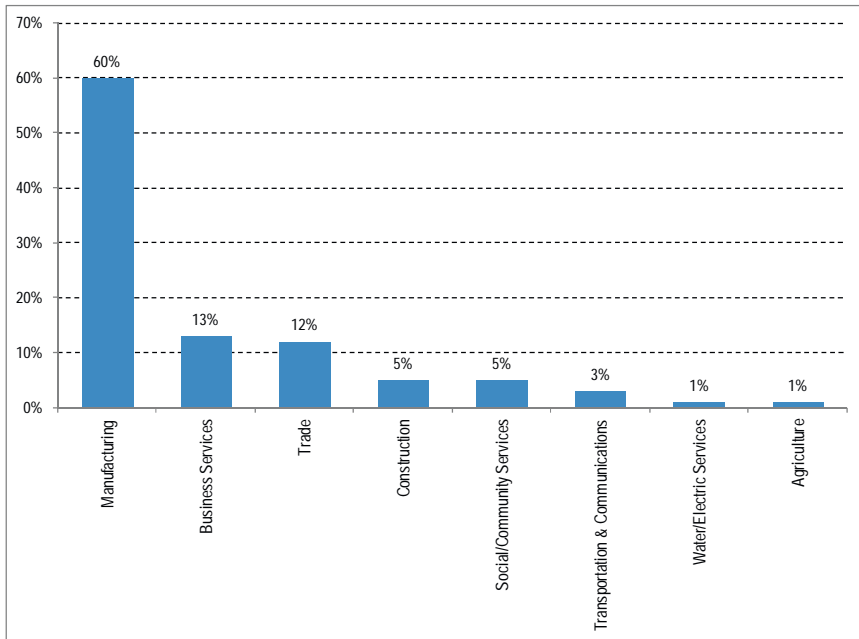
The Paso del Norte Region needs to be understood in terms of its component parts as well as an integrated whole because of its bi-national, multi-state character and complex economy. The possibility for extending successful initiatives and developing new programmes requires finding points of intersection between governmental organisations and educational institutions operating under very different budgetary conditions, incentive structures, and leadership and accountability systems. Among the most important differences among the sub-regions within the Paso del Norte Region affecting human capital development is the significant difference in their labour demand profiles.

This chapter will address key issues in the Paso del Norte efforts to advance the region's ability to develop and effectively utilise its human resources. These issues include:

- Differences in intra-regional labour demand
- Strategies to widen access while maintaining excellence in tertiary education institutions
- Efforts to build connections between innovation capacities and specialised industry-based human capital
- Extension of recent efforts to build regional workforce intelligence systems

2.1 Industrial make-up and human capital development needs

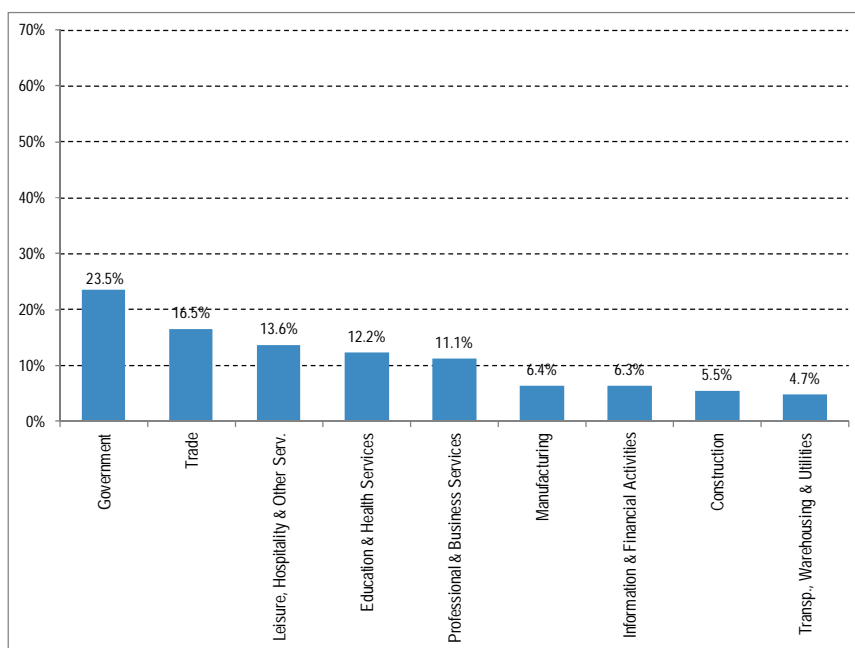
Although exact comparisons are limited by differences in the terminology defining industrial sectors, there are considerable differences in the industrial make-up of the two most closely associated metros in the region, Ciudad Juárez in Mexico and El Paso in Texas, US (see Figures 7 and 8). 60% of the Ciudad Juárez labour force is employed in manufacturing, and the city constitutes one of the largest manufacturing centres in the world. Other sectors of the economy, including business services, trade, and transportation, support the dominant manufacturing sector, the most important component of which is the automotive parts industry. The governmental sectors of the economy are very small.

Figure 2.1. Employment by sector in Ciudad Juárez, 2008

Source: RSC (Regional Stakeholders Committee) (2009), “The Paso del Norte Region, US-Mexico: Self-Evaluation Report”, OECD Reviews of Higher Education in Regional and City Development, IMHE, www.oecd.org/dataoecd/48/2/44210876.pdf

By contrast the El Paso economy is more diversified, with a relatively large government sector. Some of El Paso’s sectors, including the hospitality sector, trade and business services are interconnected with the manufacturing strength of Ciudad Juárez. A study by the Institute for Policy and Economic Development at the University of Texas at El Paso (based on an input-output model for the Ciudad Juárez and El Paso economies) indicates that there are also supplier linkages between the manufacturing industries in the two cities (Romero, *et al.*, 2008).

The third metro in the region, that of Las Cruces, New Mexico is smaller than the two other metros in the region and has a higher proportion of knowledge workers because of the relative importance of the New Mexico State University in the local economy and because of government defence and research facilities in Otero County, including The White Sands Missile Range.

Figure 2.2. El Paso MSA non-farm employment by sector, June 2009

Source: RSC (Regional Stakeholders Committee) (2009), “The Paso del Norte Region, US-Mexico: Self-Evaluation Report”, OECD Reviews of Higher Education in Regional and City Development, IMHE, www.oecd.org/dataoecd/48/2/44210876.pdf

The differences between the cities of Juárez, El Paso and Las Cruces have resulted in human capital programmes and practices that are intended to serve the individual cities but are less effective in serving the region as a whole. The ability to realise the potential of the higher education institutions to enhance the economic development prospects of the region as a whole requires an understanding of the quite substantial differences among them and identification of points of intersecting interest and capacity.

To be globally competitive, the Paso del Norte Region needs to improve educational attainment levels on both sides of the border, foster new business formation and develop high value jobs. Educational attainment levels at the US side of the border are a limiting factor in terms of the region’s ability to develop and attract high value economic opportunities. 27.5% of the region’s population (aged 25 years and older) have an associate degree or higher in 2008, compared from 21.5% in 1990. The higher education attainment levels (associates degree and above) lag behind that of New Mexico (33.5%), Texas (31.7% and the United States 35.5%).

In the State of Chihuahua and Ciudad Juárez in Mexico, educational attainment levels are improving rapidly, but remain below that of the United States and El Paso and Doña Ana Counties. Data from the 2005 population estimates indicate that the percentage with a higher education degree in Ciudad Juárez is about one point higher than the state – about 14.5%. Without considerable improvements on the Mexican side, it will also be difficult to make improvements in education performance on the US side (NCHEMS, 2007).

Currently, the US and Mexican metros and their higher education institutions have considerably different approaches to human capital development. These different approaches reflect: *i*) the role of higher education in the national education system and the organisation of higher education credentials,¹ *ii*) the capacity for autonomous action by higher education institutions to address education issues specific to the region; and *iii*) the way in which the connection between tertiary education institutions and the regional labour market needs are interpreted and acted on.

2.2 Sub-regional challenges and achievements

Situation in Ciudad Juárez

Tertiary education attainment rates in Mexico are low: in 2007, only 15.9% of the population aged 25-64 had completed tertiary-type B education or tertiary-type A and advanced research programmes compared to the OECD average of 27.5% (OECD, 2009a). Mexico also has the highest disparities in tertiary education rates across regions among OECD countries. While the education attainment of the population of the State of Chihuahua and Ciudad Juárez is higher than in many Mexican states and improving, it remains below that of the United States and El Paso and Doña Ana Counties (NCHEMS, 2007). There is a pressing need to continue to raise the educational levels in Mexico and in Ciudad Juárez.

Despite the large proportion of public spending on education, Mexico has one of the lowest levels of years of schooling in the OECD area. This has implications for educational attainment, as indicated by Mexico's weak performance in the OECD's Programme for International Student Assessment (PISA) exercise. PISA examines, through tests and surveys of 15-year-olds, how well national systems equip their young people with key skills. According to the results of latest round of PISA in 2006, set out to measure the science performance of 15-year-olds, Mexican performance was the lowest in the OECD area: Mexico obtained 410 points in science, 410 in reading and 406 in mathematics, as compared to the OECD average

of 500, 492 and 498, respectively (OECD, 2009a). The State of Chihuahua has the eight highest scores among Mexican states in the results from the last two PISA evaluation but still lags behind by more than 2.5 standard deviations from the OECD average in science and mathematics and just under 2.5 standard deviations in reading. Furthermore Chihuahua did not improve its scores in relation to the Mexican average in the 2006 PISA evaluation, advancing one place in science but moving back two places in reading and four in mathematics (OECD, 2009c).

To improve the situation, Mexico is collaborating with the OECD and the National Union of Educational Workers (Sindicato Nacional de Trabajadores de la Educación, SNTE) on the design and implementation of reforms for schools in Mexico. During this two-year project that was launched in 2008, the OECD will support the Ministry of Education with analysis, advice and communication on school leadership, teacher policy and assessment to assist Mexico in implementing education reform. The problem of access to higher education in Mexico, as in other countries, begins in primary and secondary schools, which have persistently high drop-out rates. Although industrialisation, such as that occurring in Ciudad Juárez, is associated with increases in years of schooling at the primary level, there is also some evidence that young women drop out of secondary school at higher rates when industrial work in the *maquilas*² is available to them.

The Autonomous University of Ciudad Juárez (UACJ) is a growing university, and the university estimates that the student population will rise from 20 000 to 40 000 by 2020. Currently, it has limited focus on widening access and maintains that its capacity to move forward in this area is limited by space constraints. Comparable increase in widening access to higher education on the Mexican side is, however, necessary in order to have significant improvements in the local and regional cross border economy. Improvements in educational attainment are also necessary to enhance the flexibility of the population through skills diversification in order help adjustments to changes in the labour market. They also necessary to foster the transition towards the third generation of *maquilas*³, which are characterised by the intensity of knowledge, research, development and design activities (Carrillo and Zárate, 2009).

The Autonomous University of Ciudad Juárez (UACJ) aims to broaden and deepen its regional impact through diversification of subject matter to include more applied scientific and technical programmes. These programmes are organised within the university by institutes in engineering, biomedical research and social science. These institutes are supported by the Consejo de Vinculación Académico-Productiva (COVAP), a state government initiative to institute a “triple helix” model of economic

development formed around educational institutions, the government and industry. The institutes should engage in a closer collaboration with the universities in Las Cruces and El Paso engaged in similar research. This research and technical capacity has the potential to serve regional needs, for example providing cross-regional data relevant to planning for natural resource use and to stimulate new entrepreneurial businesses related to the needs for product and process innovation in the large and diverse manufacturing sector in Ciudad Juárez.

Ciudad Juárez and the State of Chihuahua are also building training institutions to fill the increasing need for higher skilled personnel in the manufacturing enterprises located in the state and in Ciudad Juárez. Although not, strictly speaking, tertiary education institutions, institutions such as CENALTEC, respond directly to the demand for more skilled workers in the *maquila* sector and in the regional economy.⁴ They contribute to localised learning and overall human capital development in the region.

The CENALTEC model exemplifies best practice in skilled workforce training because it is organised around specifically defined industry skill needs and engages firms and trade groups directly and over time to insure that training programmes change as firm skill needs change. One limitation to this model is that some plants are driven exclusively by cost competition (rather than labour force skills, for example). In Ciudad Juárez, trained workers have lost employment opportunities when the plant that contracted to hire them decided to relocate production to another part of the world to reduce costs. Despite this drawback, there is evidence that the best opportunities for maintaining plant loyalty to a regional location lie in labour market training institutions that can produce continuous productivity increases (Cooke *et al.*, 1998). Further efforts to encourage the sectoral model could focus on building the capacity of workforce intermediary organisations. CENALTEC or a cooperating public or private organisation could, for example, employ a specialist to initiate and maintain contacts with individual employers and employer associations to determine their changing skill needs. Industrial groups made up of suppliers using similar technologies should be encouraged to form and cooperate with CENALTEC. In this way a workforce development system can emerge in the region.

Box 2.1. CENALTEC: Developing high-skilled workforce for the Ciudad Juárez industry

The Centro de Entrenamiento en Alta Tecnología (CENALTEC, High-Tech Training Centre) is part of the Technological Development Support Institute (INADET) of the State Government of Chihuahua, which provides workforce training tailored for industry needs. CENALTEC started in 2000 as a joint effort between the national, state and local government and the local *maquila* industry (assembly plants) and with an investment of USD 5 million.

The centre that offers high-technology training programmes, aims to support the state government's efforts to attract high-tech industries and to produce tangible improvements in the standard of living and to increase the region's productivity and overall competitiveness. CENALTEC's educational model is practical oriented, with 80% of the course length devoted to learning-by-doing activities.

CENALTEC's high-precision tooling and machining training programme and faculty are recognised and/or certified by the Regional Training Centre (ROC) and Metal-mechanics Training Centre (KENTEQ) from Netherlands, the US Institute for Metalworking Skills (NIMS) and the American Society of Mechanical Engineers (ASME).

One of the strengths of CENALTEC is its capacity to design and deliver tailored programmes for the local industry needs. Training programmes, starting from 20 hours, include technical English, high precision machining, CAD/CAM, CNC machining, TIG/MIG welding, PLCs (programme-able logic controller), metrology and computer use & maintenance. Tailored programmes can be flexible in timing, length, scope and contents.

Since 2000, CENALTEC has trained personnel of more than 180 local *maquila* industries of different sectors such as automotive, electronics, plastics, auto parts, as well as small machining shops. More than 3 500 technicians have graduated from regular and short courses and 84 technicians have received certificates. The results of CENALTEC have contributed to the relocation of companies in the automotive and aeronautics industries in Chihuahua. In 2009, CENALTEC embarked on a closer collaboration with local Universities, for example Monterrey Tech, allowing their engineering students to take specific courses according to their fields.

CENALTEC is now working with a group of local companies to develop a comprehensive training programme on plastic injection moulding. The aim is to support the State government's efforts to attract new companies to the region.

Despite significant progress made in Ciudad Juárez in human capital development, there is a need for comprehensive long-term efforts to increase completion rates in secondary education and the preparation of both youth and adult population for further education. Widening access to higher

education will require multi-stakeholder collaboration between higher education institutions, schools and government. Narrow skill development will not serve the population and the region in the long run and 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. The Autonomous University of Ciudad Juárez's current focus on the high-end of R&D is necessary but not sufficient approach to economic development. *Maquila* industries in Ciudad Juárez are global operations with the capacity to buy the best R&D in the world and they do not have to rely on local providers.

Situation in El Paso

The Paso del Norte Region is overwhelmingly composed of people of Mexican heritage. 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 very low educational attainment⁵. 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 higher education institutions have taken steps to widen access to higher education. In collaboration with their public and private sector stakeholders they have formed the El Paso Collaborative for Academic Excellence and made notable progress in widening access to higher education and in educational attainment. Underlying individual institutional efforts is a College Readiness Consortium, which connects efforts in primary and secondary education institutions in all school districts in the region to higher education programmes to increase access and attainment (see Box 2.2).

Information gathered by the El Paso Regional Economic Development Corporation (REDCo) shows that the educational attainment of the regional workforce significantly improved between 2000 and 2009. The proportion of the El Paso population with a high school (secondary) degree increased from 66% of the population to 72% of the population. The proportion of the population with a bachelor's degree or higher increased from 17% to 20%. While the progress is commendable, the El Paso higher education attainment (26% have associate degree) remains considerably below the national average and also that of State of Texas and New Mexico. There is a need to scale up the efforts of the El Paso Collaborative for Academic Excellence and backed them up with sustainable funding to ensure long term impact.

Box 2.2. El Paso: widening access to HE through broad-based long term collaboration

The ability of the higher education institutions in the region to widen access and increase educational attainment depends significantly on preparation in primary and secondary education. The El Paso Collaborative for Academic Excellence is a long term multi-stakeholder public-private effort, initiated by and based at the University of Texas at El Paso, to improve educational attainment and retention from the first year in school through college or university degree programmes. The collaborative includes membership from the business community, all levels of educational institutions (from primary through university), the public sector and a non-profit organisation concerned with improving educational achievement.

The goal of the collaboration, which started in 1991, was to make systematic changes in educational policy and curriculum in all of the twelve El Paso County School Districts that would produce measurable results in performance in key areas of the curriculum. A specific goal was to decrease the achievement gap across ethnic and socioeconomic groups.

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

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

Box 2.2. El Paso: widening access to HE through broad-based long term collaboration (continued)

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

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

The University of Texas at El Paso (UTEP) has also taken specific steps to make higher education affordable and accessible to students who almost universally have to work as well as to attend college. UTEP has undertaken programmes to change course scheduling, enable students to borrow money to purchase books needed for courses during the semester and pay for their education as they acquire the funds to do so. The programmes at UTEP are particularly important given the low-income levels of the college age population and their households, their lack of familial experience with higher education, their need to combine work and study and propensity to avoid borrowing to invest in higher education.

Both El Paso Community College and the University of Texas at El Paso (UTEP) also face significant challenges as measured by graduation and retention rates for students. According to regional Self-evaluation Report, the UTEP has set a goal in its contract with the University of Texas System to increase its six-year graduation rate at an average of 3% per year to reach 50% by 2014 (RSC, 2009). The ability of the El Paso higher education institutions to improve the retention rates depends on their capacity to provide support services to the first generation students, reform the higher education teaching methods and provide flexible learning opportunities for those who combine work and study. It also requires

improved financing and close collaboration with school districts to ensure that students are better prepared for higher education.

The State of Texas has established funding mechanisms to support skills upgrading in the industry. Through Texas Skills Development Fund companies can qualify for customised training grants from the Texas Workforce Commission through the Texas Skills Development Fund. Eligible company must work with a community college or other authorised training provider. Typical grants are around USD 1 200 per trainee and are limited to USD 500 000 per project.

El Paso faces a shortage of skilled labour and difficulties in retaining educated workforce. The region is in fact a net exporter of educated workforce, particularly engineers and computer scientists. While the University of Texas at El Paso (UTEP) is renowned, for its ability to educate engineers, particularly Hispanic engineers, 85% of engineering graduates of the university leave the region mainly because of the low wage rates. The region's per capita income, USD 16 864, is 71.8% of that of Texas (USD 23 487), 77.8% of New Mexico's (USD 21 673), and 63.6% of the United States (USD 26 485). Both El Paso Community College and UTEP have taken steps to improve the alignment of their educational programmes and service with regional workforce demand. The focus of this work is, however, on public sector employment in education, social services and health care.

Significant multi-stakeholder public-private efforts should be made to foster new businesses, including collaborative efforts to boost business formation, for example through entrepreneurship education. Furthermore, creating stronger ties between students in fields of critical importance to the region and regional employers through internships and co-op programmes should be made a priority.

Situation in Las Cruces

Programmes to widen access to higher education and increase performance are also present in the Las Cruces metro area and at New Mexico State University (NMSU) but they play a less prominent role than in El Paso. The university draws its student population from a broader geographic area extending to the United States as a whole and has a more limited focus on serving the local population. Las Cruces programmes tend to focus on the community college population as a target group with the goal of increasing the educational attainment of students who are likely to remain in the region. With this goal in mind, the Las Cruces School District has its own early college high school programme, "The Bridge". It is a community-based grassroots effort involving private business, local and

state government and local secondary and post-secondary institutions to address high dropout rates. While commendable in its own right, this effort is too limited to make significant progress in improving higher education attainment. Stronger regional collaboration and communication would enhance the capacity to learn from successful programmes in the Paso del Norte Region.

The New Mexico State University and the Doña Ana Community College (DACC) both have close relations with the State of New Mexico and the state has established Higher Education Incentive and Matching Funds. General Fund appropriations for these vary each year depending on state priorities and available money; some appropriations are for multiple years. The state has for example Higher Education Endowment Fund that provides matching funding to community colleges and universities for endowed faculty chairs, professorships, faculty development, etc. The workforce Skills Development Fund provides matching funds to community colleges for development, expansion and support of entry-level high-skills training programmes.

The Doña Ana Community College (DACC), adjacent to the New Mexico State University campus, provides technical training in skills related to industries in the region including automotive technology, digital graphics technology, electronics technology and welding. This industry skill development orientation is unusual in the US context and reflects both the high demand for medium-skilled labour in the defence facilities and suppliers in the Las Cruces area and a cooperative approach between employers and technical training providers.

The approach to human capital development in the higher education institutions in New Mexico has focused specifically on training for knowledge intensive jobs influenced in part by the labour demand in near-by defence establishments such as The White Sands Missile Range. The New Mexico institutions have also devoted resources to training and support for business development.

2.3 Entrepreneurship in higher education institutions

The US universities, the University of Texas at El Paso (UTEP) and New Mexico State University (NMSU), are focused on the potential to create a profit stream for the university from licenses and patents. There is, however, limited evidence of success in this arena. Beyond income from licenses and patenting of faculty inventions, they also aim to foster innovative new start-ups and spin-offs from university research. For example the University of Texas at El Paso has initiated a programme in

2009 to commercialise university inventions with a foundation-sponsored Center for Research in Entrepreneurship and Innovative Enterprises (CREIE). This programme is supported by UTEP courses in entrepreneurial skills (see also Chapter 3).

The New Mexico State University's (NMSU) Arrowhead Center approach is industry-focused with more potential to build strengths in the local and regional economy. Industries targeted by the Arrowhead incubator include energy and natural resources, aerospace and commercial space, biosciences, digital media and national security. The NMSU approach is regional, extending at least to the El Paso area and potentially to Ciudad Juárez and offers a wide range of services and skills training to potential entrepreneurs. For example, the Arrowhead Center makes the expertise of corporate and university researchers available to small businesses.

The Paso del Norte Region faces a challenge of limited labour demand for educated graduates and a need to build skills related to business establishment and entrepreneurship. The Kauffman Foundation-sponsored programmes, including Hispanic Entrepreneurship, at the University of Texas at El Paso and the New Mexico State University programmes in business development and incubation have begun to address this need. These programmes should be tied more closely to regional efforts, such as those being undertaken by REDCo and within the policy institutes in higher education institutions, to identify sources of future regional growth. The focus should be on an industry orientation rather than on individual firms.

In Mexico, the entrepreneurship activities in public universities are in early stage of development. The Ministry of Economy has recently taken steps to enhance entrepreneurship in public universities and has underpinned this with competitive funding from the Fondo PYME (SME Fund, Small and Medium-sized Enterprise Fund). The Autonomous University of Ciudad Juárez (UACJ) has a Small Business Incubator and 17 electives at the undergraduate level geared towards entrepreneurship in four different institutes. For the time being, the different institutes remain uncoordinated and there are inadequate instruments to support entrepreneurship education. In order to scale up the activities, coordinated institution-wide efforts need to be made and a wider portfolio of activities needs to be introduced. However, it should be noted that new business formation in general faces serious challenges in Mexico due to bureaucratic constraints.

At the same time, in Monterrey Tech, which is a privately funded university, all students take part in entrepreneurship education and courses are delivered using a wide range of learner centred models, such as problem-based learning, project-oriented learning and research-based learning. The

small Ciudad Juárez campus of the Monterrey Tech offers 10 bachelor degree programmes and master and doctoral degrees through the Virtual University of Monterrey Tech. The campus has a focus on social incubation. In 2009, its Sustainable Social Development Institute supported 18 projects, which were in pre-incubation and four in the incubation phase. The projects in the social incubator are usually aimed at facilitating the move from self-employment to micro-businesses and to formal economy.

A core element of university support for innovation and enterprise in most countries is through new business incubation and graduate entrepreneurship (Potter, 2008). Experience elsewhere shows that the best support for graduate entrepreneurship comes from teaching programmes where students work in teams to form real companies mentored by entrepreneurs. Such programmes can run at undergraduate and graduate levels and be targeted at students from across the sciences, engineering, business and arts disciplines. The Paso del Norte higher education institutions, however, provide limited practical experience of new venture formation to their students.

Despite projects, study programmes and initiatives, entrepreneurship education in the Paso del Norte Region is in an early phase of development, reflected in the limited breadth and refinement of entrepreneurship education activities in the higher education institutions and a small proportion of students benefiting from them. Higher education institutions should step up their entrepreneurship activities through a broad portfolio of activities and courses, enhance the institutional anchoring of entrepreneurship education, build capacity among entrepreneurship educators and integrate entrepreneurship education into the curricula. Table A.2.1 (see Annex 2.1) identifies various approaches to entrepreneurship education that the higher education institutions in the Paso del Norte Region could consider. The table also identifies some of the challenges involved in these approaches that need to be taken into consideration.

The Paso del Norte higher education institutions should also share good practices among themselves and the key stakeholders in a more systematic manner. Examples of higher education institutions collaborating with each other and the key stakeholders to boost graduate employment can be found for example in Brandenburg, Germany where all higher education institutions have established a joint resource centre in entrepreneurship and small and medium-sized enterprises (SMEs) with the regional development agency in order to pool resources and gain critical mass.

Box 2.3. BIEM - The Brandenburg Institute for Entrepreneurship and SMEs

The Brandenburg Institute for Entrepreneurship and SMEs (BIEM) is the entrepreneurship institute of the regional development agency and nine public higher education institutions including universities and universities of applied sciences. BIEM was founded in 2006 as a registered non-profit organisation. One of its main objectives is to reinforce, complement and co-ordinate the entrepreneurship support activities offered by Brandenburg's higher education institutions by pooling resources and enhancing collaboration and exchange. BIEM helps to achieve the “critical mass” needed to realise projects with wide ranging impact.

The annual budget of EUR 100 000 is financed by the European Structural Funds, the Ministry of Economics of Brandenburg and other project-related revenues (*e.g.* fees for services). BIEM has eight employees. Each partner organisation runs additional projects and employs additional personnel according to project needs or the overall management of an entrepreneurship institute/centre.

BIEM's activities include entrepreneurship education, start-up support, entrepreneurship research and networking with business support organisations and other universities. It focuses on the expansion and better integration of entrepreneurship education into curricula, including innovative teaching methods, broad communication of activities, and an expansion of co-operation beyond BIEM's core partners (*e.g.* by involvement of university staff and external experts, agencies and companies). Partner higher education institutions benefit from rising numbers of students participating in entrepreneurship education activities and an increase in the number and variety of courses available for their students.

Higher education institutions have established “entrepreneurship location managers/animators” (Standortmanager), who act as “one-stop-interlocutors” for would-be entrepreneurs. This structure contributes to building stronger linkages between the university's internal and external support services and to integrating entrepreneurship education and start-up support services. Other projects include “Entrepreneurship ACs”, that evaluate entrepreneurial potentials and learning needs before start-up and match them with adequate mentoring during start-up, “Team Competency Lab” that focuses on team building and coaching at the BTU Cottbus or GO:Incubator at the University of Potsdam.

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

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

Conclusions and recommendations

Higher education institutions in the Paso del Norte Region have responded according to their own capacities and orientations to the needs for regional learning and human capital development. For example, the El Paso higher education institutions have made considerable progress in widening access to higher education. This represents a rare approach to human capital development that incorporates the entire educational trajectory. Las Cruces has a strong focus on industry skill development unusual in the US context. In addition, the Arrowhead Center focuses on building new firms related to industry strengths in the region and provides a wide the range of services available to entrepreneurs and small firms. On the Mexican side, the Autonomous University of Ciudad Juárez and CENALTEC have engaged in “triple helix” type sectoral strategies in which a higher education institution and technical training institutes work in close interaction with industry to provide a technically skilled workforce and continuous improvements in productivity.

The current examples of industry collaboration and initiatives to widen access and improve retention in educational institutions are aimed at serving the individual cities and sub-regions, but are not reflected in a wider regional agenda. The ability to fuel local growth by cultivating relevant skills is the best guarantee that the region will thrive in future. A region that wants to be globally competitive needs to have a highly skilled workforce and knowledge-based economy than can absorb this workforce. Considerable efforts should be made to improve the educational attainment levels of the regional population on both sides of the border and to foster new business formation as well as employability and entrepreneurial skills of higher education graduates and the rest of the population. While Ciudad Juárez will need to raise the levels of education attainment and enhance the flexibility of its population through skills diversification in order to help adjustments to rapid changes in the labour market, El Paso and Las Cruces will need to continue their efforts to expand with higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bilingual and bi-cultural environment. To break out of the “low-skilled equilibrium” production processes need to be improved and productivity of local employers enhanced. Here higher education institutions can play a key role through stronger collaboration with the local enterprises. Opting for low skill / low-wage jobs will not benefit either side of the region. The OECD Review Team recommends that the following measures be taken to address the significant challenges in human capital development in the Paso del Norte Region:

- A wider portfolio of robust data related to the regional context and the situation of individual higher education institutions should be developed in the Paso del Norte Region to support evidence-based decision making and targeted efforts to address human capital development needs. The most effective region-wide graduate labour market systems are based on the collection of comprehensive labour market intelligence, on-line publication of the data in a single place to improve students' ability to make rational choices about their studies and to help graduates and employers to come together which increases students' chances of moving into employment; and using the data strategically to identify regional priorities and at an institutional level, to respond to the data in terms of course provision and the provision of employer specified skills.
- The Paso del Norte Group, higher education institutions, other educational institutions and key stakeholders of the economy and society should work together to establish a Strategic Plan for Regional Human Capital Development to define region-wide goals, policies and priorities extending from primary to tertiary education and beyond. To form the basis for regional comparative advantage this strategy should build on the strengths based in higher education *i.e.* the widening access agenda in El Paso, industry skill development in Las Cruces and “triple helix” collaboration to improve productivity in industry in Ciudad Juárez. Regional policy makers should draw on the experiences from each “model” and identify ways to extend these activities to the region as a whole. The challenge is to selectively build on these strengths to generalise the knowledge they represent across the region and to select projects for cooperative efforts that take advantage of the strengths of the higher education institutions, while recognising limits and barriers inherent in different institutional contexts. As part of this strategic plan, a higher education coordinating body should be established to define goals, policies and priorities.
- Higher education institutions should continue and expand efforts to increase the enrolment and success of the first generation students. These efforts should build upon existing successful models of widening access, effective support services for students, including both academic and social supports and learner-centred teaching methods. Both higher education institutions and governments should increase financial assistance to low income students, including both institutional aid and state aid. The Paso del Norte Region should replicate the El Paso model for improving performance and widening access to higher education throughout the region. Higher

education institutions' lifelong learning activities should be strengthened and they should improve their capacity to provide up-skilling and re-skilling for adult population that combine work and study or are unemployed. Particularly Ciudad Juárez needs to develop comprehensive long-term efforts to increase completion rates in secondary education and the preparation of both youth and adult population for further education. Widening access to higher education will require multi-stakeholder collaboration between higher education institutions, schools and government. Narrow skill development will not serve the population and the region in the long run. Therefore 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.

- Significant multi-stakeholder public-private efforts should be made to boost entrepreneurship, business formation and business development. Higher education institutions should focus on strengthening the regional employability and entrepreneurial skills of all graduates. Creating ties between students in fields of critical importance to the region and regional employers through internships and co-op programmes should be made a priority. Work- and problem-based learning methods and programmes to build entrepreneurship skills should be developed to improve graduate retention in the region. Similarly, efforts in dual language learning should be stepped up to assist the region in its internationalisation efforts.
- Incentive structures should be strengthened to encourage higher education institutions and their staff to engage in activities benefiting regional and local development and entrepreneurship activities. Discretionary funds should be established for supporting various kinds of teaching-related activities that include interaction between the higher education system and the community.
- The industry or sectoral orientation should be extended to human capital development in order to galvanise technical training in Ciudad Juárez, El Paso and Las Cruces around cluster-based manufacturing and manufacturing services. The workforce development system should be adapted to the needs of small firms and to the development of companies in place. The Workforce Investment Board Report for El Paso (2008) focuses on cluster development, for example, an approach that when applied to human capital development is consonant with the sectoral approach being undertaken in Ciudad Juárez through CENALTEC. The Arrowhead

Center appears to have made the most progress in working on an industry-based, small firm-oriented human capital development strategy.

- The Paso del Norte Region should focus on health occupations that offer significant potential for building human capital assets and regional research programmes that can set the region apart. This opportunity arises both because of a new and highly significant asset (Paul Foster Texas Tech Health Sciences Centre) and considerable health needs in the region. The region should take steps to develop a world-class programme that both improves health outcomes in the region and has a global impact on knowledge about methods to improve health care provision and outcomes for low-income populations. This opportunity could be enhanced through cooperation with the higher education institutions in the region in providing the regional data to contribute to the design of research and innovative health care provision programmes. In addition, the region should focus on nursing training to improve overall quality of life. Bi-national programmes are being pursued at a very small scale between California and Baja California but the Paso del Norte region offers the opportunity for a larger experimental programme to increase the number of nursing graduates on both sides of the border (see also Chapter 5).

Notes

1. See OECD, Education at a Glance 2009 for a description of differing definitions and organisation of post-secondary education in the US and Mexico.
2. *Maquiladora* is derived from the Spanish word *maquilar* meaning “to process ore for a fee”. It is commonly used to describe a foreign or domestic-owned factory in Mexico at which imported parts are assembled into products for re-export into the US market. The tariff charged on those re-imports is based on the value-added in Mexico calculated on the basis of wages paid to workers in the *maquilas*.
3. According to J. Carrillo and R. Zárate (2009) there are at least four generations of *maquilas*: the first generation is characterised by manual labour and simple assembly. The second generation is defined by the rationalisation of labour, manufacturing, and adoption of new technologies. The third generation is defined by intensity of knowledge, research, development and design activities. A fourth generation can be defined by the centralised coordination of activities for the group of plants located in the country and owned by the same company.
4. CENALTEC is open to training workers without formal secondary credentials but with workforce experience.
5. For example, one-third of the students at the University of Texas at El Paso report that they come from households with incomes of USD 20 000 or less. The poverty level in the US counties in the Paso del Norte region is 27%, more than twice the US national average. The poverty level in the Mexican settlements adjacent to the US counties is not available.

Annex 2.1: Entrepreneurship teaching approaches

Table A.2.1. Types of entrepreneurship teaching approaches

Type of approach	Main activities	Challenges
Classroom lectures	Lectures on themes such as market analysis, venture creation, new product development, project management, financing, strategy development, etc.	Classroom lectures need to be combined with more experiential approaches to learning. Theory needs to be combined with practice. Lectures must be made relevant to real-world entrepreneurship problems.
Business plans	Preparing business plans individually or in teams. Competitions and prizes for the best business plans.	Business plans must be made realistic. Ways are required to test business plans against market conditions and potential shocks. Teaching must also look at turning business plan ideas into real practice.
Case studies	Presentations and discussions of real company/entrepreneur experiences of business creation, growth, adaptation and failure.	Significant resources are required to develop case studies. Case studies must focus on problems potential entrepreneurs will actually face.
Entrepreneurs as guest speakers	Entrepreneurs invited to present their experiences in lectures and discussions, in the classroom or in their enterprise.	HEIs must find ways of attracting entrepreneurs to teaching programmes. They must also support entrepreneurs in their teaching practice, notably in drawing out the learning from their experiences.
Student business start-ups	Students start real or virtual businesses individually or in teams.	Funds will be required to create start-ups and to develop virtual firm technologies. Rules must be established for sharing rewards from successful starts.
Business games	Computer-simulated or other business games.	The requirements for developing or purchasing the technology should not be underestimated. Efforts are needed to integrate games with other teaching. Teachers need training to provide a framework for learning from the games.
Student entrepreneur clubs and networks	Student societies and networks to discuss entrepreneurship issues, create entrepreneurial teams, obtain mutual support and increase confidence.	Nurturing is required to make networks successful. Activities must be found to animate the networks. Networks should be expanded to include experienced entrepreneurs, investors, consultants, etc.

Type of approach	Main activities	Challenges
Placements with small firms	Short-term assignments with small firms to assist with business development projects such as market or technology development.	Firms must be found to provide good quality placements. University staff must support the student during the placement.
Feasibility studies	Exploring the feasibility of business ideas with environmental scans, market potential investigations, competitor analysis, etc.	It can be difficult to assess how well feasibility studies have been undertaken compared with real conditions on the ground.
Communication training	Presentation techniques, interpersonal communication.	Communication skills need to be developed under pressured and real-world conditions.
Consulting for SMEs	Student participation in consulting projects for new and small firms with the support of university staff.	It is necessary to find suitable companies and consulting opportunities. Although academics will often be expected to lead, ways must be found of involving students in the projects.
Support for graduate student start-ups following the course	Seed money, mentoring, incubation, consultancy, etc.	Sufficient funds must be generated for the support. Decisions must be made about the right amount and duration of support. Where possible links should be made with existing support providers outside of the HEI.
University-wide entrepreneurship education	Spreading entrepreneurship teaching out to faculties beyond the business school.	The right point must be found in a trade-off between the benefits of proximity and tailoring to subject specificities through separate courses for each department and the benefits of economies of scale and greater experience through centralised and inter-disciplinary courses.
Specialist entrepreneurship degrees	Undergraduate or post-graduate degrees majoring in entrepreneurship.	It can be difficult to obtain academic rigour from purely entrepreneurship degrees. It can also be difficult to attract students to these degrees. Practical entrepreneurship outcomes are not guaranteed.
Distance education programmes	Use of electronic media including web-based programmes, interactive DVDs and electronic discussion groups.	Student learning rhythm must be maintained and student isolation avoided.
External partnerships	Creation of entrepreneurship centres with financial support from business and public agencies. Advisory boards with external experts.	It is necessary to maintain academic rigour and HEI independence whilst adapting to the concerns of other stakeholders.
Courses for entrepreneurship teachers	Courses for prospective teachers of entrepreneurship to understand the entrepreneur's environment and behaviour and to develop their teaching approaches.	Ways are required to develop insights on the world of the entrepreneur for teachers who have no entrepreneurship experience and to develop teaching abilities in existing or former entrepreneurs.

Source: Potter, J. (ed.) (2008), *Entrepreneurship and Higher Education*, OECD Publishing, Paris.

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Chapter 3: Contribution of higher education institutions to regional innovation

Innovation is considered an increasingly important driver of long-term economic growth. This chapter will examine the effectiveness of current innovation policies and practices in the Paso del Norte Region and the role of research and knowledge transfer conducted by the region's higher education institutions. The chapter will first consider the efforts made by the national and state governments, regional development agencies and higher education institutions. It will highlight the key challenges in peripheral and old industrial regions. It will examine the current knowledge transfer mechanisms in place and highlight good practice from other regions. Finally, the chapter will conclude with specific recommendations to improve the regional innovation.

The key message is that despite considerable efforts by higher education institutions and their stakeholders to boost innovation, there is much room for improvement. Concerted systematic efforts are needed to break out of the path dependency and to create new businesses and better jobs.

Introduction

In the Paso del Norte Region, innovation-related policies and the consideration of the role of higher education institutions lie between national and state policies of the United States and Mexico and the states of Chihuahua, New Mexico and Texas. The national policy frameworks for innovation largely operate on an aspatial basis. At the state level, the state governments have varying degrees of innovation policy.

The major challenge for the Paso del Norte Region and its higher education institutions with regard to innovation is to develop effective innovation systems that operate across the bi-national, tri-state region as a whole. However, the concept of regional innovation systems (Cooke, 1998) as understood and implemented by policymakers in many OECD countries has not yet been implemented in the Paso del Norte Region.¹ Furthermore, the notion of the region remains problematic in the cross border context. There are also differences in legislation and governance, social and economic disparities and border security issues, which weaken the potential for mutual interaction. The region, which combines some of the characteristics of peripheral regions and old industrial regions, also has to face the challenges of “institutional thinness” and different types of “lock-in” to obsolescent practices and conceptions.

With its strong manufacturing base and growing R&D base within in higher education institutions and other research agencies, the Paso del Norte Region offers potential for the development of a more efficient innovation system. The two larger cities, Ciudad Juárez and El Paso, are building the scale of resources and institutions that can form the basis of a well functioning innovation system, and reach out to surrounding areas. These core cities and Las Cruces provide an opportunity for nodes of local innovation systems or clusters. However, to date, the regional innovation system remains under-developed, consisting of separate systems which have divergent levels of collaboration between higher education institutions, state and/or local governments and industries.

In this context, this chapter examines the following three dimensions to assess the effectiveness and coherence of innovation and R&D policies and practices within the Paso del Norte Region and its sub-regions:

- Is the innovation system well connected and responsive to the diverse industrial structure of the cross border region and the sub-regions?

- Do the existing higher education providers support the regional innovation system in an optimal way? Are there gaps in delivery where performance could be improved?
- What lessons can be learnt from international experience?

3.1 Policy framework and regional actors in the United States and Mexico

The US pro-innovation policies

The United States has for decades led the way in developing pro-innovation policies. It was the first in the world to offer companies a R&D tax credit and, through the 1980 Bayh-Dole Act, the first to allow universities to patent products originating from federal R&D funds. The technology licensing offices of the Massachusetts Institute of Technology (MIT) and Stanford University and the foundation affiliated with the University of Wisconsin (WARF) have been recognised as global leaders in commercialising university research. Furthermore, the totemic examples of the Silicon Valley or Route 128 have inspired many regions and their higher education institutions worldwide.

The United States remains solid in terms of the expenditure on higher education R&D (HERD) as a percentage of GDP as well as the share of funding from industry to higher education R&D. In terms of international comparisons, however, the United States is among the middle range of OECD countries on both measures: its expenditure on higher education R&D as a percentage of its GDP reached 0.36% in 2008 as compared to OECD average of 0.39%, while business and industry funded 5.6% of the US higher education R&D in 2007 as compared to the OECD average of 6.5%. Mexico ranked among the lowest investors in the OECD area on both measures with 0.10% and 1.3% respectively (see Figures 3.1 and 3.2).

Figure 3.1. HERD as a percentage of GDP

Selected countries, 2006¹

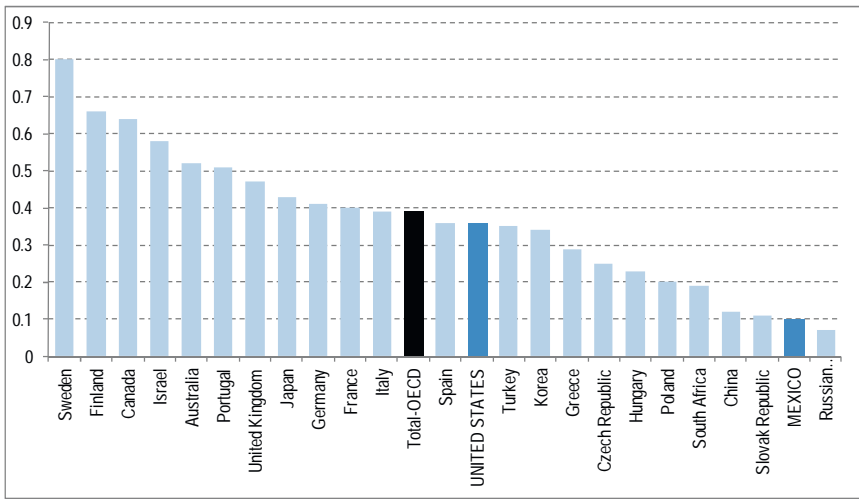
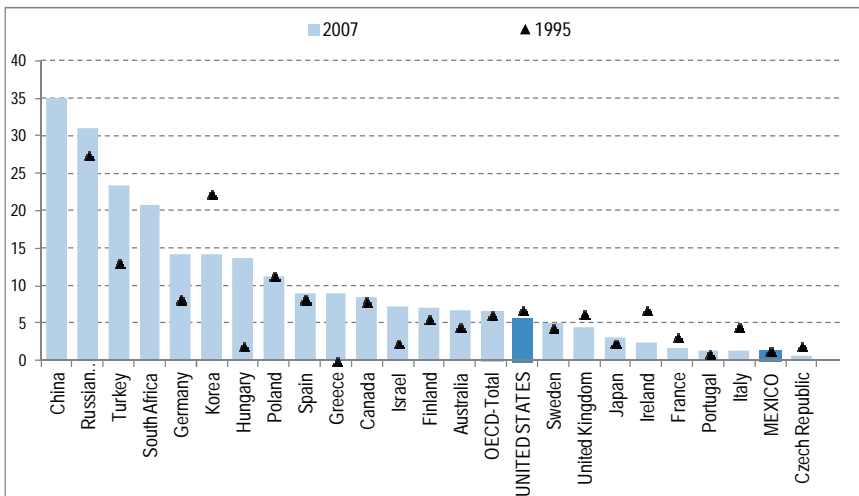


Figure 3.2. Percentage of HERD financed by industry

Selected countries, 1995 and 2007¹



1. Or nearest available year.

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

Recently, however, other OECD countries have been catching up the United States in terms of capacity for innovation. This has happened in four different arenas: *i*) human capital development; *ii*) tax credits; *iii*) commercialisation of research; and *iv*) innovation policy framework. In human capital development there is evidence that the United States is falling behind the leading OECD countries in educating younger generations (OECD, 2009b). The Americans aged 25 to 34 years are no longer more likely to have a higher education degree than Americans aged 55 to 64 years (OECD, 2009b). In addition, the United States lags behind other advanced countries in educational performance of 15-year-olds (OECD, 2009b). There are also growing achievement gaps between different groups of students in the United States (see also Chapter 2). In terms of tax credits, the US R&D tax credit has fallen to 17th for large companies (18th for the small and medium-sized enterprises) among the OECD countries. In addition, while the United States offers an incremental R&D tax credit, many other countries now offer a flat tax credit for R&D expenditures.

While the Bayh-Dole Act has accelerated the commercialisation of university-developed inventions in the United States, there appears to be a sub-optimal level and pace of commercialisation.² In the US system, the faculty-inventors are restricted to using their own university's technology licensing offices (TLOs) as a licensing agent. TLOs, however, vary in their effectiveness and in the experience of their staff. Outside of the top tier of commercialising universities with a significant deal flow and efficient TLOs, the majority of the university TLOs generate less licensing revenue for the university than the cost of their operations³ (Litan and Mitchell, 2009). In addition, the industry-academia partnerships in the United States usually involve only one firm, limiting the diffusion of the benefits throughout the economy (Wial, 2009). In terms of regional development there is also a concern that many universities have focused on technology transfer and developing revenue streams from products that have limited or no relation to the regional economy. As a result, most US second-tier universities have not been successful in building regional clusters and innovation systems (Wessner, 2009). There have been some attempts to link higher education with regional development, for example, through the University Center Economic Development Programme, which funds efforts at universities in over 40 states to connect with their local and regional economies, but the programme is limited to a funding base of USD 7.2 million (Christopherson, 2009).

Many OECD countries, including the United Kingdom, Finland, Japan, South Korea and Sweden, have created national innovation strategies designed to link science, technology and innovation with economic growth. This has been done in order to address complex and systemic challenges

through coordinated strategies that leverage the resources of the government, industry and academia. The challenges that require a multi-stakeholder approach include expanding health care, deploying digital infrastructure, achieving sustainable energy production, fighting climate change and producing a skilled labour force for the globalising economy. In the United States, however, the federal government's role in innovation has been traditionally limited to funding basic research, subsidising the education of scientists and engineers and maintaining a system of intellectual property law. The United States has not had a coordinated innovation agenda, national innovation strategy or agency to advance innovation.

Recently, the US Federal Government has taken steps to transform the United States into an "Innovation Economy" that will support innovation for sustainable growth and quality jobs. The goal is to restore the US leadership in fundamental research to lay the foundation for new discoveries and technologies, to educate next generation with 21st century knowledge and skills in order to build world-class workforce, to develop a leading physical infrastructure in order to connect people and businesses and to develop advanced information technology ecosystem. These will form the basis for innovation that will promote competitive markets that spur productive entrepreneurship and catalyse breakthroughs for national priorities for example in clean energy, health care and advanced vehicle technologies (NEC, 2009). The nation's first Chief Technology Officer has been appointed; USD 100 million in grants has been provided for the development of regional clusters of high-technology focused areas and USD 50 million to build a national network of business incubators to encourage entrepreneurial activity in economically distressed areas; the Bureau of Economic Analysis has been directed to measure the role of innovation in the economy; and as part of stimulus package, considerable investments have been made to boost green R&D, digital infrastructure, broadband, health IT, speed rail and the smart grid for energy distribution.

The regional picture in the United States

While many US state and local governments have established technology-based economic development programmes to promote innovation, these programmes remain focused on the same high-technology industries regardless of whether they are suited to the regional and local economies (Wial, 2009). The Texas Emerging Technology Fund (ETF) provides financial support that boosts innovation for example through industry-university partnerships. The regional economic development agencies on the US side of the Paso del Norte Region – the El Paso Regional Economic Development Corporation (REDCo) and the Mesilla Valley

Economic Development Alliance (MVEDA) – see their main role as attracting direct investment and serving industry that is either relocating or expanding in their respective sub-regions.⁴ These agencies work in close collaboration with the higher education institutions. In addition, the Upper Rio Grande Workforce Development Board provides labour market information to regional employers and other stakeholders such as educational institutions.

In Texas, REDCo, the El Paso Regional Economic Development Corporation, a non-profit organisation funded mostly by the local private sector in El Paso, focuses its efforts on serving business and industry interested in relocating or expanding their operations to the Greater El Paso. Contrary to other regional development agencies, REDCo sees its role in wider terms and reaches out to Ciudad Juárez. REDCo has identified four primary targets for business development and relocation, each of which provide opportunities for manufacturing, engineering and R&D. The fields are: *i*) military/defence/homeland security; *ii*) life sciences; *iii*) alternative and renewable energies; and *iv*) automotive industry. REDCo is also interested in attracting data centres, suppliers to the *maquila* industry, high-end white collar operations, such as headquarters and technical support centres and water technologies.

The Mesilla Valley Economic Development Alliance (MVEDA) focuses its efforts on serving industries considering location and expansion within Doña Ana County which is the second most populated county in the State of New Mexico. MVEDA is a public/private sector economic development partnership that is financially supported by the City of Las Cruces, Doña Ana County, New Mexico State University, Doña Ana Community College, the Las Cruces public schools, the Village of Hatch and over 90 local businesses and organisations. MVEDA collaborates with other state and regional economic development agencies including the New Mexico Economic Development Department and the New Mexico Partnership in bringing new jobs to New Mexico. MVEDA provides labour market analysis, land and building options, financial contacts, job training and employee recruitment assistance, custom research, coordination of state and local assistance and site tours.

Pro-innovation policies in Mexico

In Mexico, national policies do not yet sufficiently support regional innovation systems or clusters. There is no co-ordinated regional development policy approach and current efforts for regional development focus on poverty or infrastructure rather than competitiveness. Only a few enterprise-related policies (sectoral, small and medium-sized enterprises,

FDI programmes) take regional specificities into account while most sectoral programmes are place-blind. While Science, Technology and Innovation (STI) Policy is increasingly recognising the importance of regional innovation systems, the concentration of innovation resources in Mexico City, and to a lesser extent in Monterrey, slows down the capacity building at the state and sub-national levels. The overall national budget for STI programmes is also very small and the regional allocation is a small, albeit increasing share of the budget (OECD, 2009c).

The National Science and Technology Council (CONACYT) provides some incentives for regional engagement of higher education institutions to foster knowledge transfer and university-industry collaboration. CONACYT uses the Mixed Funds Programme (Fondos Mixtos), FOMIX, and Alliances and Innovation Networks for Competitiveness (AERIs) to promote scientific and technological development at the sub-national level. Both require participation of a higher education institution. In 2009, the Institutional Fund for Regional Development through the promotion of Science, Technology and Innovation, FORDECYT, was created to complement the FOMIX programme by targeting both geographic regions (states of neighbouring municipalities) and thematic regions (groups of municipalities or states with common challenges). CONACYT also has a programme with the Mexican Institute for Intellectual Property (IMPI) to support technology transfer offices in higher education institutions, research centres and other institutions. Furthermore CONACYT supports the emerging regional innovation systems through financing advanced degree training, competitive research and scholarship. There are also 27 CONACYT centres around the country (OECD, 2009c), including the Centre for Advanced Materials Research (CIMAV, in its Spanish acronym) in the City of Chihuahua, with a satellite office in Ciudad Juárez.

The regional picture in Mexico

The Chihuahua Council for Economic Development (Consejo de Desarrollo Económico de Chihuahua), CODECH, acts as a regional development agency for the State of Chihuahua. It is the leading force in the “triple helix” collaboration between academia, government and private sector and leads the industry-academia liaison council, COVAP, which was established in 2006 to match the supply and demand for skilled labour in selected industries. INADET (Instituto de Apoyo al Desarrollo Tecnológico) under the Secretariat of Industrial Development promotes the development of technological infrastructure in the State of Chihuahua. It promotes technological R&D institutes and organisations, establishes and administrates advanced technical training institutes, provides financial support for innovation and technological improvement in small business and

supports the establishment of linkages between industry, government and educational institutions. Based on the INADET's liaison programme in 2007, R&D institutes belonging to the National Science and Technology Council (CONACYT) rendered 1 540 specialised services to 402 industrial companies in the State of Chihuahua.

There is also the Council for Regional Economic Development (Consejo de Desarrollo Económico Regional), CODER, which supports the design and implementation of regional policies in areas surrounding the state capital city of Chihuahua, 372 km (231 miles) from Ciudad Juárez. The economic development agency of Ciudad Juárez (DECJ) has a focus on attracting foreign direct investment to the city.

Small business development in the United States

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

Collaboration is essential for innovation as small businesses and universities play an increasingly important role in the innovation process. Usually, small and medium-sized enterprises (SMEs), however, face considerable difficulties in working with the higher education institutions and accessing their knowledge and expertise. In the United States, a number of programmes are in place to support development and innovation in SMEs and to help them judge the commercial potential of academic research results. While aspatial in their design these programmes have benefited SMEs and local industries at the regional level. They have helped to create a “demand pull” within SMEs and encouraged them to evaluate commercial potential of research results. These “demand pull” policies are a response to the universities' emphasis on knowledge generation and excellence in research rather than knowledge transfer and the fact that professors are primarily motivated by publishing the acknowledgement. Channelling technology transfer funds through higher education institutions or public research laboratories may therefore not be the best way to commercialise research results.

For example, the Manufacturing Extension Partnership (MEP) enables small companies to improve their productivity and create the capacity to innovation. This programme has been measurably successful in increasing small company productivity. Its funding decreased from USD 138.4 million

in 1995 to USD 90 million in 2008 (Christopherson, 2009) to pick up again in 2009. Other important programmes include the Small Business Innovation Research Program (SBIR), the Small Business Technology Transfer Research Program (STTR) and the Advanced Technology Program (ATP) (see Box 3.1). The US higher education institutions in the Paso del Norte Region have taken advantage of these programmes although no data is available about the scale of their engagement, the number of companies involved or the outcomes of the collaboration.

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

In 1982, the United States passed the Small Business Innovation Research Act (SBIR) in order to facilitate the absorption of new technology by small and medium-sized enterprises (SMEs) and in 1992 it passed the Small Business Technology Transfer Research Act (STTR). The SBIR provides up to USD 850 000 in early stage R&D to small technology companies or to entrepreneurs who launch a company. The STTR programme provides up to a similar sum to small companies working in cooperation with academic researchers in public laboratories in order to explore the commercial feasibility of new ideas emerging from these institutions. The different federal departments that allocate R&D funds to private firms run both programmes. In 2007, all departments combined, SBIR was funded at USD 1.14 billion and STTR at USD 131 million. In order to qualify for SBIR grants, firms must have fewer than 500 employees and conduct R&D in the United States. In addition the principal investigator must work at least half time in the proposing firm. The STTR grants have similar firm-size requirements, but the principal investigator may be employed at either the firm or the research institution. Also the SMEs have to be more than 50% owned by its managers and/or employees. This requirement has the benefit of concentrating funds in the early stages of technology development. SBIR and STTR have helped thousands of innovative firms to explore the benefits of academic research results by reducing the cost of exploration and conversion of scientific ideas into commercial products (Auerswald and Branscomb, 2003). An evaluation of SBIR conducted in 2006 concluded that the SBIR programme is sound in concept and effective in practice and achieving most of its specific objectives. SBIR awards played a key role in the decision to pursue a research project and SBIR funding is often used to bring in academic consultants to partner with firms.

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

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

The Small Business Innovation Research Program (SBIR) is the largest US Innovation Partnership Programme with a budget of USD 2.3 billion in 2009 and has been in place for more than 25 years with a stable budget: 2.5% of Federal Agency R&D budget have been set aside for small business awards. SBIR has focused on funding proof of concept and prototypes and helped firms cross the “valley of death” and attract private capital or win public contracts.

In the United States, Small Business Development Centers (SBDCs) have a 30-year track record as an SME service network, with 1 100 centres located in higher education institutions, which serve annually 750 000 SMEs. Affiliated with the US Small Business Administration, SBDCs also assist clients gain debt and investment capital, domestic and international contracts. In 2007, the network assisted SME clients create 73 377 new jobs, save another 93 449 jobs at-risk, obtain new growth capital totalling USD 3.3 billion and increases sales by USD 7.2 billion (OECD, 2009c). In El Paso, the Small Business Development Center is administered by the El Paso Community College. It hosts the Small Business Management Institute, provides a wide range of services including free on-line learning opportunities, other training and seminars.

Small business development in Mexico

Compared to the United States, new business formation faces challenges in Mexico predominantly due to bureaucratic constraints. However, following the US model, Small Business Development Centers

were also created in Mexico. Started in 2001 with the support of USAID Mexico, the Mexican Association of Small Business Development Centres (AMCDPE, in its Spanish acronym) was created to build capacity among Mexican higher education institutions to fulfil their role as actors within Mexico's economic development infrastructure. Today AMCDPE is a network of nearly 90 SBDCs that are housed across the country and hence have a regional focus. As in the United States, the SBDCs link higher education institutions and different levels of government to serve micro and small and medium-sized enterprises (SMEs). There have been plans to establish a web-based trade platform to link 75 000 small business clients of the US SBDCs with the Mexican network to increase bilateral trade opportunities, market research and technology deployment among SMEs on both sides of the border (OECD, 2009c). Currently there are no SBDCs belonging to the Mexican Association of Small Business Development Centres' network in Ciudad Juárez whereas the City of Chihuahua has four.

The Mexican SME Policy includes programmes that encourage collaboration and innovation. The Ministry of Economy, through the Fondo PYME (SME Fund), encourages the engagement of higher education institutions with their SMEs in the region. For example, the Programme for Innovation and Technology Development funds business accelerators and innovation laboratories that in many cases are housed in higher education institutions. The incubators of the national Systems of Incubators are also often run by higher education institutions (OECD, 2009a; 2009b). The Mexican Government along with Santander Bank rewards higher education institutions for their university-enterprise collaboration on a competitive basis.

In the State of Chihuahua, INADET (the state government's institute for the support of technological development) has launched the Applied Research and Technological Development Program for Small Businesses (PIADET). PIADET promotes collaboration between small companies and local or national research institutes and higher education institutions. Small companies benefit from improved competitiveness through technology transfer, applied research resulting in technological and process improvements and new prototypes. In 2003-08 support was given to 30 companies in 10 counties throughout the State of Chihuahua for a total of USD 340 000, ranging from USD 2 000 to USD 15 000 by a company. Many of the technology transfer activities involved CENALTEC (see Chapter 2, Box 2.1).

3.2 The Paso del Norte Region: a peripheral and old industrial region

The Paso del Norte Region combines many of the characteristics of peripheral and old industrial regions that have been identified as being less innovative in comparison to more central and agglomerated regions. The key challenges in the peripheral regions are a lack of dynamic clusters, low levels of R&D and innovation due to the predominance of small and medium-sized enterprises (SMEs) in traditional sectors and/or branch plants with limited absorptive capacity and a weak endowment with innovation support institutions.

In contrast, the old industrial regions have a predominance of mature industries and externally controlled firms. Various forms of “lock-in”, such as excessively strong business and policy networks and narrow orientation of knowledge providers on existing trajectories, may also hamper regional development. In both types of regions the focus is on incremental and process innovation (Tödtling and Trippl, 2005; see Box 3.2).

Different types of regions call for differentiated innovation policy approaches. In peripheral regions the key challenge is to strengthen and upgrade the regional economy by implementing measures that foster “catching up learning”. In particular, policy measures should target small and medium-sized enterprises (SMEs) and their innovation weaknesses as well as improving innovation attitudes. In addition to attracting innovative companies from outside and attempts to embed them in the region, there is also a need to support new firm formation and enhance the innovation capacities of the existing companies. Establishing mobility schemes, for example innovation assistants for SMEs and improving medium level skill provision are also necessary (see Table 3.1).

In old industrial regions it is important to foster the renewal of old sectors and innovation activities in the related industries and to upgrade the knowledge base. Policy should focus on industrial and technological diversification and on the reorganisation of existing firms, networks and institutions as well as formation of new enterprises. Foreign direct investment can bring complementary knowledge into old and new clusters. Higher education institutions should focus on supporting business activities in new industrial and technological fields and build up providers of new skills (see Table 3.2).

Box 3.2. Peripheral regions and old industrial regions

The main characteristic of **peripheral regions** is “organisational thinness”. There is a lack of dynamic clusters, support organisations and strong institutions promoting entrepreneurship and innovation. If there are clusters they are normally found in traditional industries with limited R&D and innovation activities. The emphasis is on incremental innovation and on process innovations. Although low and medium level qualifications may be readily available, the more specialised qualifications are rare due to a less developed knowledge infrastructure of specialised knowledge suppliers such as universities and research organisations. Networks are weakly developed in particular those to more specialised knowledge suppliers, such as universities and research organisations. The lower level of higher education and R&D provision reduces the internal innovation activity in the region and leads to a low absorptive capacity of the local firms. As a consequence, local firms – especially SMEs – have difficulties in accessing knowledge outside of the region which they need for technological upgrading as well as diffusing such knowledge which local gatekeepers have acquired among themselves in regional clusters. Technology transfer offices and organisations have been set up by higher education institutions – typically universities of applied sciences – or local business organisations but they are often not effective due to the lack of absorptive capacity in the economy. This implies that the knowledge does not reach the local firms (SMEs) or it does not meet their demand well enough, being too sophisticated to support the mode of innovation (producing incremental innovations) applied by the local firms.

Old industrial regions suffer from various forms of “lock-ins” that constrain their development potential and innovation capabilities. They are characterised by overspecialisation in mature industries which has led to a loss of regional competitive advantage and innovation capacity. Innovation activities follow mature technological trajectories and are focused on incremental and process innovations. Process innovations dominate over efforts to introduce radically new products in to the market. Old industrialised regions often have a developed and specialised knowledge generation and diffusion system oriented on the traditional industries and technology fields. A supply oriented approach to technology transfer reaches larger firms but fails to reach the smaller ones.

Source: Tödting, F. and M. Trippel (2005), “One Size Fits All? Towards a Differentiated Regional Innovation Policy Approach”, *Research Policy*, Vol. 34, No. 8, Elsevier, Oxford, pp. 1203-1219.

More differentiated innovation policy approaches are needed for each region, and the Paso del Norte Region and its sub-regions are no exception. The proposals in the paragraphs above, however, should be seen as a basis for a more tailored policy approach. In order to formulate and implement

policy intervention and initiatives, policy makers should have robust data about the specificities of the regional innovation system in the Paso del Norte Region and the factors undermining its development potential. The following sections will examine the various ways the region and its higher education institutions are responding to the challenges.

Table 3.1. Types of regions and innovation policy approaches

Focus	Type of region Peripheral regions (organisational thinness)	Old industrial regions (lock-in)
Strategic orientation of regional economy	Strengthening/upgrading of regional economy	Renewal of regional economy
Innovation strategy	Support “catching up learning” (organisation, technology).	Support innovation in new fields/trajectories
Firms and regional clusters	Improve strategic and innovation capabilities of SMEs. Strengthen potential clusters in the region.	Support product and process innovation for new markets. Support clusters in new/related industries or technologies.
	Link firms to clusters outside the region.	Restructure dominant industries. Diversify existing industry.
	Attract innovative companies.	Support new firm formation.
	Support new firm formation.	Attract cluster-related FDI.
Knowledge providers	Attract branches of national research organisations with relevance to the regional economy.	Set up research organisations and HEIs in new relevant fields.
Education/skills	Build up medium level skills (e.g. technical colleges, engineering schools, management schools).	Build up new skills required (technical colleges, HEIs).
	Mobility schemes (e.g. “innovation assistants” for SMEs).	Attract new skills.
Networks	Link firms to knowledge providers and transfer agencies inside the region and beyond, following a demand-led approach.	Stimulate networking with respect to new industries and technologies on regional, national and international levels.

Source: Modified from Tödtling, F. and M. Trippel (2005), “One Size Fits All? Towards a Differentiated Regional Innovation Policy Approach”, *Research Policy*, Vol. 34, No. 8, Elsevier, Oxford, pp. 1203-1219.

3.3 Responding to regional needs and demands

A central concern of this review is establishing the extent to which higher education institutions respond to the needs of their surrounding regions and the Paso del Norte Region and what mechanisms are in place to facilitate this. Individually each higher education institution has developed mechanisms for engaging with business and industry through research and technology transfer and the US universities have dedicated offices for technology transfer and intellectual property. While important for the development at the sub-regional level, this reinforces a sense of fragmentation.

Knowledge exchange between higher education and business and industry can take place through a wide range of mechanisms. Table 3.2 identifies some mechanisms and their presence in the Paso del Norte Region.

Table 3.2. Knowledge transfer mechanisms in the region

Type of approach	Paso del Norte	Main activities	Challenges
Licensing	NMSU UTEP	Selling of licenses by university agents to use university-owned patents, copyrights and other intellectual property.	Alternative commercialisation options should be considered with capacity to generate not only revenues but also economic development outcomes. Other strategies are required for intellectual property that cannot be legally protected or where tacit knowledge is attached to an innovation.
Spin-offs	NMSU UTEP UACJ ITESM	Creation of new firms based on knowledge acquired in the university, by university staff, students or external investors.	Numbers of spin-offs often remain at a low level. Taking stakes in spin-off enterprises is riskier than licensing. A choice may have to be made between concentrating resources on a few potentially high-growth spin-offs and spreading resources to support a larger number of spin-offs. Successful spin-off activity requires investing in entrepreneurial skills and attitudes in university staff, students and graduates.

Type of approach	Paso del Norte	Main activities	Challenges
Technology transfer offices (TTOs)	NMSU UTEP	Offices that manage the process of selling university patents and other intellectual property, usually through licenses.	Offices need to be well connected to and respected by academics. Linkages should be built not only with large firm customers but also SMEs. TTOs are likely to function best in HEIs with a large pool of exploitable intellectual property. Need to refocus on supporting industry productivity and innovation.
Technology brokers	RCIC BNSL	People and agencies to facilitate relationships among academics, entrepreneurs and support institutions that will help identify commercialisation opportunities and create exploitation partnerships.	Brokers need to audit and monitor intellectual property within the HEI and build relationships going beyond the obvious departments of business and engineering. Brokers need professional profiles with credibility for both academics and business.
Science parks	Under development in Ciudad Juárez (City of Knowledge), Las Cruces (Arrowhead Business and Research park) and El Paso (International Airport development, close to Fort Bliss)	Organisations that aim to increase the wealth of its community by promoting the culture of innovation and competitiveness of associated businesses and knowledge-based institutions. They manage the flow of knowledge and technology amongst HEIs, R&D institutions, companies and markets; facilitate the creation and growth of innovation-based companies through incubation and spin-off processes; and provide other value-added services and high quality space and facilities.	Since co-location does not necessarily generate knowledge transfer, regular channels for interaction between university staff, graduates and business must be developed. Science parks in smaller universities may not have sufficient knowledge transfer opportunities to attract firms. Location (proximity to services, transport) and connectivity are important in ensuring networking that will add value.
Incubators	NMSU UTEP UACJ ITESM	Programmes designed to accelerate the development of entrepreneurial companies through a range of business support resources and services. Incubators vary in the way they deliver their services, in their organisational structure and in the types of clients they serve. In many countries, funded by regional or national governments as part of economic development strategy. In the US, most independent, community-based and resourced projects.	Because spin-off numbers can be very low and variable, heavy investments in physical incubators should be avoided. To keep focused on the objective of providing start-up support, a policy to transfer firms to commercial premises as soon as they are ready needs to be developed.

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

Managing the university-industry interface

Each higher education institution has created its own mechanisms to manage the external interface. In some cases, there appears to be a fragmented approach to managing the university-industry interface with a number of different offices and units. For example, in the New Mexico State University, the Office of the Vice President for Research and the Graduate School and International Programs co-ordinate research activities and collaboration in the region. The Office of Strategic Initiatives (OSI) monitors opportunities for funding and helps develop and manage proposals for large projects. It also helps faculty create collaboration inside and outside the university. There is also the Intellectual Property Office and the Office of International and Border Programs (see Chapter 4, Box 4.3). The University of Texas at El Paso has a number of offices that manage the university-environment interface. These include the Technology Transfer Office, the Office of Research and Sponsored Projects which provides oversight and support for interdisciplinary research centres and the Office of Strategic Initiatives (OSI) that helps building partnerships and opportunities with a wide range of federal and military research facilities in the region.

Reorganising external affairs under a joint structure could lead to improved communication within the higher education institution, cost savings and more approachable structure from the perspective of external stakeholders. In many higher education institutions a single office has been established to manage the institution's external affairs including regional collaboration (see Box 3.3).

Box 3.3. Reorganising external affairs to enhance coordination and focus

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

Box 3.3. Reorganising external affairs to enhance coordination and focus (continued)

- What kinds of university-business relations programmes and services do business leaders need from the university in the areas of research partnerships, technology transfer and economic development collaborations (e.g. employment resources, continuing education, information services, consulting services, patents and inventions, laboratory services, research partnerships, special economic development projects and outreach for fund development purposes)?
- How do business leaders perceive the way UW-Madison currently applies its resources in the areas of research partnerships, technology transfer and economic development collaborations?
- How can the university better communicate its resources in the areas of research partnerships, technology transfer and economic development collaborations?

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

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

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

Collaborative mechanisms between the higher education institutions in the Paso del Norte Region remain limited. There is currently no mechanism of pooling the knowledge and expertise of all higher education institutions

to deliver support to industry. In particular small and medium-sized enterprises (SMEs) face a range of barriers in accessing the knowledge resources of the universities, which may discourage regional university/SME collaboration. While setting up a joint publicly visible office for higher education institutions in a bi-national, tri-state context is a challenge, modern technology can facilitate collaboration in this area.

In North East England, the Knowledge House is an initiative that provides an example of collaboration between universities using virtual and face-to-face collaboration. The Knowledge House was created in 1995 specifically to overcome the barriers in collaborating with the small and medium-sized enterprises (SMEs), and to increase the amount of technology transfer taking place between local firms and universities. The purpose was to create a structure that suited SMEs looking for help with a particular technical problem. Usually, the first barrier an SME faces in contacting a university about possible cooperation is the lack of knowledge of who to contact. The Knowledge House provided a single point of contact for all five universities in the North East England, plus the North East branch of the Open University in England. Over the years, the Knowledge House has evolved and developed and now serves all types of industry, ranging from multinationals to micro and small businesses. Each participating higher education institution has retained its own technology transfer office (see Box 3.4).

Box 3.4. Knowledge House: a collaborative network to support SMEs

Established in 1995 Knowledge House is a joint effort of the five universities in the North East of England (Durham, Newcastle, Northumbria, Sunderland and Teesside) along with the Open University in the North through universities regional association, *i.e.* the Universities for the North East (Unis4NE). It helps companies access university skills, expertise and specialist resources. It offers expert solutions, for developing ideas and solving problems through collaboration, consultancy, training and research. Knowledge House has a central headquarters and staff, which are placed at partner sites of the different universities. The network and its operations are supported by a web-based enquiry handling/project management and client relationship management system.

Box 3.4. Knowledge House: a collaborative network to support SMEs (continued)

Knowledge House can be accessed via a central node, based at a Regional Technology Centre, or any of the five university nodes. The initial enquiry is then sent out to contact people at each of the five regional universities, inviting them to suggest academics that could address the identified need. Each university has a co-ordinator responsible for ensuring that the requests are disseminated to the correct contacts. Ideally Knowledge House is able to offer the SME a choice of academic consultants and can facilitate a meeting for the firm's managers to meet with and select the most appropriate person for their needs.

The Knowledge House has generated an income in excess of GBP 13 million for its universities from over 1 300 projects since 1996, with GBP 7.6 million of this coming in the last four years. The Knowledge House's profile has risen significantly over time, with more than half (60%) of all enquiries generated since 2003. In 2007 the Knowledge House generated GBP 4.7 million for the participating universities by delivering 364 completed projects from over 800 business enquiries. Business growth has averaged 25% since 2000.

In contrast to networks providing signposting services only, Knowledge House offers a comprehensive service, stretching from the receipt and circulation of enquiries through project management and delivery to post completion evaluation. It is also playing its part in the integration and consolidation of the business support services in the North East through formal agreements and joint appointments with other non-university business support agencies such as the Business Links Service and the Regional Development Agency. Knowledge House is also facilitating a culture change within the academia as an increasing number of higher education staff across the region's universities are becoming engaged with the Knowledge House activities.

Source: OECD (2007), *Higher Education and Regions: Globally Competitive, Locally Engaged*, OECD Publishing, Paris; and Potts, G. (1998), "The HESIN Knowledge House: A Front Door to North East Universities" *Local Economy*, Vol. 13, No. 3, Routledge, London, pp. 267-271.

Mobility schemes

As noted in Chapter 2, the Paso del Norte Region is a net exporter of educated workforce, particularly in the fields of engineering and computer sciences. For example, many graduates of the University of Texas at El Paso (UTEP) in science, technology, engineering and mathematics are recruited by national and international companies outside the region. The university's production of engineers and scientists far exceeds the limited workforce

demand from local and regional employers and the university is exporting most of its graduates in these fields to the telecommunications industry in north Dallas, the energy industry in Houston, the aerospace industry in southern California and high tech companies in San Jose, Seattle and elsewhere. About 49% of UTEP graduates leave the region but many come back, and many say they desire to stay in the region if work is available. Similarly, the engineering graduates of the New Mexico State University (NMSU) are recruited by businesses across the world. Recently, Ciudad Juárez has started to experience brain drain when graduates find employment outside of the region.

In light of this development, it is surprising that there is only limited evidence of knowledge transfer programmes based on people mobility between higher education institutions and industry in the Paso del Norte Region. While a number of institutions have *ad hoc* systems in place, and in some fields there are internship arrangements for students, systematic programmes linking for example post-graduates in the regional industry are not in evidence.

However, the Autonomous University of Ciudad Juárez has an ongoing visiting programme with the manufacturing community through its various laboratories. The New Mexico State University (NMSU) encourages the exchange of research staff between the university, industry and public organisations, affiliated faculty and visiting faculty positions. Its College of Business runs an Entrepreneur in Residence Program through which business and industry leaders can share their entrepreneurial experiences with students and faculty and work on projects. NMSU also has different types of grants for students and staff that can be linked to regionally relevant research projects.⁵ The University of Texas at El Paso (UTEP) has programmes with various industry and national laboratory partners that focus on the exchange of research staff. UTEP staff and students participate in internships at Los Alamos, Sandia, Oak Ridge and Lawrence Livermore National Laboratories. Many of the university centres work with industries like Boeing and Lockheed Martin Corporation. UTEP also works with small businesses within the local region to identify positions for students who must complete internships with national laboratories or industry. However, no robust data was provided about the scope of the various programmes in terms of participating staff or students and the number of companies.

To improve graduate retention and quality and attractiveness of local jobs, the region should consider establishing specific programmes to link the students, graduates and post-graduates with the local industry. The Knowledge Transfer Partnership Scheme in the United Kingdom has been running successfully (previously as Teaching Company Schemes) since the 1970s. Knowledge Transfer Partnerships improve the competitiveness of the

companies through introduction of some form of innovation or new technology, while an additional benefit is usually the recruitment of the postgraduate associate; around 75% of associates in projects lasting from one to three years are offered jobs in the company (see Box 3.5).

Box 3.5. UK Knowledge Transfer Partnerships

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

The scheme is partly funded by the companies involved and partly by a public organisation such as the Technology Strategy Board or a Research Council, with more advantageous terms available for small and medium-sized enterprises (SMEs). Typically an SME would pay around GBP 20 000 per year for involvement. The projects are usually 2 years in duration and the postgraduate associate is employed to work in the company during this period on a pre-defined project. The associate is paid a salary and in some cases is registered for a higher degree (usually devoting 10% of their working time to professional development), and forms the linkage between the company and the supervising academic in a university or research organisation. The academic partner is compensated for some of the time of the supervisor and for university overheads (KTP, 2010).

The primary outcome of the project is usually the implementation of some form of innovation or technology in the company, although an additional benefit is usually the recruitment of the associate and around 75% of associates in projects lasting 1-3 years are offered jobs in the company. The 2008/09 annual report for the scheme reported 977 active projects and estimated the benefits to UK business would be over 6 500 staff trained, 1 119 new jobs created and an increase in pre-tax profits of GBP 126 million (TSB, 2009).

Source: OECD (forthcoming), *The State of Victoria, Australia*, Reviews of Higher Education in Regional and City Development, OECD, Paris.

Commercialisation

As noted earlier, there has been considerable encouragement for the US universities to promote the commercial exploitation of their technologies. Much of this activity is based on a technology-push model as inventions developed in the university are marketed to potential licensees in industry. Similarly, the US universities in the Paso del Norte Region have established their own dedicated offices to handle commercialisation and intellectual

property issues. These include the Intellectual Property Office within the Arrowhead Centre at the New Mexico State University (NMSU) and the newly established Technology Transfer Office and the Centre for Research, Entrepreneurship and Innovative Enterprises (CREIE) at the University of Texas at El Paso. The NMSU Intellectual Property Office has been created to profit economic development in the State of New Mexico whereas the aim of CREIE is to promote innovation and knowledge exchange between researchers and industry and to bring people together to pursue joint ventures. Its ambition is to serve as a broker between academics, local companies and international partners and assist in finding venture capital to support research that has commercial value. It is still too early to evaluate to what extent CREIE is achieving these goals (see also Chapter 2).

The national legal framework for intellectual property rights in the United States is helpful in protecting ideas and research of the members of the academia.⁶ However, both the New Mexico State University and the University of Texas at El Paso identified legal costs, lengthy time for patent issuance (sometimes technologies are outdated by the time patent is granted), limited budgets and the limited long term return on investment as barriers to patent and commercialisation activities. Moreover, the University of Texas at El Paso also reported that formal partnerships are difficult to establish because of disagreements between the university and the industry partner on the ownership and rights of university generated intellectual property (RSC, 2009).

The existing technology licensing offices (TLOs) in the Paso del Norte US universities do not appear to have economies of scale or scope to optimally commercialise faculty innovations. While no robust data was available, the scale of commercialisation activity appears to remain relatively small (see Table 9). Despite increasing numbers of patents, no information was provided about the revenues generated and no indication was provided on how much of this activity has benefited the respective states (or the cross-border region). It can be expected that the existing technology licensing offices actually lose money as is the case with many other TLOs in the United States.⁷ It can also be expected that much of the current activity involves commercialisation outside of the region.

On the Mexican side, the legal basis for intellectual property protection is not yet fully developed. As a consequence, internal procedures or policies to address intellectual property rights are at early stages of development in many Mexican higher education institutions. For example, the higher education institutions in Ciudad Juárez do not have technology-licensing offices. While the institutions cannot report transactions in this arena, individual faculty members have registered patents with the Mexican Institute of Industrial Property (IMPI). However, no data was available.

Some universities see the lack of national legal framework as a constraint on the commercialisation of research for both academia and industry.

Table 3.3. Universities in the region – patents

	NMSU*	UTEP 2009
License agreements executed	3	1
License agreements in negotiations	3	
Patents awarded	3	3
Patent applications filed	11	1
Provision patents filed	5	11
Disclosures filed	12	28
Foreign patents awarded	3	

* recent activity

Source: RSC (Regional Stakeholders Committee) (2009), “The Paso del Norte Region, US-Mexico: Self-Evaluation Report”, OECD Reviews of Higher Education in Regional and City Development, IMHE, www.oecd.org/dataoecd/48/2/44210876.pdf

Given the limited scope of the revenues generated by the technology transfer offices, broadening the understanding of knowledge transfer, knowledge utilisation and exploitation would be useful. By placing less emphasis on financial returns to the university and focusing on how the university research can support jobs, industry productivity and innovation in the region, the university technology transfer offices could move away from a transaction-based system to a system that is based on developing continuous partnerships with industry, government and other partners. Key aspects of knowledge mobilisation include working to develop open access/open source systems and invention that have low revenue potential but high societal return. This type of broader knowledge transfer would have the potential to build support among broader segments within higher education institutions (beyond business and engineering faculties) and within non-profit sectors located in the cross border region. Recently the University of British Columbia’s University-Industry Liaison Office has gone through a strategic change to provide support for a broader set of support services to the region (see Box 3.6).

The development on the US side of the Paso del Norte Region is increasingly dependent on investments from the US federal government for border security, defence, health and environment. The large public role in the regional innovation system could move the idea of innovation away from the “commercially useful knowledge” towards a broader definition of generating “new knowledge.” The risk is that the success is measured according to the ability to attract public funding for an idea. A publicly-

driven innovation system may also negatively impact entrepreneurship attitudes. There was some evidence that the university faculty in the Paso del Norte Region see innovation as something happening in the university laboratory but fail to make the connection to job creation and the market where the products and processes need to be tested. For risks involved in publicly-driven innovation systems, see the “Higher Education in Regional and City Development Bío Bío, Chile” (OECD, forthcoming).

Box 3.6. Enlarging TTO perspectives to a broader set of support services: The University of British Columbia

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

- shifting the control of intellectual property to individual researchers in order to become more flexible and sensitive to industry sector considerations
- developing innovative ways of distributing many new discoveries that may not have a large financial potential but can nonetheless support a broader level of innovation
- acting as a leading contributor to the creation of principles to allow the developing world vital access to university inventions
- partnering with university faculties to develop new opportunities and resources for entrepreneurs within the university
- devising new ways of measuring the effectiveness of technology transfer and sponsored research activities that go beyond financial values to look at broader social and academic impacts

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

There is also a risk that the emphasis on public financing may delay the emergence of private sources of capital for innovation. This has been the case also in the Paso del Norte Region. Until November 2009 El Paso was one of the few cities of its size in the United States without a venture capital

group. The situation has, however, improved with the launch of Cottonwood which aims to create new, innovative business in the El Paso area in a number of fields, including water technology, advanced manufacturing, medical devices and alternative energy. These fields reflect the needs of the cross border region and have also been identified as key areas in the US innovation strategy. Cottonwood has an initial USD 8 million in funding pledged by several investors with the aim of increasing to USD 20 million to USD 25 million in pledged funds. The first investments were scheduled to be announced early 2010. Cottonwood appears to be particularly welcome as it bridges the “valley of death” for innovative start ups by focusing on seed money in the range of USD 500 000 to USD 1 million. This range is commendable in view of the fact that while the average venture capital investment is USD 8.3 million, most early stage US firms are in need of investments in the range of USD 100 000 to USD 700 000. Venture capital firms often find it too risky to invest in early-stage firms (the proof of concept/prototype is not yet achieved). Furthermore, they do not want to manage numerous small investments (Wessner, 2009).

The higher education institutions in the Paso del Norte Region have a tendency to measure success in innovation by the amount of (public) investment made, not the amount of commercial return generated or jobs created. This could be remedied by constructing efficiency/performance indicators for public agencies including higher education institutions involved in innovation. These indicators could include: *i*) time to process project applications; *ii*) cost to the proponent (in time and resources) of applying to various public programmes; *iii*) administrative costs for the programmes, etc. The indicators should be measured and benchmarked against a set of credible comparators that include good private sector actors as well as top public sector agencies. Speed is of the essence for innovation, so if authorities create programmes and instruments to substitute for the absent private sector, these should seek the highest levels of efficiency.

New business formation

The Paso del Norte Region suffers from brain drain, which suggests that finding ways to increase entrepreneurship could be an effective strategy for job creation. In the United States, small businesses employ 30% of high tech workers such as scientists, engineers and information technology workers. Spin-off companies are also likely to be locally based and have a local economic benefit. Recently, the US Economic Development Administration has launched a USD 50 million initiative to create a national network of business incubators to encourage entrepreneurial activity in economically distressed areas.

The Paso del Norte higher education institutions are in early stages of development of entrepreneurial activities. Higher education institutions have taken some initial measures to boost university spin-offs and graduate entrepreneurship in the region. For example, the Arrowhead Center of the New Mexico State University (NMSU) has currently one spin-off company and three separate business ideas in its incubation centre. Industries targeted by the Arrowhead incubator include energy and natural resources, aerospace and commercial space, biosciences, digital media and national security. The NMSU offers a range of services and skills training to potential entrepreneurs.

Work at the Materials Research and Technology Institute in the University of Texas at El Paso (UTEP) has produced start-ups dealing with an environmentally friendly technology for producing durable paints and pigments, producing clean transportation fuels from low quality petroleum sources and methods of using photosynthetic organisms in refinery waste for the production of biodiesel fuel. Geomedia, another UTEP start-up company, develops a seismic portable pavement analyser to inspect highways. Recently, UTEP also helped launch its first biotech company spin-off SeneXta Therapeutics, licensing a promising drug therapy for Alzheimer's disease, however this spin off is based in Switzerland.

On the Mexican side of the border, the Autonomous University of Ciudad Juárez (UACJ) launched its incubator in late 2008. It incubate 22 new projects during 2009, half of those related to medium to high innovation content in the areas of biomedical science, engineering and software. In 2009, two out of these had graduated. Entrepreneurship education is in an incipient phase with 17 electives at the undergraduate level in four different institutes that remain uncoordinated. Monterrey Tech's business incubator network provides support for the development of new businesses. The Ciudad Juárez Campus has a strong focus on social incubation. In 2009, the Sustainable Social Development Institute of the Ciudad Juárez Campus supported 18 projects that were in pre-incubation and four in the incubation phase. The social incubator facilitates the move from the self-employed to formal economy.

While no robust data were available about business creation or revenue generation, it appears that the current rate of facilitated business formation is about one company per university per year. This rate can be regarded as modest for a large university and the Paso del Norte universities are currently well underperforming on this measure (compare with the UK – see Charles and Conway, 2001 and HEFCE, 2008).

Mechanisms to improve collaborative cross border efforts among higher education institutions in business incubation and development remain

limited. The Bi-National Sustainability Laboratory (BNSL) is an initiative of Sandia National Laboratories, the US-Mexico Foundation for Science (FUMEC), the University of Texas at El Paso and the New Mexico State University and other regional organisations. It works with business as well as academic groups to help new technology driven start-ups. BNSL aims to create bi-national, collaborative partnerships focused on emerging technologies and to promote and implement economic development efforts within the border region to develop a sustainable, technology-based economy. The BNSL provides a broad array of services, including business development consulting, business incubation/technology accelerator, specialised facilities and “flex” space, seed funding and assistance to access funding from government sources, angel investors or venture capitalists, intellectual property consulting and other legal services, technology maturation and commercialisation strategies, strategic partnering and advanced training/certification. BNSL has a wide range of partners on both side of the border, including the Department of Commerce Economic Development Agency, the CONACYT (Mexican national Council of Science and Technology), FUMEC (the US-Mexico Science Foundation), higher education institutions in El Paso, New Mexico and Mexico (University of Texas at El Paso, El Paso Community College, New Mexico State University, Central New Mexico Community College, New Mexico Tech, University of New Mexico, Autonomous University of Ciudad Juárez, Monterrey Tech) and other regional organisations.

The Paso del Norte Region needs to aggressively step up concerted efforts to support entrepreneurship activities that are currently at early stages and share good practices among the higher education institutions, business and government. The work in the Mexican side of the border has begun to address this need and the Kauffman Foundation sponsors programmes, including Hispanic Entrepreneurship, at the University of Texas at El Paso and the New Mexico State University programmes in business development and incubation. These programmes should be extended and tied more closely to regional efforts, such as those being undertaken by REDCo and within the policy institutes in higher education institutions. The focus should be on an industry orientation rather than on individual firms. Recent OECD work on entrepreneurship recommends that university provision of entrepreneurship programmes should be expanded, focusing on growth-oriented entrepreneurship and using interactive and experiential teaching methods. International experiences highlight different approaches that the Paso del Norte Region and its higher education institutions could benefit from. In Brandenburg, Germany, universities and other higher education institutions collaborate together and with the regional development agency in order to pool resources and gain critical mass in advancing entrepreneurship (see Chapter 2, Box 2.3).

Monterrey Tech, one of the leading entrepreneurial universities in Latin America, has a broad approach to entrepreneurship that ranges from a wide portfolio of high-tech spin offs to an impressive record in support of social entrepreneurship, including notable work in remote and rural areas. Entrepreneurship training is compulsory to all students. In 2009, altogether 8 900 Monterrey Tech students took part in entrepreneurship education provided by 118 professors. Year after year, Monterrey Tech boasts the highest number of patent requests in Mexico. In 2007-08, the research centres generated 23 spin-off companies and the network of business incubators and accelerators created 4 700 direct jobs in Mexico. Universities throughout Latin America are following the Monterrey Tech curriculum and best practices in business formation and regional economic development (see Box 3.7).

Box 3.7. Enhancing entrepreneurship in Monterrey Tech

The Monterrey Tech (Tecnológico de Monterrey or ITESM) is a private institution of higher education founded in 1943 by Mexican business leaders. Today, Monterrey Tech has 33 campuses throughout Mexico and 6 academic centres in Latin American countries. It also has international offices in North America, Europe and Asia.

Monterrey Tech has pioneered entrepreneurship education in a wide range of disciplines and is using interactive methods to provide all students with the skills that they need to create and develop their own businesses. Entrepreneurship is a mandatory requirement for graduation in all study programmes and interdisciplinary open innovation spaces are available in most areas of study. Moreover, each campus provides business incubators for for-profit enterprises as well as for ventures seeking improvement in social and community development.

The Programa Emprendedor (Entrepreneur Programme) was launched in 1985 to develop entrepreneurial skills of students as part of the curricula. In addition, in 2002 an entrepreneurial certificate was launched as an option in several campuses. In 2007, a bachelor degree in business creation and development was launched and today it is been offered in 16 campuses with minors in consulting, research & innovation and social development and with an opportunity to focus on business in Asia, business culture in China or globalisation. There are also three graduate programmes in entrepreneurship: master in innovation and entrepreneurial development through the virtual university, master in entrepreneurial and technological innovation in partnership with Babson College and master in family business creation.

Box 3.7. Enhancing entrepreneurship in Monterrey Tech (continued)

The Monterrey Tech's Institute for Entrepreneurial Development (IDE) was established in 2006 to coordinate efforts in business creation and development. IDE has 26 business incubators, 14 business accelerators and 12 technology parks. In 2009, altogether 1 318 firms were involved in the IDE business development programmes; 1 068 of them in incubation phase ranging from pre-incubation to post-incubation, 198 in acceleration and 52 in technology parks. The Centre for Intellectual Property and Technology Transfer supports faculty members, students, investors and businesses with intangible asset and intellectual property valuation, commercialisation of technology developed by Monterrey Tech and acquisition of technology to create high-tech companies. The Angel Investors' clubs Network of Monterrey Tech integrates more than 130 private investors within the 10 regional clubs that have been established. In addition, the Sustainable Social Development Institute is running 60 incubators for social entrepreneurship in different parts of Mexico to support regional development and the creation and development of micro-businesses in the community.

The Ciudad Juárez campus of the Monterrey Tech's has 900 students, mainly local students. They are enrolled in 10 bachelor degree programmes, and masters and doctoral degrees which are offered through the Virtual University of the Monterrey Tech. The Ciudad Juárez Campus has a strong focus on social incubation. In 2009, the Sustainable Social Development Institute of the Ciudad Juárez Campus supported 18 projects which were in pre-incubation and four in the incubation phase. The projects in the social incubator are usually aimed at facilitating the move from self-employment to micro-businesses. In addition, the Ciudad Juárez Campus has provided training in basic computer skills, English language and mathematics to nearly 300 people. In addition, more than 60 people have studied online.

3.4 Engagement with clusters and industrial sectors

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

Economic Development Administration to support the creation of regional innovation clusters that leverage regions' existing competitive strengths to boost job creation and economic growth.

Cluster and industry-based development on the US side

There are considerable disparities across the Paso del Norte Region. One scenario is that these disparities may narrow over time with the wages in El Paso levelling out or decreasing and the wages on the Mexican side increasing. Alternatively, evidence suggests that income inequality on the US side will continue to increase with growth in high wage jobs related to the US federal investments and with continued inflow of poor people over the border because of the effects of the recession in Mexico. On the US side the tendency in the past has been to attract low skill/low-wage jobs but not to the degree that diversifies the region's job skills level. The cluster analysis prepared for the Upper Rio Grande Workforce Development reinforces the picture of an economy that is competing on low wages. In an analysis of the 45 "value chain" clusters constitution 65% of El Paso's employment, the Workforce Board study found that in the second quarter of 2005, only three clusters – plastic and rubber manufacturing, machine tools, and copper and copper products – paid an average wage that was above the US average for that cluster. The three clusters employed only 1.5% of the workforce (NCHEMS, 2007).

The low skill/low wage propensity is, however, a self-defeating strategy not only to El Paso and Las Cruces, but also to the entire cross border region. The higher education institutions on the US side should play a more active role in helping the Paso del Norte Region to build a robust economy based on knowledge and innovation. El Paso and Las Cruces will need to continue their efforts to expand alongside higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bi-lingual and bi-cultural environment and the ability to reach markets across NAFTA countries and Latin America.

The US side of the region is a home of a number of defence-oriented organisations that play an important role in the regional innovation system by generating or using considerable amount of R&D. These include Spaceport America, Los Alamos National Labs, Sandia National Labs, White Sands Missile Range and Fort Bliss. Due to their economic size, measured in hundreds of millions of US dollars, they are of critical importance for the regional economy and innovation system. They strengthen the local economy by an annual expenditure of USD 6 billion and offering employment opportunities for higher education graduates in science and engineering, in particular aeronautics (Chihuahua), aerospace

(Doña Ana Community College and New Mexico State University) and biosciences (New Mexico State University and University of the Texas at El Paso). While the communities on the US side of the border are the direct beneficiaries, the indirect economic spillovers may benefit the entire region. While Fort Bliss has taken steps to reach out to the community, the economic impact of military related activities remains low due to the limited interaction with the regional community. In addition, the projected mix of military forces at Fort Bliss, increase in combat troops and decrease in the number of officers, makes it harder to attract more highly educated people to the region (see Box 3.8).

Box 3.8. Key regional innovation actors in aerospace, defence and border security

Spaceport America, New Mexico

Spaceport America is a site for launching (or receiving) spacecraft in sub-orbital flights. This is an USD 200 million investment funded by the New Mexico State and local governments, located 72 km (45 miles) north from Las Cruces. The project, which is under construction, aims to create the infrastructure for commercial space flying. It will house the space travel services of Virgin Atlantic already committed to a 20-year utilisation contract as well as Space Port America Institute, a non-profit organisation, engaged in providing educational services. This investment aims to bring economic vitality to the region by opening up commercial space travel, educational services and tourism opportunities. It also encourage entrepreneurs to take advantage of business opportunities related to space travel by providing them with enabling support infrastructure.

Los Alamos National Labs, New Mexico

Los Alamos National Labs is a US Department of Energy national laboratory, located in Los Alamos, about 483 km (300 miles) north of Las Cruces. The laboratory is one of the world's largest science and technology institutions that conducts multidisciplinary research for fields such as national security, outer space, renewable energy, medicine, nanotechnology and supercomputing. It is the largest institution and the largest employer in northern New Mexico with approximately 12 500 full-time employees plus approximately 3 300 contractor personnel. There are also roughly 120 employees of the US Department of Energy stationed in the laboratory to provide federal oversight of the work and operations of the labs. Approximately one-third of the laboratory's technical staff members are physicists, one-fourth are engineers, one-sixth are chemists and materials scientists and the remainder work in mathematics and computational science, biology, geoscience, and other disciplines. Professional scientists and students also come to Los Alamos as visitors to participate in scientific projects. The staff collaborates with universities and industry in both basic and applied research. The annual budget is approximately USD 2.2 billion.

Box 3.8. Key regional innovation actors in aerospace, defence and border security (continued)**Sandia National Labs, New Mexico**

Sandia National Labs is a national laboratory managed and operated by the Sandia Corporation (a wholly owned subsidiary of Lockheed Martin Corporation) located about 354 km (220 miles) north of Las Cruces, New Mexico. Sandia National Labs is one of the two major US Department of Energy research and development national laboratories. Their primary mission is to develop, engineer and test the non-nuclear components of nuclear weapons. The primary campus is located on Kirtland Air Force Base in Albuquerque, New Mexico and the other is in Livermore, California, next to Lawrence Livermore National Laboratory. Both Labs have about 8 400 employees and an annual budget of USD 2.25 billion.

White Sands Missile Range (WSMR), New Mexico

White Sands Missile Range is a rocket range of almost 8 300 km² (3 200 square miles) in area, the largest military installation in the United States and includes the Oscura Range and the WSMR Otero Mesa bombing range. White Sands Missile Range and the 2 428 km² (600 000 acre) Fort Bliss Range Complex to the south form a contiguous swath of territory for military testing. The missile range is located in New Mexico about 42 km (26 miles) east of Las Cruces, New Mexico.

Fort Bliss, Texas

Fort Bliss the fastest growing military base in the world. It is a United States Army post in New Mexico and Texas. With an area of about 4 400 km² (1 700 square miles), it is the Army's second-largest installation behind the adjacent White Sands Missile Range. It is US Army Training and Doctrine Command (TRADOC) largest installation, and has the Army's largest manoeuvre area (for practicing military manoeuvres) behind the National Training Center. Fort Bliss also provides the largest contiguous tract of virtually unrestricted airspace, 3 900 km² (1 500 square miles) or 40% of the land owned by the US Army, which is needed for missile and artillery training and testing in the continental United States. The current population is about 10 000 and it is target to grow to 35 000 by 2012 due to base consolidation.

The research programmes in the US universities in the Paso del Norte Region are supporting the defence and border security industry, but also have a wider emphasis embracing border health and environmental sustainability (see also Chapter 4). For example, the New Mexico State University (NMSU) has defined five research clusters that facilitate multidisciplinary work: *i*) biosciences; *ii*) information sciences and security systems; *iii*) natural resources sustainability and renewal; *iv*) Southwest border region's health, education, culture; and *v*) the development of the 21st century aerospace. The university collaborates with Los Alamos National Laboratory, White Sands Missile Range, Sandia National Laboratory, The Air Force Research Laboratory, other research institutions in New Mexico, state and federal agencies and private contractors such as Raytheon, Boeing and Science Applications International Corporation. The New Mexico State University's Arrowhead Center has an industry-focused approach with potential to build strengths in the local and regional economy throughout the Paso del Norte Region.

The University of Texas at El Paso's (UTEP) strategic plan from 2008 to 2015 has a regional emphasis on interdisciplinary research to address the challenges in the multi-cultural cross border region. UTEP aims to focus its research and sponsored projects on fields that are relevant to the border region and which also provide advantages in seeking federal and state funding. These fields include the environment, particularly air and water quality, Hispanic health disparities, border security and immigration, transportation and community health. Research partners include mainly public organisations or non-profit associations, such as the Paso del Norte Health Foundation, the Regional Office of the US Environmental Protection Agency (EPA), the District Office of the Texas Department of transportation (TxDOT), the US-Mexico Border Health Commission, The Pan-American Health Organization (PAHO), the International Boundary and Water Commission and Fort Bliss. UTEP has also built its infrastructure to address the regional challenges with the help of major investments from the State of Texas and the University of Texas System.⁸ In future it will be important to retain and enhance the regional focus of UTEP research and mobilise the university more systematically for regional development.

The universities and community colleges benefit from state level investments that can boost cluster development and industry-university collaboration. For example the State of Texas has established funding mechanisms to support knowledge transfer. The Texas Emerging Technology Fund (ETF) is a USD 200 million fund created by the Texas Legislature in 2005 available to companies who seek to commercialise new technologies. ETF funds can also be used to develop collaborative relationships with higher education institutions in Texas to leverage federal

research grants and to achieve research superiority in certain technologies. The Technology Enhancement Fund of the State of New Mexico provides funds to research universities to support innovative applied research in agriculture, biotechnology, energy, materials science, microelectronics, water resources, aerospace, telecommunication, manufacturing science.

The higher education institutions on the US side seem to be focusing their activities on high technology areas or manufacturing where cluster development is at early stages of development. Undue focus on high technology sectors without a developing private sector base should be avoided. The collaboration with industry is spurred by public investments from federal government in border security, defence, health and environment. Challenges here are linked to publicly driven innovation strategies that may have negative impact on entrepreneurship attitudes. Whilst the higher education institutions were able to provide examples of engagement with individual businesses and publicly funded organisations, they found it more difficult to identify examples of well-established and systematic good practice engagements involving industries or groups of firms. Much of the evidence was of research-led collaborations initiated by university researchers or centres. New emerging sectors such as aerospace and logistics provide opportunities for closer cross border collaboration with Mexico. Broadening the sectoral orientation and the disciplines that underpin engagement could be beneficial for large and growing clusters in the service sector. At the moment, industrial engagement is seen by the university faculty as a science and engineering pursuit rather than a role that could embrace business schools, social sciences and the humanities. For example, a sector such as tourism, which has potential in the region, it could draw on faculty expertise in historic preservation, fine arts and cultural studies as well as business studies and ICT and also provide work-based learning and outreach opportunities.

Cluster and industry-based development on the Mexican side

On the Mexican side, the Chihuahua State Government has identified a number of clusters through its competitiveness committee. These include high and low technology fields as well as mature and emerging industries, such as electronics, aeronautics, *maquila*, nanotech, auto, ICT/software, agro and food industry, mining and building materials, wood and furniture. The state has invested in “triple helix” collaboration between the government, academic and industry. It has also developed mechanisms to facilitate cluster development. For example in 2006 on the initiative of the state government and the industry, an industry-academia liaison council COVAP was established to help match the supply and demand for highly skilled labour in selected enabling industries (the plastic injection moulding

industry and the metal mechanics industry). The COVAP collaboration includes labour market forecasts and studies, alignment of study programmes to industry needs, mechanisms to link industry and educational institutions (internships, mobility schemes) as well as monitoring and evaluation of results. While no robust data was available about the outcomes of the COVAP collaboration, this work is commendable as it has taken a concrete approach to improve the productivity through human capital development.

Ciudad Juárez, the largest manufacturing region in North America and the leading *maquila* city in Latin America, has over 200 manufacturing facilities. The multinationals in the city focus on the automotive and ICT/software industry and include Philips, Delphi, Lear and Cisco. As global operations they can purchase the R&D anywhere in the world and do not rely on obtaining it from the local higher education institutions. Many plants are also driven exclusively by cost competition. In order to maintain plant loyalty to the region, the regional and local governments need to ensure that opportunities for skills development and labour market training are in place to produce continuous productivity increases. There is also a need for stronger sector-based collaboration between higher education institutions and small and medium-sized enterprises.

There are a number of interesting initiatives in place. Based in the cities of Chihuahua and Ciudad Juárez, CENALTEC was established in 2000 through joint efforts by the Federal Ministry of Public Education (SEP), Chihuahua State Government and private enterprise. CENALTEC focuses on sector-based skilled workforce training and provides process improvements in small businesses through the Applied Research and Technological Development Program for Small Businesses (PIADET). Further efforts to encourage the sectoral model could focus on building the capacity of the workforce intermediary organisations to determine the changing skill needs of employer associations. Industrial groups made up of suppliers using similar technologies should be encouraged to form and cooperate with CENALTEC (see also Chapter 2).

The Monterrey Tech works to diversify the regional economy and collaborates in close partnership with manufacturing centres and *maquiladoras* such as Delphi with the aim to bring leading edge R&D to the region in the fields of biotechnology, health sciences, mechatronics, information and electronic technologies and development of new technology based education systems.

The Autonomous University of Ciudad Juárez (UACJ) has a focus on collaborating with the leading industries in the region. This work is carried out for example through the Centre for Applied Science and Technology

(MEMs) while the industrial engineering lab and the materials lab collaborate mainly with the national and international companies to enhance supply chain development. The university reaches out actively to the industry in the region: once a semester, 120 manufacturing facilities are visited to offer university services, co-operatives and R&D. UACJ has implemented co-operative work-based learning opportunities, co-ops which are mainly in the field of engineering and involve the leading industry partners. A considerable proportion of engineering students work while pursuing a degree (Regional Self-evaluation Report indicates two figures: 60% and 34%) and contribute to the knowledge transfer to the regional industry. Majority of these students are eventually also employed by the manufacturing industry.

However, the single most important effort in Ciudad Juárez is the development of the new 300-hectare campus “Ciudad del Conocimiento” (the City of Knowledge) for the Autonomous University of Ciudad Juárez. The City of Knowledge will bring together the satellites of the key higher education institutions in Mexico and will form a major knowledge hub with a capacity to draw foreign direct investment and to impact regional economic development. This project benefits from both state and government funding. The City of Knowledge will provide an opportunity to step up the widening participation efforts of the university. The challenge is to ensure that the investments in real estate will underpin enhanced knowledge exchange and innovation for the benefit of regional development and to integrate and sustain the effort over time. There is also scope to expand the collaboration with the higher education institutions on the other side of the Rio Grande in view of the broader development needs of the region. Furthermore, there will be a challenge to engage students and graduates, to develop a pipeline of spin off firms and graduate start-ups as well as ensuring that effective support is delivered to small and medium-sized enterprises and not only large firms (see also Chapter 4)

The State of Chihuahua and Ciudad Juárez have excelled in the “triple helix” collaboration bringing together government, academia and industry. There is a growing understanding of the opportunities for “bespoke” industry courses and the contribution of university research to addressing industry and business problems and issues among the higher education institutions in Ciudad Juárez. While the focus on continuous skills development for the benefit of the industry is commendable, too narrow skills development will not serve the population and the region in the long run. More emphasis needs to be put on developing general competencies that will allow people to adjust to rapid changes in the labour market and have the capacity for lifelong learning. Considerable efforts should be made by the state and local government and educational institutions to raise the

levels of education attainment. This is particularly important task for the Autonomous University of Ciudad Juárez. While focus on the “high end” of R&D is important this should not take place at the expense of strong undergraduate programmes.

Conclusions and recommendations

The Paso del Norte Region combines the characteristics of peripheral and old industrial regions which manifest in a lack of dynamic clusters, low levels of applied R&D and innovation due to the predominance of externally controlled firms, and small and medium-sized enterprises (SMEs) in traditional sectors. There is also a lack of networking and idea circulation and innovation support institutions have weak capacity and infrastructure. Various forms of “lock-in” are present in the region ranging from narrow orientation of knowledge providers on existing trajectories to a “low wage equilibrium” including low job creation.

Whilst there have been significant efforts by higher education institutions, regional development agencies, business and civil society as investment in the research infrastructure of the Paso del Norte Region, the connection with innovation and business formation is not yet adequately developed. There remain a number of challenges which the region faces and where higher education institutions could offer more to support the development of businesses and public sector innovation, particularly in health and environmental fields. These challenges include:

- Limited sense of a regional innovation system.
- Fragmentation of support for innovation leading to duplication of R&D projects, limited synergies and absence of a genuine market client.
- Low absorptive capacity and weak innovation culture in small and medium-sized enterprises and a lack of tradition of collaboration.
- Lack of robust information and data on innovation performance.
- Fragmented support from universities for enterprise at early stages of development.
- Public sector dependency and a lack of private sources of capital for innovation.

Overall in the Paso del Norte Region there appears to be limited evidence of the development of an innovation system in the form of a regional cross border system. While there is substantial investment from the

federal and state governments in the research components of the system and some areas of successful innovation within firms, there is limited integration between the system components and an absence of an underlying culture of collaboration. The higher education institutions did not present themselves as a coherent system, and there was no attempt to set out the collective needs of the region in terms of innovation infrastructure or for the universities to coordinate their actions in meeting such needs. The situation has led to replication of efforts and initiatives, and an overemphasis on science disciplines rather than wider coverage of the needs of business and industry.

Support for innovation remains fragmented within and among higher education institutions each developing their own initiatives often in isolation from each other and sometimes with other agencies. There appears to be no effective guidance system for business to identify where best to source support for innovation. While the main emphasis is on science and technology-driven innovation, Ciudad Juárez presents some good practice examples on incremental demand-led innovation. There seems to be few attempts to connect technologically-oriented centres with business faculties and with other disciplines to provide support for service and non-manufacturing sectors.

Within the region as a whole there is a low absorptive capacity and nascent innovation culture in the small and medium-sized enterprises (SMEs), and lack of tradition of collaboration between the SMEs. One consequence of this is a poor articulation of demand by the SME sector for services from the higher education institutions. Elsewhere SMEs are sometimes engaged in clusters with associations that are able to articulate generic needs and purchase services collectively on behalf of industry. There was limited evidence of this happening in the Paso del Norte Region.

There was a lack of information and data on innovation performance within the private sector and also within higher education institutions. There has not been a detailed investigation of the nature of innovation within firms, the barriers and problems and the experiences of collaboration with higher education institutions. Policy seems to be developed in the absence of evidence of the region's needs.

Entrepreneurship attitudes remain underdeveloped. There was limited evidence of enterprise support within the student and graduate community being mainstreamed within degree programmes and through supporting infrastructures. Where such support existed, it was fragmented with no real collaboration across higher education institutions in the region. Furthermore, there is dependency on the investments from federal government on both sides of the border. The large public role in the regional innovation system

could move the idea of innovation away from the “commercially useful knowledge” towards the generation of “new knowledge.” A publicly-driven innovation system may also negatively impact entrepreneurship attitudes and delay the emergence of private sources of capital for innovation.

To help the Paso del Norte Region break out of the path dependency, the OECD Review Team recommends that the following measures are taken to promote regional innovation:

- A systemic perspective should be applied in developing a regional development strategy by improving the connectivity in the regional innovation system through stronger collaboration and networking, consensus building for economic development and more efficient division of labour between the educational institutions and their partnering industries in order to create close research collaboration across higher education and research and industry, particularly small and medium-sized enterprises. Consistent innovation indicators should be developed and monitored over time (see Annex 3.1).
- The state and local governments should ensure that research on clusters and the demands of industry extend into the service sector. Clusters should also be conceptualised as cutting across the manufacturing-service divide. For example manufacturing innovations should increasingly incorporate service components. Higher education institutions should be encouraged to draw upon business schools, humanities and social sciences in providing assistance to business.
- To upgrade existing industry and to improve graduate retention, the region should consider establishing specific people-based mobility programmes to link the students, graduates and post-graduates with the local business and industry in a more systematic way. Models for linking postgraduate students with the local industry include the Knowledge Transfer Partnership Scheme in the United Kingdom that has improved the competitiveness of the companies through introduction of some form of innovation or new technology and helped retain 75% of the postgraduate associates which participate in the projects.
- The Paso del Norte Region, its higher education institutions, public and private sector should make systematic concerted efforts to support new business formation, minimise the administrative burden and build an environment and mechanisms that support start-up and entrepreneurial companies through aligning incentives for a sustained period of time. The higher education institutions should

attempt to match global levels of excellence in supporting entrepreneurship throughout the curriculum and build comprehensive support programmes encompassing entrepreneurship training, practical experience of creating new businesses for groups of students and incubation facilities tied with seed funds for new graduate ventures. Private funding sources willing to invest in “ideas” rather than real estate should be strengthened.

- To support the revitalised entrepreneurship agenda, public authorities should construct efficiency/performance indicators for public agencies including higher education institutions involved in innovation to reduce the tendency to measure success in innovation by the amount of (public) investment made, rather than the amount of commercial return generated or jobs created. These indicators could include: *i*) time to process project applications; *ii*) cost to the proponent (in time and resources) of applying to various public programmes; *iii*) administrative costs for the programmes, etc. The indicators should be benchmarked against a set of credible comparators that include good private sector actors as well as top public sector agencies.
- The universities in the Paso del Norte Region should focus their concerted efforts on challenge-driven innovation on the key issues in the cross border region, such as water, Hispanic/border health and border security in its broader sense and use the region as a “laboratory” for research, knowledge transfer and outreach to reach global levels of excellence. Job creation should be seen as the goal of innovation activities.
- The universities in the Paso del Norte Region should broaden their understanding of knowledge transfer, knowledge utilisation and exploitation and place less emphasis on immediate and direct financial return to the university. By focusing on how the university research can support jobs, industry productivity and innovation in the region, the university technology transfer offices could move towards a system that is based on continuous collaboration with industry, government and other partners. Stronger emphasis on the development of open access/open source systems (*e.g.* Digital Commons at UTEP) and interventions with low revenue potential but high potential to yield societal returns in order to build support among broader segments within higher education institutions (beyond business and engineering faculties) and within non-profit sectors in the cross border region.

- The Paso del Norte higher education institutions should develop a more practical engagement with business and a more collaborative way of referring enquiries from businesses and industry with the help of virtual and face-to-face collaboration. This service should be proactive rather than just a portal and the states should provide additional funding to encourage greater involvement by the small and medium-sized enterprises (SMEs). The Knowledge House in the North East of England provides a well functioning model linking five universities and Open University. Each higher education institution should consider establishing a single office to manage the institution's external interface including regional collaboration in order to improve communication within the higher education institution, generate cost savings and create more approachable structure from the perspective of external stakeholders.
- State government and higher education institutions in Ciudad Juárez should balance the current focus on industry skills development and high end R&D with considerable efforts to develop general competencies among the population to help adjustments to rapid changes in the labour market and to facilitate lifelong learning. Systematic concerted efforts should be made by the State of Chihuahua, educational institutions and key stakeholders to raise the levels of education attainment.
- El Paso and Las Cruces should continue their efforts to expand with higher skill/higher wage jobs in the environmental and health fields, defence-related fields and in global service operations that take advantage of the bi-lingual and bi-cultural environment. The higher education institutions on the US side should play a more active role in helping the Paso del Norte Region to build a more robust economy based on knowledge and innovation.
- Incentives for higher education institutions should be strengthened to increase their capacity to act as technology transfer “agents” to bring non-local knowledge to the region and to create community partnerships. Incentives for higher education institutions and their staff to engage in local and regional development should be developed. The state governments should seek to encourage greater collaboration between higher education institutions through joint investments in research facilities and incentive programmes.

Notes

1. Regional Innovation System (RIS) approach draws attention to the firms, clusters and institutions of an innovation system, to the interdependencies within the region and to higher spatial levels. A RIS is made up of two subsystems embedded in a common regional socioeconomic and cultural setting: the knowledge application subsystem and the knowledge generation and diffusion subsystem. In the idea case, there are interactive relationship with and between these subsystems facilitating continuous exchange of knowledge, resources and human capital. RIS approach is relevant because: *i*) regions differ with respect to their industrial specialisation pattern and their innovation performance; *ii*) knowledge spillovers are spatially bounded; *iii*) the exchange of tacit knowledge, which is important for successful innovation, requires intensive contacts of trust which are facilitated by proximity and *iv*) policy competences and institutions are partly bound to sub-national territories (See Tödtling and Tripl, 2005).
2. Evidence on the effectiveness of the Bayh-Dole Act is mixed. The Expert Panel on Commercialization concluded that it was directly responsible for the creation of thousands of new firms and added tens of billions of dollars to the US Economy (2006). However, an earlier study of Stanford, MIT and Columbia found very little change in these universities' patent and licensing portfolios in the 120 years following the passage of the act and concluded that it had very little, if any, effect on technology transfer (Mowery, *et al.*, 2001 in Niosi, Connecting the Dots between University Research and Industrial Innovation).
3. According to Stanford University's Office of Technology Licensing, for the last 15 years, Stanford has received an average of three to four new invention disclosures weekly, for a cumulative total of more than 3 200 disclosures. Of this total, Stanford has licensed over 800 inventions (+ over 400 licenses for the DNA patents alone), approximately one in four. Of these 800, about one-third produce income, but of these, only 22 inventions produce at least USD 100 000 per year.
4. REDCo provides a range of services to its clients ranging from up-to-date information on community infrastructure, business climate, labour force, workforce training options, taxation, regulation in Texas, New Mexico or Mexico; industrial briefings and industrial tours, access to initial, no-fee consultations with a diverse range of professionals licensed to practice in the United States and Mexico as well as site selection analysis and supplier assistance.

5. The NMSU Interdisciplinary Research Grant programme provides up to USD 50 000 to faculty teams whose research is of high quality and falls within one of the research clusters defined by the university; the Graduate Research Enhancement Grant provides up to USD 18 000 of matched funds to support graduate students working with faculty on external research projects; the Undergraduate Research Incentive Grant provides awards of up to USD 2 500 to undergraduate students working with faculty members on research projects.
6. In the United States, the national legal framework for intellectual property rights helps support the role of higher education institutions in research and innovation. By obtaining patents, trademarks, copyrights, the faculty-inventors can protect their work, freeing them to foster relationships with industry.
7. In Mexico, higher education institutions play a vital role in supporting regional clusters and innovation systems, but this “third mission” of regional engagement remains underdeveloped with no specific funding streams to support this type of activity.
8. The State of Texas and the University of Texas System have made major investments in the University of Texas at El Paso. More than USD 260 million in new construction and renovation projects are planned and scheduled to support growth and new programme directions in biosciences and biomedical engineering, chemistry and computer science and health sciences and nursing. New graduate programmes particularly in science and engineering will address regional and national issues. Under the University of Texas System there have been major increases in research. In 2007, UTEP research expenditures totalled nearly USD 50 million, USD 27 million of that federally funded, ranking UTEP fourth among Texas public universities.

Annex 3.1: Measuring regional entrepreneurial activity

Regional entrepreneurial activity metrics

The list of indicators below can provide a guideline to measure a region's progress on entrepreneurial activity of a region. Entrepreneurial activity can be measured through objective (hard data) and subjective (soft data) variables and can be monitored at regular intervals (quarterly, 6 month, yearly). This set of metrics can serve also to compare regions. Furthermore, a weighted sum of these metrics could be designed to create a regional innovation index or a regional entrepreneurial intensity index.

Primary regional metrics:

- Venture capital availability (hard data)
- Angel investors availability (hard data)
- Entrepreneurial support infrastructure (soft data)
- New company formation (hard data)
- State of cluster development (soft data)
- Utility patents (hard data)
- Intellectual property protection (soft data)
- Availability of scientists and engineers (hard data)
- Quality of scientific research institutions (soft data)
- Regional spending on R&D (private firms, government labs, universities, etc; hard data)
- Net Brain drain (soft data)
- University-industry research collaboration (soft data)
- Willingness of a firm to license foreign technology (soft data)
- Capacity of the firm to innovate when confronted with a technology deficit (soft data)
- Government procurement of advanced technology products (hard data)

- Labour laws flexibility (at will employment and no compete limitations – hard data)
- Willingness to take a large size of the compensation at risk (soft data)

Secondary/supporting regional metrics:

- Tertiary education enrolment and graduation (hard data)
- Education expenditure (hard data)
- Quality of math and science education (hard data)
- High-tech exports (hard data)
- Buyer sophistication (soft data)
- Time required starting a new business (hard data)
- Number of procedures required to start a business (hard data)
- Number of procedures to enforce a contract (hard data)
- Time to enforce a contract (hard data)
- Intensity of local competition (soft data)
- Local supplier quality (soft data)
- Local supplier quantity (soft data)

Source: Adapted from Schwab, K. (ed.) (2009), *The Global Competitiveness Report 2009-2010*, World Economic Forum, Geneva, pp. 337-338; and Dutta S. and I. Mia (eds.) (2009), *The Global Information Technology Report 2009–2010: ICT for Sustainability*, World Economic Forum, Geneva, p. 317.

An innovation and entrepreneurial intensity audit

A questionnaire of areas of opportunity to support regular audits of regional innovation and entrepreneurship intensity in the higher education institutions.

Innovation and entrepreneurship can drive economic development. The questionnaire has been developed to support the following overarching goals:

- Improve continually the regional strategy
- Increase regional competitiveness as the engine of true regional prosperity
- Regenerate the industrial base towards monotonically higher value added products and services
- Improve the productivity to produce higher quality products and services at an ever

decreasing unit cost

- Increase the skill base of human capital (quantity and quality)
- Increase the entrepreneurial attitude of society (willingness to take risk, acceptance of failure, high status of entrepreneurs etc.)
- Create jobs in new industries and/or new markets consistent with the regional strategy
- Reduce the number of marginalised
- Develop entrepreneurial attitude to innovate, embrace change and take risk in the community, government and non-profit sector

When considering the possible areas of impact of higher education institutions (HEIs) in the promotion of the regional innovation fabric, addressing the following opportunity areas is proposed:

HEI become a key actor developing an entrepreneurial ecosystem (leading by example)

1. Transition from a research university to an entrepreneurial university
2. Redefine curriculum to embrace innovation and entrepreneurship across multiple careers/disciplines
3. Retrain faculty and staff as change agents in a multi-disciplinary/multiple-stakeholders environment
4. Redefine its relationship with business and the community-at-large
5. Measure outcomes and outputs, and fine-tune the process to optimise results, constantly
6. Leverage the latest technology as a key enabler
7. Connected to the community, the region and the world via meaningful activities

HE Curriculum (what they do):

8. Strength the quality of creativity, innovation and entrepreneurship classes in the curriculum
9. Requirement for all areas of study (Monterey Tech model) vs. only few (business, engineering)
10. Promotion of multi-disciplinary classes, projects and activities, open innovation spaces etc.
11. Link classroom activities with experiential learning (Problem/work based learning)
12. Develop a set of classes which deal with bi-national businesses and multi-cultural markets
13. Create non-degree curriculum in innovation and entrepreneurship open to society

HE Co-curricular activities (how do they do it):

14. Science fair, business plan and elevator pitch competitions etc.
15. Business incubators/accelerators (entrepreneurial Ecosystems)
16. Open Innovation spaces
17. Business/technology consulting projects
18. Internship programmes
19. Communicate events widely across the region
20. Open events to society

HE integration to society (for whom they do it):

21. Alignment of the curriculum with the regional strategic (economic development) initiatives
22. Open to collaborations with other universities, research institutions, businesses to foster the application of knowledge and innovative applications for the benefit of society
23. Provide ample of opportunities for students to conceive and launch their new ventures
24. Provide a network of services for student entrepreneurs and their new ventures
25. Open services to the society in general
26. Promoting angel/VC investing groups
27. Bringing mentors and coaches from the business community
28. Engage productively retired executives as advisors and mentors or entrepreneurs
29. Creating networking events, guest speaker, panels, etc. open to the public
30. Industrial liaison/technology transfer/licensing offices
31. Grants and contract offices
32. Support offered to family owned business, social benefit ventures and established corporations and businesses

HE integrating to the world (for whom they do it):

33. Global faculty in science, technology, engineering and business
34. Ability to attract foreign students interest in science, technology, engineering and business
35. Creation of bi-national degrees
36. Promoting mobility of students, faculty and staff, regionally and globally
37. Ability to conduct global programmes promoting people and ideas circulation

38. Enabling faculty and students to reach out via meaningful projects and engagements

HE integration to local and regional government policies (with who they do it):

39. Funding, tax incentives, subsidies for the creation of business incubation/accelerators

40. Same for technology transfer centres

41. Creating a buzz about creativity, innovation and entrepreneurship in local/regional media, via events

42. Providing degree and non-degree programmes aligned with the regional strategic (economic development) initiatives

43. Provide training programmes aligned with labour market demand and future job opportunities

HE promotion of innovation at the base of the socio-economic pyramid (total inclusion – including the marginalised):

44. Promote innovation to maximise social benefit (social value creation as well as economic value creation)

Source: Adapted from Volkmann, C., et al. (eds.) (2009), *Educating the Next Wave of Entrepreneurs: Unlocking entrepreneurial capabilities to meet the global challenges of the 21st Century*, World Economic Forum, Geneva, p. 28.

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Chapter 4: Contribution of HEIs to environment, health and social development

The higher education institutions in the Paso del Norte Region have an important role to play in addressing the significant environmental and social problems facing the region and its constituent communities. This chapter focuses on three critical areas of higher education institutions' activity in the region: environmental sustainability, poverty and health and community engagement. The chapter highlights good practice from the region and internationally and concludes with recommendations to make collaboration and outreach more effective. The main message of the chapter is that whilst higher education institutions are often actively engaged with their local stakeholders, the picture of diverse projects and programmes is fragmented. Much more could be achieved through a comprehensive region wide approach to development, stronger evidence base and coordination of targeted efforts to address the key challenges in the region.

Introduction

Despite many manifestations of cross-border interdependence, economic and social development in border communities also reflects their different positions in their national economies. Comparing social and environmental conditions in the border states and, especially, in border cities is not without difficulty.¹ However, in terms of social indicators, it is obvious that the most notable characteristic within the Paso del Norte Region is that El Paso and Ciudad Juárez are both distinctively different from national patterns in their respective countries, the United States and Mexico.

US Census data indicate that El Paso City in Texas and County are among the poorest in the United States. El Paso City is the fourth poorest among middle size US cities (with 250 000 population) with a poverty rate of 27% in 2007. El Paso County has the third highest poverty rate in the United States (for counties of a similar size) with a 2007 rate of 29%. In the city of El Paso poverty is twice the US average. Doña Ana County in New Mexico does not provide as stark a contrast as El Paso but it is also one of the poorest counties in the United States, with a poverty rate of 25%. Exemplifying its status as a high poverty area, Doña Ana County includes 37 federally designated underdeveloped communities, *colonias*. The State of New Mexico estimates that 97% of *colonias* residents have an average annual income of USD 5 000. These *colonias* are without safe, sanitary and affordable housing, drinkable water, sewer, and/or drainage systems (DAC, 2010). In both El Paso and Doña Ana counties, per capita personal income is considerably below the US average, at approximately 66% of US average personal income.²

By contrast, the border states of Mexico have lower unemployment rates and higher wages compared to other regions of Mexico. According to CONAPO (Consejo Nacional de Población), Ciudad Juárez is among the 100 most developed municipalities in Mexico. While no recent information is available on poverty rates in Ciudad Juárez or the State of Chihuahua, OECD indicates that the poverty rate in Mexico declined from 21% to 18.5% between the late 1990s and mid-2000s (those who earn less than 50% of the country's average income are considered by the OECD as poor). In addition, Mexican border cities also have the lowest poverty rates and highest literacy rates in the country. While the national illiteracy rate in 2008 for Mexico is 7.7% (INEGI, 2009), in Ciudad Juárez only 2.3% of the population is illiterate (CONEVAL, 2007).

The differences in the position of border cities relative to the national socio-economic conditions affect attitudes toward and capacities for addressing environmental, social and health problems affecting the region as

a whole. In Mexico, Ciudad Juárez is perceived as a successful example of national attempts to connect with global markets, while in the United States the border counties and cities are perceived as exemplifying the problems created by an open border with a country with a poor and poorly educated population.

The higher education institutions in the region can contribute to developing co-operative strategies that can respond to issues that are difficult to address through inter-governmental co-operative efforts. These contributions are particularly valuable in the development of region-wide information systems and research efforts.

4.1 Environmental sustainability

The Paso del Norte Region faces difficult environmental challenges because of the fragility and limits of its desert environment, poverty and rapid population growth. The region has historically suffered from environmental degradation caused by air pollution, chemicals used in agriculture (including DDT)³ and hazardous waste dumping. These environmental problems have had deleterious consequences for the health of the population. Experts on environmental conditions in the Paso del Norte Region note that, because of the continuing and rapid population growth in the region, it has been difficult to keep up with the very serious environmental problems (Lehman, 2001).

Paso del Norte's air quality remains a serious challenge on the US-Mexico border and has been of particular concern to residents of the region for many years (Joint Advisory Committee, 1999). Ciudad Juárez exceeds national ambient air quality standards (official norms) for ozone, carbon monoxide, and particulate matter less than 10 microns in diameter (PM10), and El Paso exceeds national ambient air quality standards for ozone, PM10, and carbon monoxide. These types of air pollution are linked to respiratory and cardiovascular diseases, and to premature mortality (Blackman *et al.*, 2004). In addition, the region faces an on-going challenge in providing the quantity and quality of water required for its growing population.

Global greenhouse gas emissions are projected to increase by more than 50% by 2050, causing a significant increase in world temperatures (OECD, 2009). The Paso del Norte Region and particularly Ciudad Juárez, is subject to severe drought, which has considerable impact on the water supply system. Persistent and widespread drought started in mid-1990s as a consequence of land cover change in Mexico. Climate model experiments indicate that the south-western part of the United States and Mexico will experience progressive drying during the 21st century as a result of convergence of natural and anthropogenic drought (Stahle, 2009).

According to a recent study of trans-boundary water planning (Hamlyn, et al., 2002), “The paradox of a large and growing population in a region with limited and diminishing water resources represents a significant challenge to all communities in the Paso del Norte. This situation is particularly dire for Ciudad Juárez, the largest and most rapidly growing city in the Paso del Norte, which faces a near-term crisis due to severe depletion of fresh ground water. In a cruel irony, due to a combination of geography, institutional barriers, and limited financial resources, Ciudad Juárez is more restricted in its options than either of its neighbouring cities.

The region recognises the severity of water problems in the Paso del Norte and has taken steps in the area of water reclamation, water conservation efforts and policies. However, much more needs to be done. The effect of international trade treaties promotes further industrial expansion, and many economic development organisations work to lure more industry into the region, thus spurring population growth and increasing water demand. City planners continue to impose regulations that mandate a low-density development with ample yard space, thereby unwittingly encouraging homeowners to expend precious water resources on outdoor landscaping. The amount of land under irrigation in the region has not reduced, and many farmers have begun planting orchards of pecan trees that, although yielding greater profits, require more water per unit of land area than the crops they replaced. Hard choices and difficult “trade-offs” lie ahead, but planning has been slow to respond to this challenge. What is needed is a comprehensive, regional approach to water planning and growth management, but the political fragmentation of the region impedes such action.

While climate change and persistent drought are a challenge, they can also be an opportunity to develop a more resilient and sustainable economy. It can encourage positive developments for regions, including increased efficiency in energy management, industrial production, spatial development, public and private transport, construction and operation of buildings and water management. Up-scaling the research and innovation effort may yield significant returns in local and regional development. For example, jobs related to renewable energy and energy efficiency are projected to increase to several millions worldwide by 2030, many of them in a small number of innovative regions. In addition, despite the current financial crisis, venture capitalists anticipate a continuous increase in their investments to boost clean technologies (Deloitte, 2009).⁴

In the absence of a comprehensive regional approach and incentives, higher education institutions are less likely to make rapid progress in supporting sustainability and green economy. There is also a risk that the main beneficiaries of technology transfer from higher education institutions

will be the large enterprises, delaying the market penetration of the green market by SMEs. Positive outcomes would require concrete action to identify opportunities for change, to create innovations in water management and to make low-carbon technologies more attractive, and develop skills to make wider use of green technologies. International experience has shown that universities can play a key role in this arena through research and cluster based development (See Box 4.1).

Box 4.1. HEIs in supporting renewable energies and eco-innovation clusters

Expertise in wind engineering and wind energy at the Danish Technological Institute and at Ålborg and Århus Universities is essential in the development of the Danish wind energy industry (Cooke, 2008). Similarly, patented research on improved pasture seed mixes (SugarGrass) at the Institute for Grassland & Environmental Research (IGER) has given rise to a dynamic bio-fuel cluster in the rural North Wales. Research in storm-water treatment at Monash University in Australia resulted in one of the most efficient technologies (Enviss) of porous pavement to capture storm-water which is now being commercialised by a spinoff firm (Enviss, 2010). Swinburne University of Technology in Australia collaborates with Suntech to develop the next generation of solar cells, expected to double the efficiency of current solar cells (SUT, 2009).

Eco-innovation clusters between government, industry and academia merge excellence in education, frontier research in environmental technologies and job creation through spin-offs, venture capital and integration of enterprises. **The Lahti Cleantech cluster in Finland** has encouraged innovation and development of environmental technologies by bringing together small and large enterprises, educational institutions and regional authorities. As a result, 170 new jobs have been created and the project has attracted investment worth more than EUR 30 million. In the **Rhône Alpes Region in France**, regional and national investments in R&D helped develop the Tenerrdis competitiveness cluster which develops clean technologies in construction, transport and energy production (Kamal-Chaoui and Robert, 2009). **Knowledge Transfer Networks (KTNs) in the United Kingdom** have been set up in eco-innovation to foster the growth of new green industries. 75% of business respondents have rated KTN services as effective; 50% developed new R&D and commercial relationships with people met through these networks; and 25% made a change to their innovative activities as a result of their engagement within KTN (TSB, 2010).

Source: Kamal-Chaoui, L. and A. Robert (eds.) (2009), “Competitive Cities and Climate Change”, *Regional Development Working Papers*, 2009/2, OECD Publishing, Paris; OECD (forthcoming) Higher Education in Regional and City Development: State of Victoria, Australia.

The Paso del Norte HEIs' contribution to sustainable development

Higher education institutions can contribute to sustainability and green economy by generating innovations, producing new skills, providing platforms for knowledge sharing and exchange and producing behavioural changes in the local communities. They can also support local and regional authorities in monitoring progress in reducing carbon emissions and evaluating green investment programmes. In addition they can demonstrate good practice through on-campus management and development.

Faced with the considerable challenges of the cross-border region, the Paso del Norte higher education institutions have taken steps to address the situation through their research activities and demonstrating good practice on campus. In Mexico, the Autonomous University of Ciudad Juárez (UACJ) collaborates with the federal government through the National Water Commission, CONAGUA, in a multidisciplinary research on water resources. Its new campus “the City of Knowledge” will be powered by wind and solar energy and will contain energy efficient buildings. UACJ has also established a University Environmental Network comprising faculty, students and external community with the aim to promote sustainability. Monterrey Tech has a three-tier action plan to promote the sustainable use of natural resources through integrating the concept of sustainability into curricula, raising awareness among university community and collaborating with private and governmental agencies, for example through research on wind and solar energies and the development of sustainable low-income housing.

On the US side, both the New Mexico State University (NMSU) and the University of Texas at El Paso (UTEP) integrate sustainability guidelines in new construction and capital improvement projects. As members of the United States Green Building Council, they use green building standards that promote a whole-building approach to sustainability by maximising operational efficiency and minimising the environmental impacts.

The New Mexico State University (NMSU) is the host of the Water Resources Research Institute, which was formed in 1963 to address water problems of New Mexico and the Southwest. The university also collaborates with the Arrowhead Center in assessing fossil fuel levels in New Mexico. In addition, it has Institute for Energy and Environment that combines expertise in environmental education and technology development, renewable energy resource development and nuclear waste management. NMSU is a member of the American College and University Presidents Climate Commitment and is pursuing a Leadership in Energy and Environmental Design Certification for the US Green Building Council. The

university has formed the NMSU Sustainability and Climate Change Taskforce whose aim is to make the university carbon neutral.

The University of Texas at El Paso (UTEP) is committed to environmental stewardship, energy efficiency and sustainability. Its Centre for Inland Desalination Systems (CIDS) is a centre of excellence for the total spectrum of inland desalination topics. Its Pan-American Center for Earth and Environmental Studies (PACES), established in the late 1990s, conducts basic and applied research and serves as a repository for information in geological, geophysical, ecological and environmental processes and changes in land usage in the region. In addition, the university has a Centre 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 technologies and water disinfection technologies (see Box 4.2).

Box 4.2. UTEP Center for Environmental Resource Management (CERM)

The Center for Environmental Resource Management (CERM) focuses the University of Texas at El Paso's research on the environmental problems that threaten the region's health, safety, well-being and economic development. These problems include water quality & availability, air quality, hazardous waste management and remediation, energy, desert ecosystem protection, environmental health, justice and sustainability. CERM projects include:

- The development of the Rio Bosque Wetlands Park through restoring 1.5 km² (372 acres) adjacent to the Rio Grande to its original habitat based on a 30-year agreement with the City of El Paso
- PATCH (Partnership for Advanced Technology in Colonia Housing) provides assistance to low-income communities and neighbourhoods in applying Energy Star and other energy efficient technologies in affordable housing
- *Agua para Beber* (Drinking Water): a community-based, train-the-trainer programme that teaches appropriate water disinfection technology and home sanitation and healthy home environments. 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. The *Agua para Beber* project won the Texas Environmental Excellence Award in 2007.

Source: RSC (Regional Stakeholders Committee) (2009), "The Paso del Norte Region, US-Mexico: Self-Evaluation Report", OECD Reviews of Higher Education in Regional and City Development, IMHE, www.oecd.org/dataoecd/48/2/44210876.pdf

Cross-border, cross-state collaboration for sustainable development: water resource planning and air quality

Institutional fragmentation in the bi-national, tri-state Paso del Norte Region has a negative impact on the water resources planning and air quality improvement. As a consequence of the jurisdictional divisions and differences in water laws, water planning in the region remains decentralised. More progress has been made in the cross border collaboration for air quality improvement.

Much of the higher education institutions' research and outreach in water management and air quality improvement are driven by individual institutions or departments that collaborate with stakeholders in their immediate surroundings. However, some remarkable collaborative efforts have been initiated by regional higher education institutions.

Multi-disciplinary and cross border programmes to address water issues began in 1992 when the University of Texas at El Paso, funded by the Ford Foundation, established the Bi-national Water Program as a response to potential conflicts over the use of the region's diminishing water resources and public anxiety over health risks. This programme provided mechanism to encourage communication between the federal, state and regional agencies, municipalities and irrigation districts as well as private sector and non-governmental organisations. In 1996, a substantial grant from US Department of Commerce's Economic Development Administration (EDA) helped the programme to develop an economic development strategy for the sustainable use of water in the Paso del Norte Region. In 1999, a coalition of academics and non-governmental organisations (now funded by the Hewlett Foundation) formed the Paso del Norte Water Task Force, which has acted as a forum for the exchange of information. It is also working on a regional Geographic Information System (GIS) to facilitate the compilation, mapping and analysis of the region's water resources.

In cross border air quality issues, universities have also played an important role through the Joint Advisory Committee (JAC) for the Improvement of Air Quality which was established in 1996. JAC has 20 members, 10 from the United States and 10 from Mexico including air quality experts, business leaders, academics, environmentalists and public health officials. JAC facilitates knowledge sharing and coordination of projects in the Paso del Norte Region. It has also given opportunities for the local communities to work on initiatives to improve air quality.

Other regional initiatives of importance include:

- Collaboration between the University of Texas at El Paso and the co-operative extension at New Mexico State University to conduct research on increasing irrigation efficiency in the Rio Grande Basin
- Collaboration between the New Mexico State University (US) and farmers in Chihuahua, Mexico to develop and implement water conserving agricultural production methods
- Participation of the region's higher education institutions in the educational and research programmes being undertaken by the Paso del Norte Watershed Council
- Geographic information systems collaboration between the University of Texas at El Paso (through the Regional Geospatial Service Center), New Mexico State University in the United States and the Autonomous University of Ciudad Juárez in Mexico which focuses on environmental/hydrologic conditions. This collaboration has been particularly important in developing procedures and baseline data for a transnational multi-hazard risk assessment at the regional scale (Collins, Grineski and Romo Aguilar, 2009).

A particularly important opportunity for cross-border planning capacity lies in a joint initiative by higher education institutions to develop Geographic Information Systems (GIS) that can provide spatial data for the region as a whole. This initiative, which arose from collaboration among the faculty of the region's higher education institutions, developed a Coordinated Water Resources Database and GIS website as well as developed a model of Rio Grande water flows. One goal of the collaboration is to share regional water resource data needed for groundwater availability models. A result of information sharing and collaboration is the development of a flood control model for the entire Paso del Norte Region. A comprehensive data system that would combine environmental and social-demographic data and present a picture of the region as an integrated eco-system could have a galvanising effect on the regional leadership and on policy makers, demonstrating how actions taken in one part of the region may affect the region as a whole, including unintended consequences.

Universities' brokerage role in addressing the challenges linked to water resources and air quality, the data gathering and sharing initiatives have begun the process of addressing environmental problems on a regional scale and in a more integrated manner. They can underpin governmental efforts to provide a more comprehensive approach to natural resource management. As successful examples of collaboration and regional data gathering, they also provide a model for a related set of initiatives in the

arenas of health research and provision. Gathering socio-economic and health data is more complicated than gathering environmental and geomorphological data but the cross-regional co-operative processes and learning that has taken years to build in the natural resource field might increase the ability of health researchers to develop a regional data base.

Skills development for green jobs and sustainable development

The development of a green economy depends on the availability of skilled people to fill the new jobs related to renewable energy and energy efficiency. Simultaneous development of diverse skills and extensive retraining will be necessary. Skill development for the new green jobs can be efficiently organised by pooling learning resources of education institutions and industries at the regional level. This requires transparent pathways between different levels of education and also between higher education institutions. Despite the fact that in the US side the pathways between community colleges and universities are in place and usually function relatively well, it is unclear to what extent the region as a whole and its higher education institutions are prepared to face this challenge.

Promising, but often small-scale initiatives are under way. For example the University of Texas at El Paso's environmental education (Environmental Science) and a related mission under a federal grant from The US National Aeronautics and Space Administration has fostered the education of highly qualified minority scientists and engineers. The programme supported 83 bachelor's level and master's level students during the course of the NASA supported initiative, including six PhD students.

4.2 Paso del Norte HEIs' contributing to border health

The Paso del Norte Region is home to a significant population of very low-income people, many without access to any form of health care insurance and unable to afford health care provision. Extreme poverty exists on both sides of the border although the population affected by extreme poverty is larger in Ciudad Juárez (see also Chapter 2).

Because of poverty and exposure to environmental hazards, the Paso del Norte population has a high incidence of particular types of health problems, including tuberculosis, chronic diseases such as Type II Diabetes, and diseases, such as typhoid fever, that have been virtually eliminated in many countries because of inoculation with vaccines, administered in early childhood. Many of these diseases are communicable and raise risks for the regional population as a whole. For example, in 2001 tuberculosis rates in

the Texas border counties were 192% higher than in Texas as a whole and 271% higher than in the United States as a whole. The treatment of tuberculosis in the border region is particularly difficult because of the highly mobile population (Warner and Jahnke, 2003)

The situation of the border communities differs significantly from that of the nation in which each community resides. US counties on the border with Mexico rank lowest in the United States for the presence of health care professionals. This human resource problem is magnified by lack of access to health care facilities, and low per-capita income. The lack of basic health care and poverty results in uncompensated care to hospitals of approximately USD 800 million annually in the border counties, approximately 3% of all uncompensated costs in US hospitals per year, according to the American Hospital Association (Border Counties, 2006).

In Mexico, the border region and particularly Ciudad Juárez is the most industrialised part of the country. Because of the high level of industrial employment, particularly in *maquiladoras*, almost 60% of the population has access to employer-based health services through the Social Security system. An additional 3% are covered by the system of Social Security for Government Employees, bringing total coverage to approximately 61% of the border county population. However, because of the constant stream of migrants from other regions of Mexico, Ciudad Juárez contains an “open” population whose only access to health care is through the services funded completely by Mexico’s Ministry of Health (Secretaría de Salud). Government programmes have extended health care services to many in the “open” population, but gaps in accessibility continue to exist. Currently about 5% of the total border population lack access to regular health care services, although they may receive services from special programmes such as childhood immunisation.

However, the age-adjusted death rate in 2000 for the United States border region was 494 out of 100 000 people, which was substantially lower than the United States national rate of 560. This difference was largely due to lower mortality in the border region for chronic diseases such as cancer and heart disease. Infant mortality was also lower for the United States border than for the nation, despite lower socio-economic conditions on the border.

The development of joint medical and health care programmes by the higher education institutions in Paso del Norte is challenging because of the differences in the organisation of training, scope and practice of health professions and licensing of practitioners in Mexico and the United States. Medical education and licensing practices differ significantly between Mexico and the United States and the adoption of reciprocity largely

depends on the development of similar educational requirements and licensing practices. However, while physicians and nurses may be limited in their ability to practice across the regional border, the Paso del Norte Region does have some level of integration in health care services. US citizens go to Ciudad Juárez for more affordable drugs and health care; Mexican citizens go to El Paso to access specialist services. So, cross-border utilisation of medical services is common with citizens of both countries seeking preferred or affordable health care. Despite the range of health services available, however, the region remains under-served by health professionals given the size and needs of its population.

Capacity in health education and research

The recent establishment of the Paul Foster Texas Tech Health Sciences Centre in El Paso has brought significant new resources to the region both in research and health professional education. This centre will offer the opportunity to increase the training of doctors and nurses, in the region and to develop a research agenda that contributes to regional knowledge about medical conditions affecting very low-income populations. The centre will make a major contribution to the region's human capital development capacity. Its teaching hospital is the only medical school located on the United States border with Mexico and its 140 faculty members comprise El Paso's only multi-specialty group practice. Because of its location in a regional community with significant poverty-related health problems, the hospital expertise focuses on diabetes prevention, environmental health, Hispanic health, infectious and re-emergent diseases, geriatric medicine, and telemedicine. Because the Texas Tech Teaching hospital is undertaking both research and clinical programmes aimed at serving chronically underserved populations, this area of expertise has strong potential to become a regional specialisation.

Both the United States and Mexico face a national shortage of nurses. The Paso del Norte Region is particularly affected by this shortage due to difficult working conditions because of the poverty and the general lack of health services available to the region's residents. Nursing programmes face significant difficulties because of a shortage of faculty and because state licensing programmes inhibit movement of registered nurses across state jurisdictions. Texas is recognised as having one of the most rigorous licensing certification programmes in the United States.

Nursing schools in Mexico offer a wide range of training options ranging from high-school-level classes for nursing assistants to university level Bachelor and Masters degrees. There is an acknowledged shortage of nursing education programmes in the state of Chihuahua and a shortage of

nursing professionals practicing in Ciudad Juárez. There are two public universities in the state of Chihuahua that provide Bachelor degrees in nursing with an overall enrolment of 1 355 students and 105 graduates in 2008-09. The Autonomous University of Chihuahua operates its nursing programmes in Chihuahua and Parral, whereas the Autonomous University of Ciudad Juárez's (UACJ) nursing programmes are offered in Ciudad Juárez (648 students and 57 graduates in the institute of biomedical sciences, in 2008-09), in Nuevo Casas Grandes 300 km away from Ciudad Juárez, in the city of Cuauhtemoc and in a unit of historical and social studies in the City of Chihuahua.

The US side of the region has important training programmes in nursing, which expand the potential for serving the region's health care needs. The El Paso Community College School of Nursing enrolls 241 students yearly and supports a curriculum designed to promote clinical and cultural competence in order to meet the special needs of the bi-cultural region. The percentage of nurses graduating from El Paso Community College increased 149%, (from 97 to 241) between 2002 and 2008, demonstrating both increasing demand and increasing capacity in the programme. The University of Texas at El Paso School of Nursing (UTEP-SON) has Bachelor and Masters programmes that enrol 560 students each year. 130 students graduate yearly and half of these begin their nursing careers in the region. The Paul Foster Texas Tech Health Sciences Centre includes the Perry School of Nursing, which offers advanced nursing degrees, including a doctorate in nursing and health administration. Doña Ana Community College has graduated more than 450 students in their nursing programmes since 2002. The NMSU School of Nursing continues to operate at capacity as well. For both institutions, student enrolment is capped in the programmes because of a shortage of facilities and instructors. Despite the successful efforts to increase training in nursing in the region, there is a shortage of nurses as many of the graduates from these programmes leave the region after one year in search of better working conditions and higher salaries.

Despite significant barriers, there are examples of successful co-operative projects to train nurses between higher education institutions in Mexico and the United States. These programmes, originating in California, respond to the crisis produced by the inability of US nursing schools to accept and train all the applicants who wish to obtain a nursing degree. In California, bi-lingual nurses are being sent to Mexico to receive a portion of their training because of the lack of capacity in US nursing schools. Mexico is not producing anything close to enough nursing graduates. Each year only about 2 600 nurses graduate nationally and half of these go to work in

unrelated occupations. This gap is possibly attributable to the low remuneration for nurses in Mexican medical institutions.

The University of Arizona and the *Colegio de Sonora*, a private postgraduate training and research institute in the State of Sonora in Mexico have established a joint Master's degree programme in Border Public Health. The University of Arizona and the University of Sonora (UNISON) also have in place a summer training programme that provides intensive clinical and language training to medical students from both institutions. Model cross border programmes should be developed, building on the high quality of nursing education and its commitment to lifelong education and career development in El Paso, to alleviate the health issues in the region as a whole.

The considerable scale and expertise in the regional health care programmes (both clinical expertise and cultural understanding) should be applied to develop strategies to increase the quantity and quality of health care provision across the Paso del Norte Region, including in Ciudad Juárez. For example, Texas Tech El Paso has clinics located in East, West, Central and Northeast El Paso providing care to underserved areas lacking adequate healthcare. The College of Health Sciences of the University of Texas at El Paso (UTEP) engages in numerous community partnerships with clinics, hospitals, schools, non-profit organisations and governmental agencies through 400 formal agreements. In the New Mexico State University (NMSU) community partnerships in the health and medical services include internships in clinical nursing where students are placed in local schools, hospitals and nursing care programmes. The university's Co-operative Extension Services also provides health-related services to the individuals and families around the state. The Autonomous University of Ciudad Juárez has a medical school whose students perform their residency at clinics locally or in other parts of the State of Chihuahua, and once completed are assigned to different communities to perform their social service. The university also provides medical and dental care through *Brigadas Médicas* where a group of students go out offer services to the community as part of their social service. This kind of commitment combined with the scale and scope of training programmes in health care is unusual and could form the basis for a broader regional effort. Both co-operative programmes and foundation support should be considered to support these types of initiatives.

Health issues specific to a low-income population

Because of the health profile of the regional population and the high incidence of diseases related to poverty and lack of access to preventive health care as well as exposure to regionally specific environmental hazards,

higher education institutions in the Paso del Norte Region are developing research programmes focused on the specific sources of health problems that have a high incidence in border communities. These include:

- Research, including clinical trials on low-income population health, at Texas Tech’s Paul Foster School of Medicine
- Research on regional genetic disease profiles at Autonomous University of Ciudad Juárez (for example, uterine cancer)
- Research on low cost bio-medical devices that could improve preventive health care
- The development, across all higher education institutions in the region, of expertise in bio-informatics

These programmes that focus on health problems in border communities have a strong potential for co-operative research efforts that could serve the needs of the Paso del Norte Region for more effective health care. They have the capacity to position the region as a whole as an international centre of expertise and innovation on health care practices and technology that improve health care outcomes in particularly health care disadvantaged populations.

4.3 Community engagement and service

Higher education institutions in the Paso del Norte Region respond to the obvious needs of a region in which poverty and its associated problems, poor health, low levels of literacy and access to education and inadequate housing, affect a significant portion of the regional population. The universities and community colleges in the region have taken different approaches to “the third mission” of outreach and engagement depending on their broader mission, for example as a US land grant institution, or as a Mexican higher education institutions following the national requirement for social service of all university students. However, until community engagement and outreach are embedded in and delivered through research and learning processes, they will continue to struggle to provide such a service because of short term funding.

On the Mexican side, underpinning the community efforts is a social commitment and responsibility, which is facilitated by the national requirement that students must complete at least 240 hours of social service before they are allowed to graduate. While there have been national concerns about the way social service is operationalised, it has potential for considerable impact in the Mexican society and has generated good results

in mainstreaming community service activities into the core business of the higher education institutions (OECD, 2007; 2008).

At the Autonomous University of Ciudad Juárez (UACJ), as in other universities in Mexico, service learning is a required component of the higher education curriculum. The university has instituted a minimum of 300 hours of social service in the curricula, which surpasses the national requirement of 240 hours. Students can participate in programmes related to their field of study after the fifth semester of their enrolment. Students search for service opportunities in the electronic platform where third parties interested in hosting students at their respective institutions apply for assistance from any academic programme at the university. Service learning opportunities are vetted by the director of the educational programme to ensure that the placement will contribute to the student's education. The university's service learning/internship programme has on average per semester 1 680 students working in companies and 1 300 students working at the university. The university's outreach is not limited to social issues: UACJ's sub-directorate for arts and culture promotes cultural events and also reaches out to the local community. Similarly, also Monterrey Tech's campus in Ciudad Juárez has a community service programme which engages students in programmes that aim generate social, economic and education development in marginalised communities and social assistance organisations.

In Ciudad Juárez, many of the student opportunities are organised through The *Fundación del Empresariado Chihuahuense (FECHAC)* established in 1996. FECHAC is a pioneering organisation of its kind in Mexico, an intermediary between the business community and the over 100 non-profit organisations that serve the community. To date there are a total of 38 000 local business people from Chihuahua contributing through FECHAC toward social and development projects throughout the state of Chihuahua. The Autonomous University of Ciudad Juárez has supported FECHAC's important role in civic life by providing information on needs in three areas: education, social capital and health.

While not mandated in the United States, studies of the New Mexico State University and the University of Texas at El Paso show that their university graduates participate in community service and volunteer activities at or above the national rates. The University of Texas at El Paso (UTEP) contributes to the quality of life in El Paso by providing public access to a variety of social and cultural programmes relevant to Hispanic populations. Its Center for Civic Engagement, recruits students into service learning opportunities on a volunteer basis but have, over time, developed inter-institutional connections supporting non-governmental organisations in Ciudad Juárez as well as El Paso. The Center for Civic Engagement at the

University of Texas at El Paso was established in 1998 to “*to foster collaborative leadership, civility and deepen democracy in the region through what may be alternatively known as hands-on/action-oriented learning, civic education, Service Learning, and or active citizenship.*” The programme has engaged thousands of university students in public service learning, in some cases fostering long-term connections between students and the communities with whom they worked. It has also provided students with valuable experiential learning by connecting students to community-serving activities. The voluntary participation of UTEP students in these community-serving programmes is particularly notable because the vast majority of UTEP students are working part-time or full-time to support their families and pay for their education. The activities of the centre have been supported by approximately USD 4 million in grants from major foundations and have included work such as housing construction on the Habitat for Humanity model, tutoring, and bi-lingual technical writing programmes. Students from other universities in the United States have also participated in the projects, which, at their apex, connected with 100 community organisations in communities in the United States and Mexico. The scope and impact of the activities of the Center for Civic Engagement are, however, constrained by short term project funding.

The New Mexico State University (NMSU) has as a land-grant institution a special mission to serve the State of New Mexico and has cooperative extension offices in 33 counties of New Mexico. The university is home to a Heritage Center, which was established in 1986 to present and protect the histories and cultures of different ethnic groups in the region. They maintain archives of oral and community history and provide courses for NMSU students. The university has also an active Office of International & Border Programs, which includes an office in the capital of the neighbouring Mexican state of Chihuahua. Under the auspices of this office about 500 students and faculty are involved in mobility programmes (mostly unidirectional South/North), with joint or dual degrees in civil engineering, aerospace, management, agribusiness and special education, between NMSU and Autonomous University of Ciudad Juárez and Autonomous University of Chihuahua. Furthermore, this office sponsors about 40 joint R&D projects with partners in Mexico. This centre provides an excellent opportunity to scale up cross-border collaboration. However, its impact appears to remain limited due to the lack of articulation through the university teaching and research activities (see Box 4.3). Also the Doña Ana Community College (DACC) engages in partnerships with the community in the provision of social development services by offering courses that require service learning hours from students. In 2003 students participated in over 3 300 hours of service learning experiences.

Box 4.3. The NMSU's Office in Chihuahua, Mexico

The New Mexico State University (NMSU) was founded in 1888 as an agricultural college and preparatory school. In 2009, the university system had about 30 000 students, 18 500 of them at Las Cruces campus; 1 700 faculty members and almost 4 000 staff. NMSU is running 13 research and science centres, whose research per year attracts external funds to the value of USD 150 million. In addition, as the land-grant institution of the State of New Mexico it has cooperative extension offices in each of 33 counties of New Mexico.

In order to advance cross-border collaboration, NMSU established in 2005 an outreach office in Chihuahua. The New Mexico/Chihuahua Programme Support Office (NCPSO) is the university's vehicle to support sustainable economic, cultural and social development in the cross-border region by increasing opportunities and quality of life of the border population. The office has a wide range of activities ranging from academic cross-border collaboration to cultural and social activities and outreach. NCPSO supports the business community in Chihuahua and New Mexico by actively participating in fora, chambers of commerce and business associations associated with the *maquila* (assembly plants) industry, fostering cluster development, engaging in industrial policy analysis and attracting foreign direct investment. Altogether 2 500 staff from the university have been involved in these activities.

NMSU has formalised cross-border partnerships through agreements with 16 higher education institutions and four higher education consortia in Mexico. The agreements involve joint degrees and research projects. About 500 students and faculty are involved in mobility programmes (mostly unidirectional South/North), with programmes of joint or dual degrees programmes in civil engineering, aerospace, management, agribusiness and special education, between NMSU and Autonomous University of Ciudad Juárez and Autonomous University of Chihuahua. There are also 40 joint R&D projects with partners in Mexico.

NCPSO is also an active member and participant in a number of bi-national organisations considering border issues, such as the US-Mexico Border Governors Conference and the New Mexico-Chihuahua Commission. During its five years of operation, the office has received around USD 2 million in grants from competitive funds which contribute to the overall investment of USD 10 million that NMSU has channelled to this office's initiatives.

NCPSO has a strong component of cultural and social activities. For example, in 2009, it organised a full programme of art exhibitions and music concerts, which brought together Mexican and US artists and performers from both sides of the Rio Grande. NCPSO also collaborates with indigenous populations in both sides of the border to strengthen bilingual education and cultural knowledge. This work has contributed to raising aspirations and reinforcing the sense of nationhood among the indigenous populations in the region.

The programmes developed by individual higher education institutions are notable for their partnerships with external stakeholders and capacity to work across all sectors in sustained commitment. There is, however, limited evidence of collaboration between all higher education institutions in the region or systematic monitoring of results, which would help evaluate the outcomes of such activities. Furthermore, despite the obvious benefits of these programmes there is less evidence of long-term community development programmes that would build capacity within these communities to help themselves. Furthermore, the activities of the community serving organisations in Ciudad Juárez and El Paso, including those assisted by the regional higher education institutions, have been significantly curtailed by the recent violence in Ciudad Juárez.

Conclusions and recommendations

Higher education institutions in the Paso del Norte Region have responded each according to their own mission to the social, cultural and environmental needs in their own immediate surroundings. Among the major achievements are the development of bi-national organisations and cooperative initiatives, some of which have become national models, for example in the areas of transnational environmental hazards and resources analysis. They have had notable success in uniting stakeholders and leveraging significant amounts of co-operation across agencies and institutions.

However, much of this activity is project-based and dependent on short term funding from various foundations. Limited resources are often spread thinly and there is a lack of critical mass to generate comprehensive regional approach that would have real impact at the cross border regional level. Collaborative mechanisms between the higher education institutions at the regional level to build capacity and foster joint efforts remain limited in scope. Furthermore, the violence makes cross border service to community organisations in Ciudad Juárez difficult and risky.

The region has considerable activities underway for the promotion of health and environmental development. The OECD Review Team recommends that the following measures should be taken:

- A systematic exchange of information and experience should be put in place through the establishment of a forum between higher education institutions in social, cultural and environmental matters facilitated by the Paso del Norte Group in order to bring greater efficiency. Such a forum should organise thematic events, with regular information retrieval and exchange facilitated by a dedicated

website. As a first step, higher education institutions' current connections, initiatives and projects involving stakeholder collaboration, community development and/or outreach should be mapped and published in the collaboration platform.

- Building on the existing successful models, capacity should be developed in regional data gathering, and sharing regional data repositories and technical skills associated with using regional data. Successful models in the area of natural resource management should be extended to the field of health. For example the Paul Foster Texas Tech Health Sciences Centre research agenda to document and learn about the incidence of health problems in the region could benefit by intersecting with the programmes undertaken in environmental science and resource management. The economic, social, and environmental analysis undertaken by the Institute for Policy Education and Research at the University of Texas at El Paso should be used to lay the groundwork for a cooperative regional analysis capacity, inclusive of all higher education institutions in the region. In addition, higher education institutions should engage students in gathering data on health problems and socio-economic and environmental conditions. In this effort, they would learn about survey research, the intersection between environmental conditions, socio-economic status, and health problems, and methods for analysing data.
- Regional expertise in health should be applied to develop strategies to increase the quantity and quality of health care provision across the Paso del Norte Region. This expertise should be used to develop the region as a whole as an internationally recognised centre of expertise and innovation on health care practices and technical innovations that improve health care outcomes in particularly health care disadvantaged populations. It should especially address the health needs of the *colonias* settlements, which are sizable in the exurban areas on both sides of the border. Model cross border programmes in health and medicine should be developed building on the high quality of nursing education and commitment to lifelong education and career development in El Paso.
- Medical personnel training should be scaled up to the critical needs of the low income population across the region. Possibilities should be explored to increase access to Mexican health services by the US residents. Collaboration should be enhanced across the region in clinical trials and the development of low cost bio-medical technology.

- Higher education institutions in collaboration with the public and private sector in the Paso del Norte Region should increase their conjoint efforts to support sustainable environmental and economic development through a comprehensive regional approach to water planning and growth management bringing together diverse regional actors to sustainability process. Higher education institutions should scale up their efforts to provide learning and further education programmes for “green” jobs and to act as a source of expertise through research, consultancy and demonstration. Major areas of concern in the region are intense drying, insufficient water supplies and air pollution. The cross-border climate observation networking should be improved and expanded due to convergence of natural and man-made drought. In addition, drought planning and water conservation efforts should be enhanced. There should be an analysis of the benefits and costs of controlling emissions from the wide variety of emissions sources, for example, foundries, brick kilns and the *maquiladora* plants with data on abatement costs.
- Cross-border interactions between higher education institutions and non-governmental organisations should be strengthened and further developed in order to maintain and enhance regional civic co-operation. The role of non-governmental organisations in the bi-national Paso del Norte Region is critical and the higher education institutions are already in interacting with non-governmental organisations in connecting students with service learning opportunities.
- In addition to providing services to various communities, higher education institutions should 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. They should consider ways to balance the current approach, which has a focus on combating poverty, with one fostering wealth and job creation through social entrepreneurship. The region should be seen as a “laboratory” for developing research, students’ work-based and experiential learning and development projects in many different fields.
- The knowledge base about regional issues should be expended through stronger involvement of students and faculty. For example, local cable television affiliates have a weekly programme, whose goal is to report on subjects that affect the residents of El Paso, Ciudad Juárez and Las Cruces. A weekly programme *Nuestra*

Frontera primarily covers education and health. The higher education institutions in the region should be conduits for content for this programme and for other media that attempt to reach and report on the region as a whole.

Notes

1. Comparison is challenging because of national differences in the timing of information gathering, what types of data and information are gathered, how they are measured, and in monitoring and data gathering capacity. The information presented in this chapter is drawn from the most recent available both from public sources and specialised reports. It should be considered as approximate rather than definitive.
2. Regional Economic Information Systems (REIS), US Bureau of Economic Analysis (BEA); Consumer Price Index, Federal Reserve Bank of Dallas.
3. Dichlorodiphenyltrichloroethane (DDT) is an organochlorine contact insecticide that kills by acting as a nerve poison. DDT was successful particularly in the control of malaria as well as against agricultural pests. However, by the 1950s, resistance problems had developed, and during the 1960s, a number of serious environmental problems were identified leading to wide-ranging restrictions on its use. In recent years numerous studies on DDT have shown its environmental persistence and its ability to bioaccumulate, especially in higher animals. Of particular concern is its potential to mimic hormones and thereby disrupt endocrine systems in wildlife and possibly humans.
4. Deloitte's 2009 survey on Global Trends in Venture Capital reports that, despite the crisis, 63% of surveyed venture capitalists anticipate an increase in their investment in clean-tech.

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Annex 1: Review team members

Jaana Puukka, a Finnish national, leads the OECD work on Higher Education and Regional and City Development. She joined the OECD Programme on International Management in Higher Education (IMHE) in 2005 to co-ordinate and manage the first round of OECD Reviews of Higher Education in Regional Development, which took place in 2005-07 and embraced 14 regions in 12 countries. She is leading the second round of reviews in 2008-10 which is reaching out to 14 regions and city-regions in G8 countries and emerging economies. She is the co-author and editor of the OECD publication “Higher Education and Regions: Globally Competitive, Locally Engaged” (OECD, 2007). Before joining the OECD, Puukka had experience in higher education and regional development in Finland as a national and local government adviser, programme manager, practitioner and evaluator. She has management experience from both the university and polytechnic sector and has worked in university internationalisation, PR and communication and stakeholder management. In addition, she has experience in the corporate sector in the pharmaceutical industry.

Ernesto Flores, a Mexican national, who joined the OECD Programme on Institutional Management in Higher Education (IMHE) in Paris in 2009 for a 15-month secondment to support the OECD review programme Higher Education in Regional and City Development. He holds a master’s degree from Monterrey Institute of Technology and Advanced Studies, Mexico. He has worked as a Consultant in the Quality Centre of Monterrey Tech, developing projects in several companies. In 2002, he was invited to collaborate to the Strategic Planning and Regional Development Office of the Executive Office of the President of Mexico. There, he served as planner and consultant in strategic planning for Federal Government offices to support them applying strategic thinking and planning, developing scorecards and using technologies to strategy follow-up in order to align actions consistent with the Mexico’s National Development Plan. Since 2004, he was working at the Sonora Institute of Technology (*Instituto Tecnológico de Sonora*, ITSON) as planning coordinator, participating in projects aimed at improving economic and social performance in the region, such as the creation of the Technology Park and the Digital City initiatives.

In addition, he led international projects in the field of innovation-based regional development.

Carlos Baradello, born in Argentina, is the Associate Dean of the University of San Francisco's School of Business and Management where he manages the corporate and international programmes and teaches in the areas of globalisation, risks and opportunities of a networked world, global product management, global marketing, social entrepreneurship, the growing importance of the US Hispanic market and its role in the economic development and integration of the Americas; and leads transnational entrepreneurship research projects. He is also a mentor of the Global Social Benefit Incubator at the Center for Science, Technology, and Society of Santa Clara University (US), and a global academic leader of Monterrey Tech in Mexico. His interests include the fast-growing US Hispanic market and its relationship with the respective communities of origin in Latin America. Baradello has a track record across telecommunications and software sectors in start-ups and large global companies. He has developed opportunities that optimise technology with indigenous market needs, and the impact of ICTs to increase the competitiveness of emerging economies. He is an advisor and international consultant to NGOs, universities and governmental development agencies. Baradello's academic background includes an Electrical-Electronic Engineering Degree (Universidad Católica de Córdoba, AR), a Masters Degree in Electronic Engineering (Eindhoven University of Technology, NL) and a PhD in Electrical Engineering (Carnegie-Mellon University, US).

Susan Christopherson is J. Thomas Clark Professor in the Department of City and Regional Planning at Cornell University. She is an economic geographer (PhD, UC Berkeley) whose research focuses on economic policy and economic development. Her work in the field of economic development has focused on strategies for revitalising the New York State economy. In the past five years, she has completed policy studies on economic development via targeted workforce development; a clusters strategy to build the photonics industry; the role of universities and colleges in revitalising regional economies; and production trends affecting media industries in New York City. Christopherson is an expert on the film and television industries and particularly on work and the workforce in those industries. Her recent research has focused on the way in which trends in media work foreshadow changes in work organisation across the economy. She has served as a consultant to the OECD Working Party on the Role of Women in the Economy. In the field of media services, she has examined the implications of media globalisation and trade policy in China and Jordan for the United Nations Conference on Trade and Development (UNCTAD).

Her current projects include studies of phoenix industries in resilient regions and entrepreneurship in creative industries.

Francisco Marmolejo, born in Mexico, serves as executive director of the Consortium for North American Higher Education Collaboration (CONAHEC), a network of more than 140 colleges and universities from Canada, the US and Mexico, headquartered at the University of Arizona, and Assistant Vice President for Western Hemisphere Programs. Previously, Marmolejo was an American Council on Education fellow on higher education leadership development at the University of Massachusetts-Amherst. His past positions include vice president for administration and academic vice president at the Universidad de las Américas in Mexico. He has taught at several universities and has published extensively on administration and internationalisation. Marmolejo consults for Latin American universities and governments, and has been part of OECD and World Bank peer review teams conducting evaluations of higher education in Europe, Latin America and Asia. Currently, he serves on advisory boards at a variety of universities and professional organisations, including the Mexican Association for International Education (AMPEI), the American Council on Education and NAFSA. During the 2005-06 academic year he collaborated as an international consultant in the OECD Programme on IMHE. Marmolejo holds a Masters in Organisational Administration from the Universidad Autónoma de San Luis Potosí, and has conducted doctoral work at the Universidad Nacional Autónoma de México.

Alessandra Proto is a Policy Analyst at the OECD LEED Trento Centre for Local Development based in Italy, where she has been working since its establishment in 2004. She manages the activities related to entrepreneurship, innovation and SME development in Central, East and South-East Europe. She has contributed to the development of a number of OECD LEED projects, particularly with regard to the organisation of conferences and of capacity building seminars. In 2005 she worked on the organisation of an international conference on the role of higher education institutions in fostering entrepreneurship, which led to an OECD publication. Before joining the LEED Programme, Proto worked for three years as consultant for the international division of a major Italian consulting company, where she supported Italian companies in their process of internationalisation. Proto obtained her degree in economics and management of public administration and international institutions from the Bocconi University in Milan.

Annex 2: Programme of the review visit

OECD Review Visit to the Paso del Norte region, 25-31 October 2009

Sunday 25 October – El Paso, Texas, US

18:00 OECD Review Team internal meeting

Monday 26 October – El Paso, Texas, US

07:30-08:45 **Breakfast meeting with the regional coordination team (authors of the self-evaluation report)**

09:00-11:00 **Meeting with the Regional Stakeholders Committee at UTEP**

11:30-13:30 **HEIs President's Lunch Meeting hosted by the University of Texas at El Paso**

- Dr. Diana NATALICIO, President, University of Texas at El Paso (UTEP)
- Mr. Jorge QUINTANA SILVEYRA, Rector, Autonomous University of Ciudad Juárez (UACJ)
- Dr. Manuel DE LA ROSA, Founding Dean, Paul Foster Medical School
- Dr. Richard RHODES, President, El Paso Community College (EPCC)
- Dr. Margie HUERTA, President, Doña Ana Community College (DACC)
- Mr. Martín LOPEZ MENDEZ, Executive Director, Monterrey Tech's Ciudad Juárez Campus
- Mr. Enrique LUJÁN, Director, Technological Development Support Institute (INADET)
- Mr. Mario Blanco, Director, CENALTEC Technical Training Centre of Ciudad Juárez
- Dr. Waded CRUZADO, Provost, New Mexico State University (NMSU)
- Dr. Richard JARVIS, Provost, UTEP
- Dr. Garrey CARRUTHERS, Dean, College of Business Administration, NMSU
- Dr. Robert NACHTMANN, Dean, College of Business, UTEP
- Mr. Frank STOUT, Associate Dean, Paul Foster Medical School

14:00-16:30 **Meeting with regional stakeholders on the issues of water and sustainable resources management**

- Dr. María ALVAREZ, Professor and Director of the Research Initiative for Scientific Enhancement (RISE) programme, El Paso Community College
- Mr. Ed ARCHULETA, General Manager, El Paso Water Utilities
- Mr. Barry BENEDICT, Executive Director, Centre for Environmental Resource Management

- Ms. Maria Elena GINER, Deputy General Manager, Border Environment Cooperation Commission
- Dr. Oscar DENA, Professor of Geophysics and Geotechnology, Autonomous University of Ciudad Juárez (UACJ)
- Ms. Lydia NESBITT, Head, Department of Administration Sciences, UACJ
- Mr. Craig RUNYAN, Water Quality and Rio Grande Basin Initiative. Programme Coordinator,
New Mexico State University (NMSU)
- Dr. Richard SCHOEPHOERSTER, Dean, College of Engineering, University of Texas at El Paso
- Dr. Kenneth WHITE, Interim Dean, College of Engineering, NMSU
- Dr. Karl WOOD, Director, New Mexico Water Resources Research Institute, NMSU

Tuesday 27 October – El Paso, Texas, US

- 07:30-08:30 **Paso del Norte Group Breakfast meeting, presentation by the Federal Reserve Bank**
- 09:30-11:30 **Meeting with representatives of the region’s healthcare stakeholders to discuss workforce development and the healthcare needs specific to the area**
- Dr. Manuel DE LA ROSA, Founding Dean, Texas Tech University Health Sciences Center (TTUHSC)
 - David BUCHMUELLER, Chef Operations Officer, Paso del Norte Group
 - Dr. Carlos CANO, Director of Health Sciences, Autonomous University of Ciudad Juárez (UACJ)
 - Dr. Kathy CURTIS, Dean College of Health Sciences, University of Texas at El Paso (UTEP)
 - Ms. Myrna DECKERT, Executive Director, Paso del Norte Health Foundation
 - Ms. Gail MEAGHER, Dean of Nursing, El Paso Community College (EPCC)
 - Mr. Charles MILLER, Associate Academic Dean for Research, TTUHSC
 - Dr. Paula MITCHELL, Dean for Health Occupations, EPCC
 - Mr. Jose RIVERA, Director Pharmacy Programme, UTEP
 - Ms. Jacalyn RYBERG, Director, School of Nursing, New Mexico State University (NMSU)
 - Mr. Manuel SCHYDLOWER, Associate Academic Dean for Admissions, TTHSC
 - Mr. David STEELE, Senior Associate Dean for Medical Education, TTHSC
 - Dr. Frank STOUT, Associate Dean, TTHSC
 - Dr. Esperanza VILLANUEVA-JOYCE, Dean Nursing, UTEP
 - Mr. John WALKER, Nursing, Doña Ana Community College
- 12:00-13:30 **Lunch hosted by the Texas Tech with representatives of the region’s medical and healthcare leadership**
- 14:00-16:30 **Meeting with the representatives of regional economic development organisations**
- 18:30-21:00 **Dinner and discussion on regional Pre-Kinder to 16 Collaborative for Academic Achievement**
- Ms. Ana Margarita BERMUDEZ
 - Dr. Dennis BROWN, Vice President of Instruction, El Paso Community College
 - Ms. Nancy EVANS, College Readiness Initiative, El Paso Independent School District
 - Ms. Kari MITCHELL, New Mexico Bridge
 - Dr. Susana NAVARRO, Executive Director, El Paso Collaborative for Academic Excellence
 - Dr. Richard RHODES, President, El Paso Community College (EPCC)

- Dr. Joyce RITCHEY, Dean, EPCC
- Mr. Stan ROUNDS, Las Cruces Public Schools
- Ms. Karla TARANGO, Director, Chihuahua's Businessmen Association
- Dr. Jimmy VASQUEZ, Executive Director, Region 19

Wednesday 28 October – Las Cruces, New Mexico, US

- 07:00-08:00 **Meeting on bi-national issues**
- 09:30-11:30 **Meeting with representatives of the New Mexico Space Port to include cluster meeting on aerospace engineering and national security**
- Mr. Mario Blanco, Director, CENALTEC Technical Training Centre of Ciudad Juárez
 - Mr. Tom BURTON, New Mexico State University (NMSU)
 - Dr. Garrey CARRUTHERS, Dean, College of Business Administration, NMSU
 - Dr. Ahsan CHOURDHURI, Director, Centre for Space Exploration Technology Research, University of Texas at El Paso (UTEP)
 - Mr. Antonio GUERRA, Autonomous University of Ciudad Juárez (UACJ)
 - Dr. Vickie GALINDO, Director, Business Development Arrowhead Centre, NMSU
 - Mr. Enrique LUJÁN, Director, Technological Development Support Institute (INADET)
 - Ms. Lydia NESBITT, Head, Department of Administration Sciences, UACJ
 - Mr. Javier SANCHEZ CARLOS, Dean, School of Social and Administration Sciences, UACJ
 - Dr. Richard SCHOEPHOERSTER, Dean, College of Engineering, UTEP
 - Dr. Jerry WELCH, NMSU
- 12:00-14:00 **Lunch meeting with the representatives of the New Mexico Leadership**
- 14:30-16:30 **Meeting with regional stakeholders on Tech Transfer, Innovation and SME support**
- Mr. Mario Blanco, Director, CENALTEC Technical Training Centre of Ciudad Juárez
 - Mr. Kevin BOBERG, Arrowhead Centre, New Mexico State University (NMSU)
 - Dr. Garrey CARRUTHERS, Dean, College of Business Administration, NMSU
 - Ms. Vickie GALINDO, Director of Business Development, Arrowhead Centre, NMSU
 - Mr. Anthony HYDE, Director, Manufacturing Technology and Engineering Centre (MTEC), NMSU
 - Mr. Chris KIENTZ, Director of Technology Innovation, Arrowhead Centre, NMSU
 - Mr. Enrique LUJÁN, Director, Technological Development Support Institute (INADET)
 - Mr. Paul MAXWELL, Executive Director, Bi-National Sustainability Laboratory
 - Dr. Jose MIRELES, Director of Micro-Electro-Mechanical Systems Lab, Autonomous University of Ciudad Juárez (UACJ)
 - Mr. Robert NACHTMANN, Dean, College of Business Administration, University of Texas at El Paso
 - Ms. Lydia NESBITT, Head, Department of Administration Sciences, UACJ
 - Dr. Richard SCHOEPHOERSTER, UTEP, Dean Engineering
 - Mr. Eli VASQUEZ, Executive Director, Regional Centre of Innovation and Commercialization
 - Mr. Kenneth WHITE, NMSU, Interim Dean Engineering

Thursday 29 October – Ciudad Juárez, Chihuahua, MX

- 08:00-10:30 **Breakfast meeting on regional manufacturing clusters**
- 11:30-14:00 **Visit to the Autonomous University of Ciudad Juárez (UACJ) including the Biomedical and Engineering High Tech labs, meeting with regional representatives involved in biomedical and engineering research**
- 14:00-16:00 **Lunch meeting with Juárez Leadership at the UACJ Campus**
- 16:00-17:00 **Meeting with representatives of NGOs and Cultural activities in Ciudad Juárez**

Friday 30 October – El Paso, Texas, US

- 07:30-08:30 **Presentation of the OECD Review to the members of the Paso del Norte Group**
- 09:00-13:00 **Internal meeting of the OECD Review Team**
- 13:30:15:30 **Feedback session with the Regional Stakeholders Committee**

Higher Education in Regional and City Development

The Paso del Norte Region, Mexico and the United States

The Paso del Norte Region is the largest metropolitan area on the US-Mexican border, with Ciudad Juárez as a major manufacturing centre. However, the economic performance on both sides of the border region is below the OECD average. The long-term competitiveness of the region is under a threat due to ongoing violence, brain drain and environmental degradation.

The ability to fuel local growth by cultivating relevant skills is the best guarantee that Paso del Norte will thrive in future. A globally competitive region needs to have a highly skilled workforce and knowledge-based economy. To break out of the low skill/low wage economy, Paso del Norte needs to improve educational attainment levels on both sides of the border. It will also need to foster new business formation and provide jobs and entrepreneurial skills to higher education graduates.

How can Paso del Norte capitalise on the ongoing cross-border initiatives to create a more comprehensive approach to regional development? How can the universities use challenge-driven research to transform social, environmental and health-related challenges into assets and opportunities?

This publication explores a range of helpful policy measures and institutional reforms to mobilise higher education for regional development. It is part of the series of the *OECD Reviews of Higher Education in Regional and City Development*. These reviews help mobilise higher education institutions for economic, social and cultural development of cities and regions. They analyse how the higher education system impacts upon regional and local development and bring together universities and other HEIs and public and private agencies to identify strategic goals and to work towards them.

The full text of this book is available on line via this link:

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