Innovation Policy Strategy: Brazil, Kazakhstan, & Mexico

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I. EXECUTIVE SUMMARY

In the spring of 2013, a team from the George Washington University's International Science and Technology Policy program partnered with SRI International's Center for Science, Technology and Economic Development to examine the innovation systems of three countries and determine areas that need improvement by providing an outline of the situation and providing policy recommendations for addressing these policy challenges. In consultation with SRI International, the GWU team created a list of criteria for determining which countries to profile. The methodology included looking at a country's willingness and ability to invest, a commitment to innovation and absorptive capacity. The team then developed a summary of country profiles (that can be found in appendix B of this report) and SRI International selected the final three for analysis: Brazil, Kazakhstan and Mexico. Each country has a profile that identifies three policy challenges and three recommendations based on those challenges.

Brazil- As the largest and most populous country in Latin America, Brazil has been on a massive uptick in the past several decades, becoming the "B" of the BRICS[1] countries and establishing itself as an innovative economy on the continent. While Brazil has made great strides in addressing some of the challenges they face to become an innovation driven economy, there are embedded issues within the system that make moving into this phase a difficult one for Brazil. These barriers include a lack of human capital resources, poor research and development in the private sector and the internal structure of Brazil's intellectual property rights. The aforementioned barriers do not allow for increased investment from SMEs, not only domestic ones but international ones as well and inhibit the growth of innovation sectors. Based on this information, the following three recommendations were made: recommendation 1: in order to fill a short term human capital gap, Brazil should reform their immigration policies to attract high-skilled labor; recommendation #2: Brazil should implement bigger tax breaks for private industry to invest more in research and development and; recommendation #3: Brazil needs to increase policy collaboration within the existing intellectual property rights framework to facilitate IPR registrations and implement international standards.

Kazakhstan- Kazakhstan has made enormous strides in integrating into the international economic order since its 1991 independence, including a great degree of access to foreign direct investment (FDI). However, Kazakhstan did not inherit much of the Soviet Union's research and development (R&D) infrastructure, hence indigenous Kazakh commercial Science Technology Information (STI) is well behind the world standard. To diversify its economy and shift towards innovation centric production, Kazakhstan needs to improve the quality of its domestic STI capability, and commercial opportunities to translate STI activity into the economic realm. Therefore, the following recommendations are proposed to address these issues: recommendation 1: expand international collaboration, cooperation and exchanges to contribute to Kazakhstan's tertiary education system; recommendation 2: structure fiscal incentives to encourage foreign investment in knowledge intensive areas and recommendation 3: invest public R&D in niche areas of emerging technologies.

Mexico- The aggregate value of innovation inputs has increased in Mexico over the last 20 years. However, innovation output has not generally followed. Innovation activities in Mexico largely remain in isolation due to the following: large multinational companies (MNCs) do not invest in Mexico to leverage

[1] The title of an association of emerging national economies: Brazil, Russia, India, China and South Africa.

its innovative capacity, large MNCs are not developing domestic supply chains with Mexican small and medium-size enterprises (SMEs), and the public research enterprise is overly academic. These issues result in the isolation of innovation activity within firms and research institutes and limit the spillover effects of knowledge creation that are essential to creating a robust innovation system. Three recommendations - supported by the literature review, data analysis, and expert interviews - are provided that target and overcome these innovation challenges: recommendation 1: build SME capacity through awareness raising; recommendation 2: increase entrepreneurial thinking/acting in the public research centers and the university system by reforming federal labor laws to allow public researchers the ability to participate in business creation and permit flexibility for taking temporary leave; and recommendation 3: encourage the creation of a national linkages program to promote the creation of domestic supply chains.

The following report gives an introduction into the methodology employed by the GWU team, short country profiles, an in depth analysis of the various issues that benefit and challenge growth in each of these countries, as well as reasoning for the policy recommendations.

II. INTRODUCTION

This research was completed under the consultation of SRI International's Center for Science, Technology and Economic Development (SRI). Though not targeted to a specific product or service currently provided by SRI, this project might be described best as market research for SRI's programmatic work in innovation. As such, the GWU team addressed the following research questions:

1. What countries should SRI target to provide consulting services in the areas of science, technology, and innovation (STI) public policies?
2. What federal public policies can drive innovation-led growth in each of these countries?

Given the timescale of the project (approximately four months) and the number of researchers (three), the project was limited to three countries. Considering the complexity of national systems of innovations, the scope of the project was further limited to the identification of three innovation challenges for each of the selected countries. Moreover, at least one policy recommendation targeting each of the innovation challenges is prescribed.

To address the first research question, a framework has been developed through which the research team could select target countries. SRI's business development group provided the broad selection criteria: willingness and ability to invest, commitment to innovation, and national absorptive capacity. The GWU team was responsible for validating that the selected countries met these criteria. A detailed account of this process is provided in Appendices A and B. Nonetheless, a brief discussion is provided here. A country's willingness and ability to invest was established by documenting its status as middle income (at a minimum) and highlighting positive trends in recent economic growth, indicating the there was a potential for public spending on innovation initiatives. A commitment to innovation was validated through the presence of established government agencies and/or departments, with associated initiatives, having the mission of promoting and managing national science, technology, and innovation capabilities. Lastly, the ability of a country to absorb SRI's innovation training services is established by documenting a minimum level of economic development. This is done using Michael E. Porter's work on stages of economic development. Porter, Bishop William Lawrence University Professor at the Harvard Business

School, has defined four stages of economic growth: factor-driven, investment-driven, innovation-driven, and wealth-driven. Countries on the cusp of innovation-drive growth, yet still in the investment-drive stage, were determined to be the most appropriate candidates. Taken together, this process led to the selection of Brazil, Kazakhstan, and Mexico.

To address the second research question, each of GWU team members was assigned a country to analyze. Through a comprehensive literature review, data analysis, and expert interviews, three innovation challenges were identified for each country. To overcome or lessen these three innovation challenges, a basket of policy recommendations has been prescribed. The selection of these particular recommendations was based on a review of past and present federal policies for each of the innovation challenges in the respective countries. This survey is intended to highlight weaknesses in the current STI policy portfolio, understand past initiatives, and avoid redundancy. Moreover, the recommended policy tools were selected based on the policies and/or initiatives that other countries have successfully employed to overcome similar innovation challenges. Taken together, this research provides empirical evidence for the support of each of the three policy recommendations.

Per the request of SRI, the remainder of report documents the finding of the second research question only. The countries are presented in alphabetical order and the report closes with a brief summary. As previously discussed, the Appendices contain additional information on the country selection process.

III. BRAZIL

One of the biggest strengths in innovation for Brazil is namely the country's awareness that they need to gear up their resources in order to remain a player in the game. Over the past several years, Brazil has seen a rise in the use of ICT (ranks 54th worldwide), and according to the World Economic Forum, "Brazil's fairly sophisticated business community (33rd) enjoys the benefits of one of the world's largest internal markets (7th), which allows for important economies of scale and continues to have fairly easy access to financing (40th) for its investment projects" (33). This is important because it indicates that the Brazilian market has acknowledged that investment in the private sector is important for developing that infrastructure and allowing new businesses (both foreign and domestic) to enter the market.

In the past several decades, Brazil has shown tremendous ability to move their country forward and leave behind their colonial and military ruling into a nation of democracy. While their transition into a knowledge base economy has been relatively rapid, there are several roadblocks that are hindering the Brazilian government and its ability to effectively introduce changes to the system to propel greater investment into its science, technology and innovation sectors. The following sections will highlight the weaknesses of the current system, address why this is an issue, and make recommendations in three areas (human capital, private sector R&D investment and intellectual property rights policy) for addressing these huddles. More information about Brazil's economic performance, and past and current initiatives can be found in the appendices of this report.

Background: Innovation System Weaknesses

While Brazil has made excellent strides towards becoming a regional and international superpower, the country is still plagued by innovation weaknesses that could threaten its progress towards further development and a haven for science and technology research and innovation. While weak infrastructure (especially in the north and northwest of the country), poor government confidence (Brazil ranks 121 out of 144 in trust on politicians, 111 in government efficiency, and 144 in excessive regulation) and unorganized business enabling environment, Brazil's major obstacles in forging ahead towards a full innovation-driven economy stems from its poor quality of education, low R&D investment and limited capacity for commercial innovation, which includes Brazil's intellectual property rights.

Human capital in Brazil is poorly trained to handle the rise of science, technology engineering and mathematics (STEM) based innovation because the educational system in Brazil has lagged behind in preparing its workforce to understand these issues and provide them with the tools they will need to succeed; in fact, Brazil's human capital is ranked 83 out of 141 by WIPO's Global Innovation Index. "Perhaps more than any other challenge facing Brazil today, education is a stumbling block in its bid to accelerate its economy and establish itself as one of the world's most powerful nations, exposing a major weakness in its newfound armor" (Barrionuevo). According to data compiled by the World Bank, the World Economic Forum and the International Finance Corporation, Brazil's education sector, including primary, secondary and tertiary data, show that there are a huge lags in the country in this arena. This lack of prepared students to enter graduate and doctoral programs in STEM fields (rank 113 out of 144 in the World Competitiveness Index) means that per capita, Brazil is underrepresented in these fields which affects the number of patents and published materials being generated in country. According to the OECD, "research outputs are very low compared to the OECD in terms both of articles published in top-quartile scientific journal and of patents and trademarks. Over 2005-09, the relative number of patents filed by universities and PRIs per GDP was well below the OECD median" (*STI Indicators*). A lack of domestic strength in these ventures naturally means that efforts in international collaboration between scientists are also affected. "In terms of international innovation-related linkages, 27 percent of total scientific articles involved international coauthorship and 17 percent of PCT patent applications were international co-inventions" (*STI Indicators*).

In terms of research and development, Brazil's investment has been lagging. According to data from the World Bank, Brazil's gross expenditure on research and development is close to 1.08 percent (as of 2008 which is the last set of data available). To put that in perspective, most developed nations in the world are spending between 2-3 percent of GDP expenditure for R&D. Expenditures on R&D serve as a metric to gauge how inventive and innovative a country's potential is and what they prioritize internally. The issue in Latin America is that as the leader of research and development, Brazil's low R&D expenditures indicates that the region in general is vastly behind its developed counterparts. "Nearly half (47.2 percent) of Latin America's world share [of R&D expenditures] in 2008 was concentrated in Brazil, the front-runner country, while the top four countries together (Brazil, Mexico, Argentina and Chile) accounted for 87.7 percent (Gaillard 86)." In addition to low investment, the majority of Brazil's researchers (around 60 percent) work within the university system while countries like Germany and the U.S. have the majority of researchers (65 percent and 75 percent respectively) working in the private sector (Lyytinen). This shows that not only is Brazil's R&D infrastructure unfunded, but that private companies are not investing enough into R&D either.

In addition to low investments in R&D, Brazil faces a challenge in its management of intellectual property rights (IPR). "Between the 1930's and 1980's, Brazil carried out its IPR policy based on an Import Substitution Industrialization (ISI) strategy—a protectionist development strategy focused on replacing industrial imports with domestic production—which sought to acquire IPR and technological knowledge at the lowest possible cost" (Wright 2). This caused a lack of IPR development in the country and while started remedying itself in the mid-1980s still leaves a lot to be desired. "If Brazil wants to be considered a player within the global IP industry it must be more responsive to international IP regulations, improve IP-oriented institutions, encourage technology transfer (both internally and from abroad), as well as work towards the harmonization of regional and international IP standards" (Wright 5). Considering its size and breadth, Brazil has one of the lowest registered patents per capita and the patents that are registered are overwhelming for private industry. While there are other factors that affect patent registrations- a low number is individual patents means that the environment for innovation and entrepreneurship is not adequate for individual citizens to invest the time to develop new inventions and innovations.

Based on the literature and data available, the follow three policy recommendations are proposed to address this narrow scope of issues:

Recommendation #1: Fill the Human Capital Gap in the short term by Adopting Friendly Immigration Policies to Incentivize High-Skill Immigration

This change will help ensure that Brazil has the knowledge base to carry out the work that they need to do. Specifically, Brazil should implement policies to allow skilled scientists and engineers access to the country and allow them to stay as productive citizens.

Recommendation #2: Increasing Private R&D Expenditure by Providing more Tax Breaks

Since the R&D expenditure of private firms in Brazil lags behind government expenditure, creating incentives for private firms to commit more to R&D is a feasible policy that could help the markets become more competitive and increase revenue streams stemming from the work that is done in house.

Recommendation #3: Increase Internal Policy Coordination to Strengthen Intellectual Property Rights, and Adopt International Standards

Inconsistent policies and poor management of the current infrastructure means that the recommendation here is for Brazil to introduce updated and supplemental initiatives to existing framework (through the National Institute of Industrial Property) that can help deal with some of the issues that are still present and strengthen their national and international IPR management.

Arguments: Policy Justifications

Brazil has certainly moved forward in terms of defining their innovation efforts and moving the country forward. The objective of these recommendations is to strengthen Brazil's innovation system and encourage further development. Each of the following recommendations are meant to address the three aforementioned challenges by providing information on the system weaknesses, address policies in place- or the lack thereof- and highlights country examples were the recommended policy has been successful.

Human capital challenges are common in a host of countries, and common policy options include: education subsidies for additional training, educator based programs and incentives to attract top professionals, immigration reform policy, investments in education, etc. In order to address Brazil's short-term human capital issue, they should consider adopting more immigration friendly policies and procedures to entice highly trained individuals to work in country. Immigration reform will help to provide workers to industries, especially the most innovative industries that need trained workers. Brazil sees more of its citizens leaving the country instead of foreigners entering. It is unable to attract top talent because of outmoded immigration policies. “A century ago, … 7.3 percent of the Brazilian population was foreign-born. Now that figure has dropped to just .3 percent. In contrast, the 2010 U.S. Census found that nearly 13 percent of the U.S. population was foreign-born” (Whitefield). This has created a vacuum in some industries that could benefit from an influx of well trained professionals looking for new opportunities.

The process for obtaining a work visa in Brazil can be cumbersome and discouraging. While the government, and more specifically the Secretariat of Strategic Affairs (SAE), has started to clear some of the ‘red tape’ by updating submission platforms, many of the restrictions that limit the type of immigrant into the country are still in place. Current legislation does not address the need to seek specific types of immigrants (engineers versus musicians) nor does it take into account the variety of skills set needed to succeed in a particular industry; for example, traditionally big firms employ staff in Brazil, not SMEs or other similar ventures that require entrepreneurial individual (Whitefield).

Allowing for changes to immigration policy would also help incentivize the private sector in Brazil to invest more their research and development - as will be discussed in the next section- as it would give them the necessary staff to make their organizations more competitive nationally and internationally as well as allow their organizations to grow in country. According to Lumpe and Weigert’s research, “immigration policy aiming at well-educated immigrants increases incentives to create more vacancies thus raising the wage paid by firms. Therefore high-skilled immigration leads to rising educational attainment of natives.” Additionally, “immigration policies — either by changing the human capital composition of immigrants or by changing the inflow of immigrants into the host country — will have a direct effect on the job creation of firms” (Lumpe and Weingert).

Prime examples of immigration policy that has benefited workforces can be seen in Australia and Canada. Starting in the late 1960s and early 1970s, Australia and Canada made skilled labor immigration a priority. In both systems, nonhumanitarian immigration is divided into two categories: those who have relatives or friends living in country and those with high skills that can make positive impact on the labor market. A targeted capacity figure is determined annually, and then filled based on the applications received from those looking to immigrate. Once potential candidates are selected, they are ranked based on a points system including language skills, education level and other criteria deemed important by their governments. In effect, these countries see a higher level of immigration based on technical skill (over 40 percent for Australia and over 60 percent for Canada) versus those with low skill levels but with family connections in country (Antecol et al). Research in this field has concluded that while there certainly are several factors at play, selective immigration policy enacted to affect immigration outcomes can in fact have an effect on the skill level of immigrants attracted to the region.

As one of the leading Latin American countries in science and technology, Brazil needs to maintain and expand its role in the development of innovation by increasing the amount of R&D expenditure that is spent in country. Common policy options include: legislation mandated by the government to increase

R&D expenditure as a percentage of GDP, providing incentives to the private sector to commit more to R&D expenditure, tax breaks for R&D, etc.

In order to increase shares of R&D, Brazil should create incentives for private firms to commit more to R&D investment in order to spur innovation in country and have less of a reliance on national systems to supply the tools needed to create new opportunities for firms. These incentives, primarily in the form of tax breaks or rebates, would motivate firms to reassess how they manage their resources. By increasing capital investment in these firms, they would build up their technological infrastructure and in addition to building capacity, these incentives would help provide incentives from small and medium enterprises encourage more angel investing and venture capitalists, help develop technology parks and incubators, firm up relationships between universities and industry and promoting intellectual property rights (Sennes 11). This sort of legislation would "enable long term investments and the development of new technologies with research and development (R&D) expenses. R&D investments have a high-degree of uncertainty and are normally left out of the private financing system's scope. Thus, there is room for governments to work through non-reimbursable financing at low interest rates (without subsidies)" (Sennes 12). In fact, research shows that firms that are provided incentives to invest in research and development expenditures are more likely to do so than those that do not receive this inducement, especially those firms that do not have the initial means to devote capital to R&D (Gonzales and Pazo).

Several countries have actually seen great success in implementing R&D tax breaks for companies in order to increase their private R&D spending. As of 1981, the United States has implemented the Research and Experimentation (R&E) tax credit, which essentially "encourages private sector R&D by allowing corporations to take unlimited deductions for qualified research spending," (Markovich). According to the Information Technology and Innovation Foundation, there are currently 42 countries (including the United States) that now employ similar legislation and have benefited from it since its inception. Of particular note is that India currently leads all other nations in the amount of tax benefit received by small and medium enterprises as well as large companies (Stewart et al.). Several European countries are also actively involved in increasing these incentives for firms and all BRICS countries have implemented some variation of this policy to some extent already.

The ability to aid to technology commercialization is an important factor in expanding innovation initiatives, and common policy options include: harmonizing IP ownership legislation, developing technology transfer agencies, legislation defining who a patent or invention belongs to, and national IP management strategies. In a sense Brazil has modeled most of their recent efforts in this arena on the American model of innovation law and IP policy protections. While Brazil has made great strides in protecting intellectual property rights, decades of overly protectionist policies in this area are still affecting how industry, individuals and other entities interact with the government to move products to the market. Intellectual property rights have been inconsistent and resources are not well managed in the current structure. In an effort to remedy these shortcomings, the recommendation here is not for Brazil to create new legislation but to work within existing framework to pull resources in and streamline the process. One way of doing this is to bring in "...innovative companies in the design of innovation policies, with the ultimate goal of enhancing and exploiting the country's competitive advantages" (Wright 2).

Revamping Brazil's existing legislation in regards to intellectual property rights represents the chance for Brazil to continue its path towards an innovation driven economy and work to enhance the talent that is in country. Brazil has made progress in this respect, attempting to model some of its policies after American innovation laws including Bayh-Dole Act and they have expanded existing government agencies that coordinate IPR applications. According to an assessment by the Wilson Center's Brazil Institute, "if Brazil wants to be considered a player within the global IP industry it must be more responsive to international IP regulations, improve IP-oriented institutions, encourage technology transfer (both internally and from abroad), as well as work towards the harmonization of regional and international IP standards" (Wright 4).

There are several international agencies, including WIPO and OECD that have devoted a significant amount of literature to exploring whether developing countries benefit or suffer as a result of strong intellectual property rights. However, there are other developing countries that have already started strengthen their internal systems because they recognize that corporations and other business entities based in developed countries need the guarantee that their information will be protected. Jordan recently restructured their intellectual property rights legislation, creating a better environment for their pharmaceutical sector. As a result, "Jordan's pharmaceutical sector has gained new export markets and has started to engage in innovative research. New health sectors, such as contract clinical research, have emerged, and health-sector employment has grown" (Holden). Other developing countries have followed suit in a variety of ways after several reports, from RAND to the OECD have backed data that supports that developing countries benefit from these IPR protections.

Recap: Brazil

Brazil's stance in the global market makes it a ripe ecosystem to affect change and continue to move the country forward in their endeavor to strengthen their domestic and international clout. Having weathered the global financial crisis in better form than most, Brazil has an incentive to continue to work towards GDP growth and diversify its portfolio in an effort to attract the investments it needs to move into an innovation driven ecosystem. Based on this examination, short term policy recommendations for Brazil include: addressing the immediate needs of the country by adopting immigration friendly policies to attract well prepared individuals to work in their high-tech industry, providing greater tax breaks to private companies so that they are able to invest more in research and development, and to shore up intellectual property rights in the country within the existing system, paying special attention to international regulations.

Limitations of the research- This analysis is by no means complete. Outside of the STI framework, Brazil is undergoing massive changes internally to ensure that its stance in the BRICS remains unchallenged. Brazil's sheer size and government involvement means that this report only touches upon three specific issues in the scope of a more intricate system. With more time and resources, an entire overview of the Brazilian STI system could be beneficial for identifying other areas that Brazil should work on to improve their internal systems, including policy recommendations for start-ups, venture capital incentives, and cultural limitations to an entrepreneurial environment. Another limitation of this report is that it looks towards short-term solutions, as opposed to longer-term recommendations and as an emerging economy but not yet a member of international organizations like the OECD, some data categories have gaps and missing years and some data resources are outdated because those figures have not been reported/collected. Lastly, interviews with experts were difficult to schedule due to lack of response, complex schedules or failure on the part of the interviewee to have in depth knowledge on the question asked. Notes on the only successful interview can be found in Appendix C.3.

IV. KAZAKHSTAN

Kazakhstan has a very robust economy, its commodities and natural resource extraction exports having proved highly resilient against the global recession. Kazakhstan's economy has performed strongly since the early 2000s, when it managed to consolidate Soviet-era enterprises through restructuring, recapitalization and privatization. Openness to foreign investment and involvement means Kazakhstan is one of the best former Soviet states for conducting international innovation commerce. In particular, the Kazakh economy grew 7.5 percent in 2010, while having grown at an average rate of above 7 percent in the past ten years, fuelled by the production of energy and mineral commodities like oil and silver (CIA World Factbook- Kazakhstan). Such sustained economic growth gives Kazakhstan substantial economic resources to undertake capital intensive investments in research and science infrastructure, as well as economic leverage to encourage foreign technological cooperation. Current per capita GDP is at $13,900 (PPP) and total GDP is at $292 billion (PPP). It also has a land area of 2.7 million square kilometers and a population of 16.9 million (CIA World Factbook- Kazakhstan).

The three obstacles facing Kazakhstan's transition to an innovation based economy are the insufficient STEM education capabilities in Kazakh institutions, a low demand for STI professionals in Kazakh economy, and the tendency of existing Kazakh R&D to focus on secondary and tertiary development.

Background

Kazakhstan faces formidable obstacles in transitioning towards an innovation-driven economy. Firstly, the Kazakh higher education system is inadequate for providing STEM education and preparing STI professionals for practical careers, as well as collaborating with the private sector. Kazakhstan also produces very little in the way of peer reviewed scientific literature, which in turn leads to a lack of a domestic foundation to base technological innovations upon. Also, current management of Kazakh STI professionals lead much to be desired, with antiquated Soviet era requirements on education duties over research duties and insufficient economic incentives and technological infrastructure prompting Kazakh STI professionals from seeking employment abroad.

Science technology engineering mathematics (STEM) education suffers from insufficient job opportunities for graduates, burdensome bureaucratic restrictions on faculty, and uncertain education quality owed to the proliferation of "diploma mills". The World Bank reported in 2005 that half of Kazakhstan's scientists had left compared to the 1980s and that from 1983 to 2004, no new scientific equipment was brought into Kazakhstan (Kazakhstan- Country Partnership Strategy). Additionally, the average age of the Kazakh researcher is 55, according to the British Council (Matthews). While well intentioned, the requirement that each faculty member spend 800-900 hours annually interacting with students serious impacts the productivity of their research by allocating their time to doing tasks often best assigned to teaching assistants and adjunct faculty.

Currently, much of foreign direct investment (FDI) into Kazakhstan is concentrated in the extractive industries like petroleum, agricultural processing and copper, service industries (like banking) and real estate (Kazakhstan- Country Partnership Strategy). Astana, the Kazakh capital, has been very welcoming to foreign investment. Foreign investment to date includes joint ventures with Chevronto develop the Tengriz oil field (Peck 102) and the $3.4 billion oil pipeline to China. Of particular note is that only 6 percent of Kazakh manufactured exports are high tech and according to the World Bank, Kazakh industrial productivity per worker is only a third of American productivity (Kazakhstan- Country Partnership Strategy).

Currently, Kazakh R&D is concentrated at the low end of applied research. Kazakhstan has received relatively little of the Soviet STI infrastructure; what was located in Kazakhstan was related to the nuclear weapons or space programs (Peck 62). For instance, the top five categories in Kazakh patent filings from 1997 to 2011 were materials and metallurgy; engines, pumps, turbines; civil engineering; chemical engineering; and transport (Kazakhstan- Statistical Country Profile). Only about 0.25 percent of Kazakh exports were electrical and machinery in 2011 and only 0.23 percent of GDP is devoted to R&D. This indicates that Kazakhstan is still heavily reliant about resource extractions from agriculture and mining in its economy; the petroleum exports of $25 billion made up 60 percent of all Kazakh exports in 2011, with copper being the second largest export at $2.1 billion (Observatory of Economic Complexity).

Fortunately, these weaknesses can be addressed with specific policy measures to build up the foundations of Kazakh STI innovation to become commercially relevant.

Recommendation #1: Kazakhstan should expand international higher education collaboration

Kazakhstan should expand the level and complexity of international cooperation in the fields of higher education. Kazakhstan should partner with foreign education institutes, including opening satellite campuses on Kazakh soil, provide funding to encourage foreign students and professors and dialogue to identify ways to support academic freedom and independence in Kazakh higher education institutions.

Recommendation #2: Kazakhstan should also launch a dedicated program of tax breaks, low interest loans and access to infrastructure for foreign investors to invest in knowledge intensive activities in Kazakhstan.

Kazakhstan should offer incentives for foreign investors to make investments in knowledge intensive commercial activities. Foreign investors should receive favorable tax treatment and credits in return for investing in knowledge intensive activities like information technology research and production of high value aerospace supplies. Kazakhstan can incentivize public-private partnerships with foreign high tech investment by offering access to specialized infrastructure, such as in the form of technology parks, and risk sharing schemes that could be backed by the faith and credit of the Kazakh government.

Recommendation #3: Kazakh public R&D should invest in niche applications of emerging technologies to meet Kazakh market needs.

The Kazakh government should invest in emerging new technologies. Kazakhstan target planned R&D increases to fund university labs focusing on niche application of emerging technologies. These labs should partner with foreign innovation companies to deliver solutions relevant to Kazakh needs like robotic oilfield firefighting equipment and mine rescue and maintenance. The investment in new technologies needs to be in very specific fields, both to provide tailor made solutions for Kazakh and

Central Asian needs, as well as setting up early competitive advantages for Kazakh producers in a technologically dynamic global economy.

Arguments: Policy Justifications

Each policy recommendation is designed to build up the fundamental part of Kazakhstan's innovation infrastructure, focusing on developing the STI professional education capacity in Kazakhstan, providing opportunities for those STI professionals in Kazakhstan and to create pockets of excellence in specific emerging technology applications to create unique Kazakh STI capacities.

It is preferable that Kazakhstan focus on education as part of building the foundations for a strong STI infrastructure to drive innovation based economic growth Kazakhstan has a favorable demographic profile; 22 percent of the population is under 14 years old, though Kazakhstan had lost up to 2 million people from 1995 to 1999, due to the immigration of ethnic Germans and Russians, who made up a disproportionately large portion of STI professionals (Peck 60). This demographic profile means that in the next ten to twenty years, as the economy shifts to innovation focused growth, there will be a much larger pool of young educated Kazakhs than currently present, increasing the potential domestic cadre for STEM professional recruitment. Additionally, the majority of Kazakhs are well educated in terms of basic education, with a 99.5 percent literacy rate (CIA World Factbook- Kazakhstan). That provides a favorable environment for seeding more widespread tertiary STEM education.

Kazakhstan has also made it very easy for foreign academics to join Kazakh higher education faculty; five of the seven deans of the schools at Nazarbayev University are foreigners (Nazaybayev University). Kazakhstan has also taken other steps to partner and include foreign input into its STEM higher education. The Ministry of Education is responsible for the Bolashak Scholarship program, where it pays for tuition and living expenses for Kazakh students to study aboard and return to work in Kazakhstan for five years (Kazakhstan- Country Partnership Strategy). To date, over 6,000 scholarships have been awarded to Kazakh students (Kazakhs are overrepresented in the scholarship due to fluency in the Kazakh language being a key eligibility criteria) (Burnston 30).

Expanding international cooperation on higher education will further Kazakhstan's goal of developing STEM professionals and opportunities for them. Simply providing foreign study scholarships for Kazakh students is not an optimal solution; foreign education cannot provide the intellectual stimulus and organization efficiency needed for faculty researchers to develop STEM research programs in Kazakhstan. To enact the specialization of universities into dedicated research universities and "normal" pedagogical universities, foreign best practices are needed. Universities can be made more receptive to R&D activity by implementing a research/education system that divides Kazakh universities into two systems; research universities with faculty empowered to conduct basic and applied research, and teaching universities that are geared to educating STI and other professionals for the demands of the Kazakh market place.

Qatar is a good example of a nation that has been able to carry out STI investment and reform using petrodollars. For example, Cornell University and Texas A&M have built satellite campuses of medical and engineering schools in Doha; such foreign satellite campuses give Qatari students privileged access to those university's academic and human resources. Hosting foreign universities' campuses would enable

Kazakhstan universities to benefit not just from the provision of foreign talent to students, but also for administrators and faculty to learn about adapting OECD practices from technology commercialization, administration of research programs, and faculty tenure review best practices to Kazakh circumstances. Building such close ties with foreign universities would also increase Kazakh access to advanced basic research in areas like nanotechnology and advanced materials research.

Kazakhstan benefits from a wealth of natural resources and willingness to accept and integrate foreign economic and technological inputs (Burnston 51). It is the world's top uranium producer, accounting for 33 percent of the global market in 2011. Kazakhstan's relatively small population means that it would be difficult to engage in wholly indigenous development of the entire technology chain. The primary emphasis should be on encouraging companies already invested in Kazakhstan, like Chevron, Eurocopter and ZTE, to undertake joint ventures such as opening R&D centers for emerging technologies like cloud computing and additive manufacturing. In return, these foreign investors would be able keep and expand upon their commanding leads in Kazakh import trade and foreign investment, in addition to benefiting from access to Kazakh STI professionals, as well as tax credits and access to specialized infrastructure.

It is much more preferable to have Kazakh innovation commercial entities work as partners with foreign investors instead of being just recipients of technology transfer, since that will maximize employment and professional experience opportunities for Kazakh STI professionals. National Agency for Technological Development (NATD) runs the two current tech transfer centers dedicated to managing technology received from France and South Korea. There may be interest in setting up more centers dedicated to China, Germany and Japan, especially in light of Kazakh interest in developing uranium ore processing technology and production of communication equipment with ZTE (Dukenbayev). NATD technology transfer centers with France and South Korea have provided Kazakhstan with alternatives to Russian technology, especially in the defense sector (artillery and helicopters). One of the more successful tech transfers has been the facilitation of the Kazakh modification of the EC-645 scout attack helicopter (its civilian model, the EC-145, is already produced by Kazakhstan Engineering) (Kucera).

To take Kazakhstan's innovation capability to the next level, foreign investors need sufficient incentives to guarantee that they can take the risk of partnering with nascent Kazakh innovators. The Kazakh government, nonprofits and corporations need to find ways to best structure tax credits to appeal to the various business plans and models of numerous multinational corporations. Coordination between Kazakh government agencies will also be important, as well as developing the correct metric sets to gauge the effectiveness and affordability of tax credits on foreign knowledge intensive investments (Trivelpiece). Other methods like local content requirements may be less effective in creating opportunities for Kazakh STI professionals because in addition to local content requirements focusing on investment and production instead of innovation, there are high barriers to reworking existing multinational supply chains and suddenly requiring Kazakh industries to adopt world class quality control standards.

Major non-CIS trade partners include China, the European Union, South Korea and Turkey. Kazakhstan has already established technology transfer agreements with France and Japan to exchange technologies such as solar power and helicopter production. Kazakhstan is also looking to partner with

China and India to develop technology. However, if Kazakhstan does not build the foundations for close public-private partnerships between its domestic research and commercial entities, any progress made in domestically training STEM professionals will be largely wasted (Carayannis 50). This is one of the most difficult tasks that a transitioning economy must undertake but fortunately Kazakhstan can learn from the example of Asian countries.

Much of China's recent innovation driven economic growth can be tied to China going beyond technology transfer agreements with foreign investors to actively including them in technology research programs and giving them incentives to use Chinese STEM professionals. The COMAC C919 globally sourced components, including avionics from Honeywell and the LEAP-1C turbofan engine from CFM International. To successfully follow the Chinese success would require that Kazakh bureaucrats not only identify capable enterprises and promising research, but that they also show restraint to limit overt involvement, operate in appreciation of international norms and be able to build intuitional experience from failures and successes (Breznitz 213).

The Kazakh government is planning to increase national innovation by developing uranium processing and nuclear energy technologies, bioresearch in agriculture and medicines, and information technology hardware and services (Kazakhstan- Country Partnership Strategy). For instance, the Nazarbayev University has established a robotics research laboratory. There is also Kazakh interest in applied research on power generation, satellite technology and water purification technology. These interests reflect unique Kazakh needs and opportunities, such as capitalizing on services and goods supporting space launch activities at the Baikonur Cosmodrome, coping with increasing demand pressures on Kazakhstan's water supplies and generation of clean energy for rising power demand driven by higher Kazakh living standards.

Kazakhstan needs to continue increasing spending on R&D infrastructure, in conjunction with foreign partners, preferably a dual track program that engages both the Science Ministries of developing, middle income countries on one track and partnering Kazakh universities with top tier developed world counterparts. Investments can be made in emerging applications such as using robots to fight oil field fires and nanotechnology to reduce greenhouse gas emissions. This will allow Kazakhstan to continue building links with less wealthy Central Asian countries like Afghanistan, Kyrgyzstan, Uzbekistan and Tajikistan. While Kazakhstan is likely to meet its goal of 2 percent of GDP going to R&D by 2020, it is necessary that Kazakh resources be devoted the technology and basic research sectors where such money will have the greatest impact.

Three niche technology applications that Kazakh R&D could invest in could be:

- Robotics for firefighting at oil production facilities.
- Use of nanotechnology to clean up uranium processing facilities.
- Develop 3D printing technology specialized for vocational training.

Investment in emerging, niche technologies will be first aimed at satisfying unique Kazakh needs and market demands. Limiting ambitions to such a lower scope will make it more palatable and more risk manageable for foreign partners' involvement. Developing leads in unique technology applications will eventually make Kazakh exports more competitive and sophisticated, as well as contributing to Kazakhstan's role as the economic hub for Central Asia. Frankly, investing in more established R&D

sectors such as hydroxide rocket engines or solar panels would force Kazakhstan to compete against much more well-established technology leaders like the U.S. or Russia. Investing in niche applications of technology research will also make Kazakh industries and science more specialized, which could ease foreign partners' fears about aiding potential competitors.

Singapore is an example of building a successful global and regional research hub. In 2012, Singapore became the fifth most prolific source of peer reviewed journal articles in the Asia Pacific. The Center for Quantum Technologies and Institute of Molecular and Cellular Biology are key examples of the Singaporean government working with private and foreign institutions to develop both theoretical and applied research in very specific fields; fusion of quantum physics and computing, and molecular engineering and cancer genetics. Singapore's centers combine foreign talent and preexisting Singapore high tech manufacturing and service industries to maintain Singapore's regional leadership in applied commercial technology (Koh).

Recap: Kazakhstan

To successfully make the transition from the current efficiency driven economy to innovation driven growth, Kazakhstan must address three structural challenges to commercializing its STI output. First, the Kazakh higher education system does not produce a sufficient supply of STI professional graduates. Secondly, Kazakh STI professionals do not have access to many or well-paid jobs in Kazakhstan. Finally, existing Kazakhstan R&D is too heavily oriented towards basic, low value added innovation.

To address these limits, Kazakhstan needs to undertake a long term, coordinated approach of policies to build a STI research and commercial network foundation. Kazakhstan should undertake a full spectrum of international collaboration with foreign universities, from academic and administrative exchanges to possibly even setting up satellite campuses on Kazakh soil. Astana should offer incentives, like tax credits and infrastructure access, to foreign investors to invest in knowledge intensive commercial activities. Finally, Kazakhstan should structure its public R&D funding towards niche applications in emerging technologies like robotics, nanotechnology and cloud computing for first meeting unique Kazakh customer demands and requirements.

Granted, limitations in this study may undermine the prescription of these policies due to the lack of transparent and unbiased data from the Kazakh government, which is highly repressive in terms of state surveillance of the civil society and private sector, restrictions on political expression, as well as corruption. For instance, it proved to be practically impossible to find experts on Kazakhstan's STEM development. Also, the almost universally optimistic tone of UN and other international NGO reports on Kazakhstan's STEM progress seemed rather unusual, possibly reflecting at least unstated pressure to tow Astana's official line. Another inhibition for this study was that given that Kazakhstan has only 22 years of sovereign history, that there were little prior history and innovation initiatives that could be examined for failures and successes. Additionally, there is the risk that given technological uncertainty, that Kazakh R&C in niche applications in emerging technologies like 3D printing, robotics and nanotechnology may not prove to be commercially viable.

V. MEXICO

The first decade of the new millennium has been particularly challenging for Mexico. In the ten years leading up to 2010, Mexico's economy grew by an average of just 1.6 percent a year (World Databank). Mexico's slow growth over this period was due in large part to China's accession into the World Trade Organization in 2001 and the subsequent undercutting of Mexico's export industry (The Economist). It appears, however, that this tenuous decade is giving way to a prosperous period for Latin America's second-largest economy. Since 2009, Mexico has experienced three consecutive years of strong growth - between four and six percent per year (World Databank). This positive trend is expected to continue into 2013. According to AlixPartners, a consultancy, this recent growth is driven by three key factors: rising labor costs in China, proximity to the U.S. market relative to Asia, and a competitive peso relative to the renmimbi.

Mexico certainly welcomes this recent economic uptick. However, the changing economic tides are largely driven by the cost of production factor inputs, which are highly sensitive to world economic cycles. In short, Mexico's export-driven recovery is fragile. When competing on cost, it is only a matter of time before factor conditions shift - as they did with the rise of China. To establish sustained economic growth and shield the economy from cost shocks and exchange rate fluctuations, Mexico must increasingly compete on technology and process differentiation, i.e. innovation.

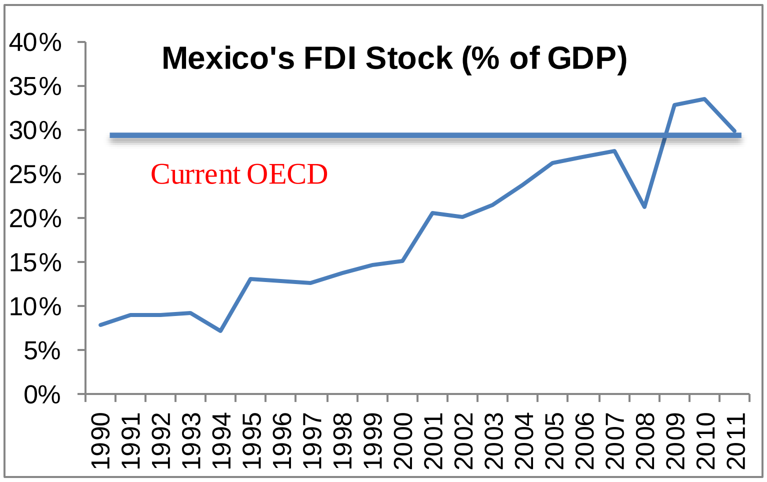
What hinders technology creation and diffusion in Mexico is similar to the innovation challenge faced by many higher-income countries with more mature innovation systems, which is linkages - or the lack thereof - between innovation actors. The aggregate value of innovation inputs has increased in Mexico over the last 20 years. However, innovation output has not generally followed (The World Bank). "Creating linkages [between innovation actors]," according to Yengency Kuznetsov and Carl Dahlman of the World Bank, "is at least as important as strengthening the individual elements of the innovation system" (41). As such, improving the linkages within Mexico's innovation ecosystem is the unifying theme for the Mexico section of this project.

Background: Mexico's Innovation Challenges

Through a combination of economic reforms and government-led STI efforts, Mexico has been able to realize non-trivial increases in important innovation inputs over the last two decades in FDI, national R&D spending, and the number of scientists and engineers working in Mexico. Despite these increased investments in innovation, however, Mexico has not experienced a commensurate increase in productive innovation output over this same period. This section details the evidence of this dynamic and goes on to provide three explanations: large multinational companies (MNCs) do not invest in Mexico to leverage its innovative capacity, large MNCs are not developing domestic supply chains with Mexican small and medium-size enterprises (SMEs), and the public research enterprise is overly academic. These issues result in the isolation of innovation activity within firms and research institutes and limit the spillover effects of knowledge creation that are essential to creating a robust innovation system.

Foreign direct investment can play a primary role in economic development, as multinational enterprises can be a source of learning about advanced methods in production, finance and marketing, which can foster innovation. Foreign direct investment can also be an important source of competitive pressure and a vehicle for technology spillovers (Nicoletti et al., 2003). In Mexico, FDI stocks have

Figure 1: Mexico Foreign Direct Investment (1990-2011) Source: OECD.Stat



generally been increasing since the signing of the North American Free Trade Agreement (NAFTA) in 1994 and, in 2011, were slightly above the OECD average (Figure 1).

As expected, FDI has increased the flows of patented technologies into Mexico. This is reflected in non-resident patent data, which have more than tripled since 1990 (Figure 2). However, there is no relationship between resident patenting and incoming FDI. Between 1990 and 2010, resident patent applications grew by just 44 percent - from 661 to 951..Thus, the FDI flows of the last two decades have not translated into enterprise upgrading in the domestic economy.

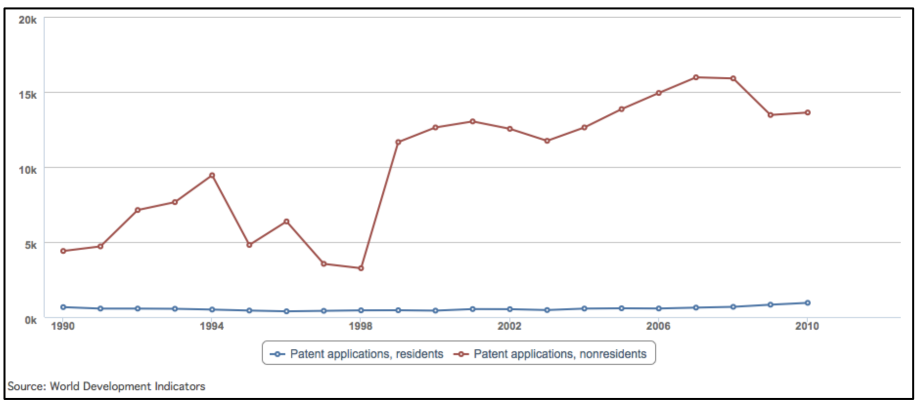


Figure 2: Non-Resident and Resident Patent Data (1990-2010)

Innovation activities are not limited to patenting activity - which stem from new-to-the-world products or processes. Non-patenting firms - especially firms that remain far from the technology frontier - can innovate through technology adoption, incremental changes to products and processes, imitation, and combining existing knowledge in new ways (Arundel, Bordoy, Kanerva 7-8). This type of innovation, however, is much more difficult to quantify. Nonetheless, if incoming FDI has spurred this type of innovation in the Mexican economy it should show up in aggregate productivity data, such as total factor productivity. However, according to the World Bank, growth in Mexico has been mostly driven by accumulations in capital and labor; the contribution of total factor productivity to overall Mexican economic growth was negative during the 1982-1995 period and negligible between 1996-2010 (The World Bank).

The inability to translate FDI into domestic innovation output is attributed to two issues: innovation in large Mexican firms (foreign or domestic) - though rising - is still minimal and SMEs in Mexico have limited absorptive capacity. Mexican subsidiaries of multinational companies do not generally act as innovation platforms (Dahlman and Yevgency 39). Though there are exceptions such as the Delphi Mexico Technology Center and its world-class engineering capabilities, multinationals largely still use Mexico for low-cost, large-scale production that is close in proximity to the U.S. market. Incoming FDI has not been knowledge-intensive, and thus, presents limited potential for domestic firms to benefit from knowledge spillovers.

Even if Mexican multinationals were generating large amounts of knowledge in Mexico, there remains the problem of low absorptive capacity of the domestic SMEs. When domestic SMEs have low absorptive capacity, they have little to offer a foreign subsidiary. As a result, there is little interaction between large innovative firms in Mexico and the SMEs that make up the vast majority (98 percent) of the economy. For example, in the automotive sector, domestic tier one suppliers have not connected to second and third tier suppliers in Mexico due the limited flexibility, reliability, and managerial skills of most SMEs as well as being incapable of meeting international quality standards (OECD *OECD Reviews* 76).

Foreign direct investment is not the only innovation activity that has increased in Mexico since the early 1990s. Though national R&D in Mexico remains one of the lowest in OECD area - and lower than non-OECD countries with similar levels of income - national R&D has been steadily increasing in Mexico over the last two decades (Figure 3). According to the latest data, gross R&D expenditures in Mexico are approximately 0.44 percent of GDP (World Databank). Though Mexico has not hit the R&D target (1 percent of GDP) set by policy makers multiple times over the last decade, national R&D has more than doubled since the mid-1990s. Nonetheless, relative to other OECD countries as well as countries at a similar stage of development, Mexico's R&D enterprise is underperforming (OECD *Science* 344). Thus, lower levels of patenting should be expected. However, countries such as New Zealand, Hungary, and Ireland all file many more patents than Mexico with lower levels of R&D intensity (OECD *OECD Reviews* 104). The increase of R&D expenditures is a necessary condition for increased innovation, however, as the patent data show - this is not sufficient.

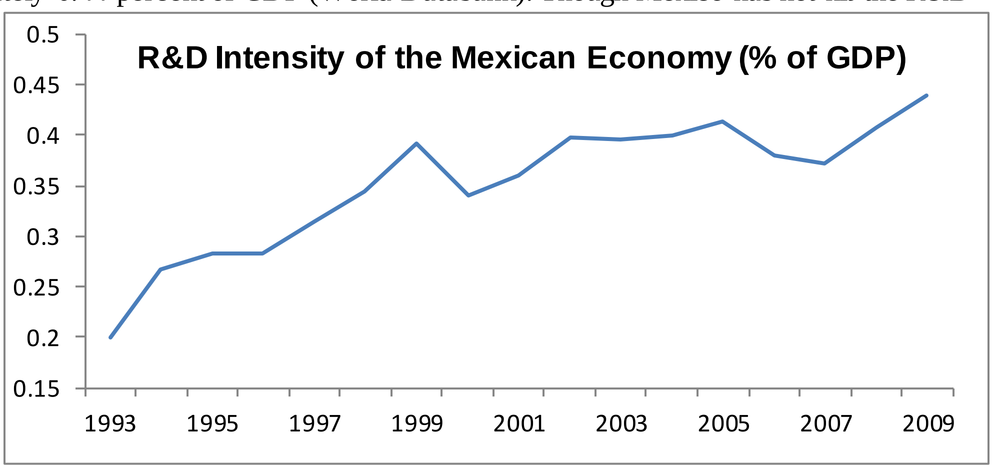
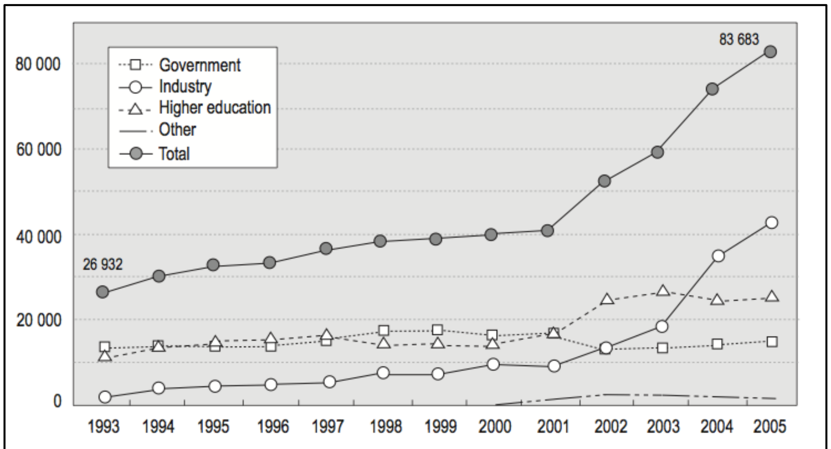


Figure 3: Gross R&D Expenditures (% of GDP) 1993-2009, Source: OECD.Stat

The number of S&T researchers in Mexico, another essential innovation input, has more than tripled since the mid-1990s (Figure 4). According to Paul Romer, New York University Economics Professor and author of the influential "Endogenous Technological Change", the number of ideas workers in an economy, coupled with R&D activities is essential to the production of new ideas (74). The uptick in Mexican knowledge workers is largely due to the creation of the National System of Researchers (SNI), a non-taxable parallel compensation program developed in 1984 intended to boost the number and quality of scientific researchers in Mexico (OECD *OECD Reviews* 15). As previously mentioned, resident patent activity increased only 44 percent between 1990 and 2010. Over this same period, the number of academic journal articles generated more than quadrupled (World Databank). Several experts in Mexican innovation policy explained that public research institutions are overly academic - with little incentive to focus their research on the productive sector (Gallegos 2013) (Malono 2013) (Torres 2013). This is not only reflected in patenting and publication disparity described above; entrepreneurial research enterprises tend to attract more private sector participation in research activities. In Mexico, however, industry participation in public research is still well below international standards. According to the latest data available - the share of income accruing from the business sector was a mere 3.0 percent of all intermural government expenditure of R&D (OECD.Stat). The overly-academic public research enterprise explains in part why, despite increases in both national R&D and the number of S&T workers, minimal patent generation has followed.



Source: CONACYT.

Figure 4: Total R&D Personnel by Sector of Employment in Mexico, 1995-2006

These data and analysis provide the evidence of a broad innovation challenge in Mexico: there are poor linkages between the public sector research system - embodied in the public research laboratories as well as the university system - and the productive economy. Furthermore, there is relatively little interaction between the large globally-competitive multinationals and domestic Mexican firms - typically SMEs. Moreover, the innovation challenges that have been preventing these linkages from forming have been identified: large multinational companies (MNCs) do not invest in Mexico to leverage its innovative capacity, MNCs are not developing domestic supply chains with Mexican small and medium-size enterprises (SMEs), and the public research enterprise is overly academic. Three recommendations - supported by the literature review, data analysis, and expert interviews - are provided that target these innovation challenges:

Recommendation #1: Build SME Capacity through awareness raising.

The current portfolio of SME support programs does not target firms that need the most support. The experience of countries such as the United Kingdom reveals that creating a program that raises the awareness of SMEs about the benefits of innovation is the missing piece in Mexico's SME support system.

Recommendation #2: Reform federal labor laws to allow public researchers the ability to participate in business creation and permit flexibility for taking temporary leave.

Public research centers and universities have applied many of the standard policy tools to strengthen incentives for public researchers to innovate. However, the impact has been minimal. Labor reform is a tool that Mexico has not yet applied that countries such as Brazil have used successfully.

Recommendation #3: Establish a National Linkages Program to promote the creation of domestic supply chains. The current set of policies, programs, and initiatives to link innovation actor - though successful - overlook an essential linkage. Policymakers should look to the successes of countries such as Ireland to develop a program that actively and directly creates connections between large globally oriented firms and SMEs.

Arguments: Mexico

This section begins with a justification for the innovation awareness raising approach for Mexican SME capability building and is followed by the explanation for focusing on Mexico's federal labor laws as logical next step for increasing the private sector orientation of the public research system. The section closes with the rationale for recommending a National Linkage Program.

When combined with microenterprises, SMEs make up 99 percent of businesses in Mexico, employ more than 60 percent of the workforce, and account for over 40 percent of GDP (Lopez-Acevado and Tan 81). As such, over the last two decades Mexico has put in place a wide variety of SME support programs. In 2010, the World Bank performed a survey and impact evaluation of all SME support programs in Mexico. The survey revealed 151 related programs with the largest government players being the National Council of Science and Technology (CONACyT), Bancomext, and the Ministries of Economy, Labor, Finance, and Environment. Combined, these programs provide a wide spectrum of support mechanisms including technical assistance and training, innovation and technical development, knowledge and information exchange, fiscal incentives, financial products, and business promotion and opportunities (89). The impact analysis of these programs revealed the following:

- The programs are poorly evaluated, if at all.
- There is limited coherency between the large number of programs resulting in programmatic overlap and inefficiencies.
- It is difficult for SMEs to access information about available resources.
- Some programs do prove more successful than other as measured by higher value added, sales, exports, and employment. However, a selection bias is suspected.
- The SMEs that need the most help are not being reached.

The report identifies several areas of improvement around SME support programs. However, one key finding paralleled the sentiments of Mr. Christian Quijada Torres, a World Bank private sector development specialist, during an interview to inform this research. Mr. Torres expressed concern that large swaths of Mexican SMEs are not aware or do not see the value in upgrading their innovative capacity. This aligns with the World Bank conclusion that the SMEs that need the most assistance may not be aware of the availability or potential benefit of the 150+ support programs available to them. Thus, it is essential for policymakers in Mexico to develop policy tools able reach this underserved group and increase the demand for the existing programs.

There are policies tools that specifically target the demand-side challenge of building SME absorptive capacity and the United Kingdom has successfully applied these tools. Research into SME absorptive capacity has revealed that firms exist at different stages of development related to organizing and managing innovation (Bessant). These stages include:

- Unaware/Passive: Firm do not realize the need for technological change and also do not know where or what they might improve, or how to go about the process of technology upgrading
- Reactive: Firms recognize the need for change but are unclear about how to go about the process in the effective fashion
- Strategic: Firm have a well-developed sense of the need for technological change and have god implementation capability
- Creative: Firms have advanced technological capabilities and are able to help define the international technology frontier

Considering Mexico's past efforts to support SMEs, many SMEs appear to be in the unaware/passive stage of developing absorptive capacity and supporting policies should be developed accordingly. To best address a culture of unaware/passive SMEs, past experience points to the broadcast mode, which refers to providing information in various forms to help improve awareness of firms about the need to change and to facilitate a more effective search for technical assistance. The United Kingdom was faced with a similar challenge three decades ago and, as a result, the government implemented numerous broadcast initiatives targeted at raising awareness among SMEs on the importance of innovation. The "Managing in the 90's" program and its successor "Fit for the Future" made use of public presentations, road shows, breakfast briefings, etc. to promote innovation to domestic manufacturing firms. Follow-on programs such as "Inside UK Enterprise" included on-site factory visits to expose potential technology adopters to a wide range of innovations in numerous sectoral contexts (Bassant). Though a broad-based evaluation of these programs is difficult, case studies of individual programs have revealed positive outcomes as a result of the UK's broadcast initiatives (Rush 338-340). Taken together, this analysis supports SME awareness raising as an essential complement to the existing SME support programs and a critical step towards building lasting SME absorptive capacity in Mexico.

In 2006, the Law of Science & Technology was reformed with the goal of increasing the orientation of the public research centers (PRCs) toward the productive economy. The PRCs were given significantly more autonomy related to budget, technical, operative and administrative matters including the ability to cooperate with public and private firms (an authority they did not previously enjoy). Legal modifications also allowed the PRCs to appropriate the results generated by their research and establish confidentiality conditions when profitable knowledge is generated in the framework of joint PRC-industry project (OECD *OECD Review* 136-137). Moreover, the Science, Technology, and Innovation Law of 2009 went further with respect to inventor compensation, allowing public research institutions and universities to pay inventors up to 70 percent of the receipts derived from intellectual property generated by their inventions (WIPO 39). Despite these reforms, entrepreneurship by researchers is still limited.

To little avail, Mexico has employed many of the traditional policy tools used to entice researchers to become more entrepreneurial. According to Pluvia Zungia of the World Intellectual Property Organization (WIPO), it is limitations in Mexico's labor policy that prevent public researchers from thinking outside the laboratory (39). Specifically, there are no clauses in the Federal Law of Labor and Responsibilities of Public Officials that allow for the participation in business creation or permit flexibility for taking temporary leave. Mexico can look to Brazil as an example of a country that has had success in this area.

According to Lee Catherine Booker of the Columbia School of International and Public Affairs, Brazil is "growing into the undisputed entrepreneurial capital of Latin American." There are many factors contributing to this boom, including the government. In 2004, Brazil passed the Law of Technological Innovation, which had the main goal of creating formal channels linking the public system with private enterprises. An essential component of this law was authorization given to public institutions to grant researchers permission to leave their labs for three years in order to form their own enterprise (Balbachevsky and Bothelho 9). The passage of the 2004 innovation law is considered a watershed moment for Brazil, situating scientific and technical researchers within an economically productive framework. A 2006 study of 58 universities revealed that, prior to the law, only 9 percent of universities formally included entrepreneurship as a goal for students and researchers, while 82 percent did so after the law (Almedia 42). This analysis shows that Mexico has not yet reformed its labor laws to give public researchers the freedom to be more entrepreneurial. Based on the experience of Brazil, this is a critical gap in Mexico's STI policy that - if filled - has the potential to boost the economic returns for public STI investments. Moreover, increasing the entrepreneurial character of the public research system will raise the profile of Mexico as a platform for innovation.

Until recently, efforts in Mexico to promote the development of linkages between innovation actors have largely been through fiscal incentive programs - an indirect approach. In 2001, the Innovation Program (PEI) replaced the largely ineffective R&D tax credit (OECD *OECD Reviews* 179). The new package of innovation support programs includes three subsidy funds (INNOVAPYME, INNOVATEC, and PROINNOVA). Each of these programs is a fund that subsidizes innovation activities in way that promotes cooperative research. Essentially, this is through the provision of larger subsidies if multiple innovation actors are involved in the research project (Lomeli). According to an analysis by CONACyT, this package of programs has generated positive outcomes: $29B in project related sales, over 10,000 jobs created between 2009 and 2010, and 180 patent applications; 36 trade secrets; 28 trademarks (Lomeli). Mexican policy makers have also been taking more direct actions to promote linkages. In 2011, CONACyT launched the Program for the Creation and Strengthening of Technology Transfer Offices, also called knowledge transfer units (UVTCs) (Chagoya). This is certainly a step in the right direction. Nonetheless, more can be done this area of direct promotion of linkages between innovation actors, especially to support the creation of local supply chains, which the UVTCs are not targeted to address.

Mexico can look to Ireland as an example of developing a national linkage program. To leverage the technological capability of incoming FDI, Ireland's Industrial Development Authority (IDA) designed a

National Linkages Program (NLP) in 1987. Primarily focused on Ireland's electronics industry, the NLP had two primary tasks: first, to support Irish SMEs' ability to innovate and, second, to assist international investors to source and identify key suppliers in Ireland. Simply put, the NLP functioned as a brokerage service with the aim of promoting local sourcing by foreign affiliates in Ireland (United Nations 184-185). Between 1987 and 1992, locally sourced material in electronics increased from 9 percent to 19 percent of MNC purchases, almost one quarter of all MNC is Ireland participated in the program, and the participating SMEs increased average sales growth by an average of 83 percent and sawing sizable increases in both productivity and employment (Dalhman and Kuznetsov 55). In sum, Mexico is currently using direct and indirect policy tools to increase the the interaction of the public sector and private sector researchers with early signs of success. However, there is current no direct efforts to in Mexico to link large, global-oriented multinational with domestic SMEs.

Recap: Mexico

The section on Mexico has identified three innovation challenges that should receive the attention of Mexican policymakers: large multinational companies do not view Mexico as a platform for innovation and, as such, perform little knowledge-inventive activities in Mexico; low absorptive capacity of domestic SMEs; and the overly academic orientation of the public research enterprise. Each of these challenges has contributed to the isolation of innovation actors in the Mexican economy. Three federal policy recommendations were provided to address these innovation challenges. Building SME absorptive capacity will create the preconditions necessary to increase the involvement of FDI in the domestic economy and, when coupled with the National Linkages Program, will begin to increase aggregate innovation output by Mexican SMEs. Moreover, the labor market reforms recommended will serve to both increase the entrepreneurial activity in the public sector research enterprise, which, in turn, will begin promote Mexico as a platform for innovation.

This analysis does have its limitations. Given more time, numerous policy options with associated country case studies and cost analyses could have been provided for each innovation challenge with the merits each approach described. This would deepen the analysis and improve the persuasive quality of chosen recommendations. Moreover, one must also understand that the policies that have worked in one country may not work well in another. Lastly, innovation ecosystems are a complex network of actors, activities, organizations, institution, and culture. What is provided here is just a narrow set of opportunities and challenges. Though significant research has been undertaken, constraints on this project precluded a thorough review of the Mexican innovation system. To genuinely established an innovation-driven economy there are numerous macro-level, or framework conditions that must be addressed, as well as the micro-policies that this report focuses on.

VI. PROJECT SUMMARY

The objective of this report was to provide SRI International's Center for Science, Technology and Economic Development with research on the innovation systems and economic development of three emerging economies that may benefit from SRI's innovation consulting services. The GWU team identified three countries of interest, conducted research into their economic and innovation profiles, documented select innovation challenges within each country, and provided one public policy recommendation per innovation challenge (nine total). SRI International can use this work to directly inform - or use it as a foundation for - its current or future services directed towards Brazil, Kazakhstan, and Mexico. Many of the innovation challenges presented in this work will find broad parallels with other countries and their innovation systems. In this sense, this work may inform SRI's engagement with countries outside of the three presented in this research. However, the nine policy recommendations have been tailored to their respective country and would not be expected to be useful beyond Brazil, Kazakhstan, or Mexico.

The GWU team retains all rights to the intellectual property developed for this project, including the report and any drafts. However, the GWU team grants perpetual license to SRI International to use the materials in any way that they see fit including publication, provided that the full list of authors is always clearly presented and the work was done in affiliation with the "Center for International Science and Technology Policy at the Elliott School of International Affairs of the George Washington University" and that the date of the reports completion be included.

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APPENDIX A: Country Selection Criteria

Porter, Michael. The Competitive Advantage of Nations. New York: The Free Press, 1990. Print.

Michael Porter, Bishop William Lawrence University Professor at the Harvard Business School, has developed four stages of competitive development: factor-driven, investment-driven, innovation-driven, and wealth-driven. "Each stage involves different industries and industry segments as well as different company strategies. The stages also differ substantially in the appropriate array of government policies toward industry."

Factor-Driven: In this stage internationally successful industries in the nation draw their advantage almost solely from factor endowments such as natural resources or an abundant semi-skilled labor force. There is little use of production technology or, if there is, it is widely available across the globe. Moreover, this technology is sourced from other nations. Thus, competition is based on price and volume. Access to foreign markets is through foreign firms. Domestic demand for imported goods is low or non-existent. Factor driven economies are highly susceptible to world economic cycles, exchange rates, and shifting factor advantages. There is a poor foundation for productivity growth.

Investment-Driven: "The investment-driven stage, as the name indicates, is one where the ability and willingness to invest is the principal advantage rather than the ability to offer unique products or produce with unique processes." Competitive advantage is based on sustained and aggressive capital investment - including the best technology made available to such countries. Note, however, that this technology is typically a generation behind international leaders. Critical to this stage is that this foreign acquired technology is not just employed but improved upon. Large infrastructure investments are also made at this stage and workforce investments are pursued to improve skills - though wages remain low. Domestic rivalry existing in competitive sectors drives continual improvement. However, home demand is still relatively unsophisticated. Nonetheless, the first emerging competitive industries tend to be those with a home market demand. Local supply chains do not typically exist and dependence on foreign suppliers constrains the pace of innovation. Direct international connections are developed. At this stage national educational and research institutions begin to develop. This stage is also characterized by rapid gains in employment and the bidding up of wages and factor costs. Loss of competitive position in the price-sensitive sectors begins. In this stage, government's role can be substantial such as "channeling scarce capital into particular industries, promoting risk taking, providing temporary protection to encourage the entry of domestic rivals and the construction of efficient scale facilities, stimulating and influencing the acquisition of foreign technology, and encouraging exports. This stage requires a national commitment and consensus to investment, which typically requires decreased consumption and poor income distribution.

Innovation Driven: "This stage is called innovation-driven because firms not only appropriate and improve technology and methods from other nations but create them." In this stage world-class supporting industries (clusters and supply chains) are created. There are typically select industrial segments that take the lead in this process, which set the example of upgrading in related sectors. The growing success in many industries puts upward pressure on factor costs - thus, competing on cost is limited to a select few sectors. Factor disadvantages, in fact, stimulate innovation. The sophistication of universities, research institutes, and infrastructure increase and the national economy becomes increasingly diversified. This stage has significant FDI as previously vertically integrated firms may now favor a dispersed supply chain. Manufacturing tends to go to countries with lower factor costs and services such as marking and engineering become more important. Thus, more human skills are needed. As education rises and incomes increase, demand becomes highly sophisticated - namely in services at the expense of durable goods. Innovation-driven economies are less affected by currency valuation and exogenous shocks. Government's role is this stage is markedly different from the previous one. Direct market intervention becomes much less appropriate. "As an economy broadens and deepens, government cannot hope to keep track of every existing and new industries and all the linkages among them...government's efforts are best spent in indirect ways such as stimulated the creation of more and more advanced factors, improving the quality of domestic demand, encouraging new business formation, preserving domestic rivalry, etc."

Wealth-Driven: This stage is ultimately associated with decline and is not of value for this project. Thus, it has not been summarized.

According to Porter, prosperity is the ultimate goal of economic development and prosperity is operationalized as productivity. Thus, the upgrading process is largely dependent on trade, in which exports form productive industries allow imports of products that could be produced in the nation only at lower productivity. Moreover, FDI that shifts less productive activities abroad is also critical. It is important to note that Porter focuses on the traded sector of the economy as, according to Porter, "without the ability to export (and sustain position against imports) in a range of [high productivity potential] industries, national productivity growth will be stunted.

As part of the criteria for choosing potential countries as SRI clients, SRI expressed the importance for a client nation to have the absorptive capacity (i.e. to be "ready") for innovation training. This requirement is what drove the team to review the literature on stage of economic development. Porter's framework defines in clear terms the type of economy - the stage of development - that SRI can help clients (nations) progress toward. This is defined above as "innovation-driven." Arguably more important, Porter describes the stage of development prior to innovation-driven: investment-driven. An investment-driven economy will have the capacity to absorb and apply the innovation policy lessons provide by SRI and this report. As such, Porter's framework was chosen to assist in country selection.

See the Appendix B for the range of metrics and countries presented to SRI for approval. Six countries (Brazil, Chile, Colombia, Kazakhstan, South Africa, and Turkey) were presented to SRI, which resulted in the selection of Brazil and Kazakhstan as well as Mexico (at SRI's request).

APPENDIX B: Country Proposal to SRI on February 24, 2013

As established in the correspondence between the GW and SRI teams on February 19th and 20th, SRI is targeting countries for their services that a.) are looking to move up the value chain through the diversification of their economies into technology-based industries b.) need policy advisory in the fields of science, technology, and innovation to do so, c.) are at a stage of economic, political, and social development to benefit from such policies and d.) have the financial resources to make the necessary investments. Additionally, each of the six countries (**Brazil, Chile, Colombia, Kazakhstan, South Africa, and Turkey)** proposed meet this criteria. Nonetheless, some additional analysis is needed to narrow down the six countries to three choices.

We have attached an additional layer of metrics for this purpose including a.) a metrics spreadsheet (Figure 1) with high level insights and b.) country profiles. The Country Metrics spreadsheet is attached to the email as a PDF document.

Insights from the Country Metric Spreadsheet:

- Based on the metric compiled, Chile and Brazil appear to be making relative more progress toward the development national or regional innovation systems while Colombia and Kazakhstan are lagging behind. Turkey and South Africa fall somewhere in between. Nonetheless, all countries share a similar profile - though national competency levels and competitive advantages vary widely.

- Each of the governments have established innovation institutions and have developed national strategies to drive innovation

- Based on metrics such as national R&D investment, patent generation, academic article generation, and talent development - each country shows signs of establishing the foundation of national or regional innovation systems. However, each measure remains well below the OECD average.

- Each country has successfully established an industrial sector, though resource-drive sectors of the economy still play a relatively large role.

- Within these industry sectors, each country has cultivated pockets of excellence with examples of medium and high-tech leaders in select industries.

- At this beginning phase, it appears likely that finding innovation metrics for Kazakhstan will be more difficult than other countries.

(ATTACH FIGURE HERE)

Excerpts from OCED Science, Technology, and Industry (STI) Outlook 2012 - Alphabetical Order - ***General Features of the S&T System:***

Brazil

Brazil is an emerging economy, which weathered the global financial crisis well with a continuing upward growth trajectory. Brazil has some well-known leading innovative firms and is at the forefront in high-technology fields such as deep-water oil extraction. A few universities undertake high-quality research. This performance, however, does not spill over to the entire, very diversified Brazilian economy. In particular, the many SMEs innovate very little. Challenging framework conditions and substantial social challenges, such as poverty, explain the generally weak STI performance. Research outputs are very low compared to the OECD in terms both of articles published in top-quartile scientific journal and of patents and trademarks. Over 2005-09, the relative number of patents filed by universities and PRIs (public research institutions) per GDP was well below the OECD median. Conditions are difficult for private firms; the ease of entrepreneurship index is low but is above that of some OECD countries. In terms of international innovation-related linkages, 27 percent of total scientific articles involved international co-authorship and 17 percent of PCT patent applications were international co-inventions. One of the reasons for these comparatively low numbers is the large size of the Brazilian economy. A major innovation system bottleneck is Brazil's human capital. In 2009 only 11 percent of the adult population had a tertiary education level. The PISA science scores of 15-year-olds are also very low.

Chile

General features of the STI system: Chile is a small open economy. It is the world's leading producer of copper, on which its exports largely depend. Economic reforms and institution building drove Chile's economic performance over the last decades. However, average GDP growth has slowed markedly in the 2000s, owing in part to the need to strengthen various aspects of the innovation system. The business sector plays a modest role in R&D; BERD accounted for only 0.16 percent of GDP in 2010, the lowest among OECD countries. Business R&D performance suffers from a relative lack of the competitive pressures that stimulate innovation. Many firms innovate through adaptation of imported technologies, which is not tracked by R&D indicators. Chilean framework conditions continue to be a challenge: the ease of entrepreneurship index is below the OECD median. Scarcity of human capital is also a major concern: all indicators are below the OECD median. Over 2008-10, 55 percent of total scientific articles had international co-authors and 31 percent of total PCT patent applications were international co-inventions over 2007-09, both above the OECD median, owing in part to the small size of the national scientific and research community.

Colombia:

Colombia is a middle-income country with large oil supplies. The economy has grown consistently over the past decade and withstood the global recession relatively well. It has a high level of FDI, notably in the oil sector; this provides potential leverage for international collaboration. Its research sector is small and it faces major societal challenges: low educational standards, low tertiary attainment, inadequate infrastructure, a high level of inequality, and suboptimal ICT and scientific infrastructures. These shortcomings have to be addressed if Colombia is to realize its ambitious STI objectives and become a knowledge-intensive economy. But the country has capitalized on its integration in international networks. In 2008-10, 50 percent of scientific articles were produced jointly with researchers abroad. Human resource indicators are relatively weak: only 10 percent of persons employed are in S&T occupations and PISA science scores of 15-year-olds are well below the OECD median. With six-fixed broadband and 5 wireless subscribers per 100 inhabitants, there is room for improvement in ICT infrastructures. The e-government readiness index is relatively high compared to other Latin American countries and similar to levels in the Czech Republic.

Kazakhstan:

Since 2000, the economy of the Republic of Kazakhstan has been growing at an annual rate of between 8-9 percent, making it one of the ten highest performing economies in the world. Kazakhstan alone attracts more foreign direct investment than all other Central Asian countries together. To date, the country's strong economic performance has been driven largely by its natural resources sector. The oil and gas sectors alone attract three quarters of foreign investment inflows. However, Kazakhstan's non-energy sectors also have competitive advantages that could be potential new sources for growth. [Source: Competitiveness and Private Sector Development: Kazakhstan 2010]

South Africa

South Africa is the continent's leading economy, with strong resource-based industries and strengths in services. Its innovation system has been shaped by infrastructure, assets and distortions inherited from the apartheid era. In 2008, BERD was 0.54 percent of GDP but 59 percent of gross national expenditure on research and development (GERD). While a large resource-based sector and the secondary economy limit the level and leverage of business R&D investments, the S&T base supports pockets of global excellence. Research and innovation rely on industry-science links and there is good integration in international business and academic networks. International collaboration plays a role in 46 percent of scientific articles and 14 percent of patents. South Africa's RTA (revealed technological advantage) in emerging technologies increased rapidly over the past decade, albeit from a low base, notably in biotechnology. RTA in environmental technologies has eroded, however. A major bottleneck for South Africa's economic and social development is the lack of a broad skills foundation. Only 4 percent of the adult population has tertiary level education; 16 percent of workers are in S&T occupations. The lack of design, engineering, entrepreneurial and management capacity is a major constraint. The ageing of the white male population of researchers and engineers further weakens the skills base. IT infrastructures are relatively under-developed: fixed broadband subscribers number about 1 per 100 inhabitants although there is a fast- growing mobile telephony market throughout all of society. The development of network industries has been hampered by market domination by state-owned firms and restrictive legislation.

Turkey

General features of the STI system: Turkey is a large emerging market economy. It has gone through crises (2001, 2009) and periods of fast economic growth over the past decade. It has shifted rapidly from an economy largely based on agriculture (which still accounts for 24 percent of total employment) and on an abundant low-skilled labor force (which supported the growth of traditional labor- intensive industries such as textiles) towards an industrial economy. Turkey is now a major European automotive producer, a world leader in shipbuilding, and a significant manufacturer of electronics and home appliances (e.g. TV, white goods). Its STI system, however, remains small. Business and enterprise research and development (BERD) was 0.36 percent of GDP in 2010, well below the OECD median, and is concentrated in a few medium-high-technology manufacturing industries and knowledge services. Connections between industry and academia are good and 13 percent of public R&D is contracted or subsidized by enterprises. Turkey has weak links to international research networks: a low 7 percent of PCT (Patent Cooperation Treaty) patent applications and 18 percent of scientific articles are produced with international collaboration. Entrepreneurship conditions are poor. Product market regulations, particularly employment protection legislation, are restrictive and network monopolies hinder competition. Productivity gains are concentrated in the modern part of the economy; the large informal sector has less access to finance, STI networks and human capital and has limited overall STI potential. Turkish ICT (Information Communication & Technology) infrastructures need to be improved and the government makes little use of the Internet to interact with citizens and businesses. Skills are weak: 12 percent of the adult population has tertiary education and 13 percent of employees are in S&T occupations. Turkey has still few researchers (2.9 per thousand employment) but their number has almost tripled in ten years. Moreover, only 1 percent of 15-year-olds are top performers in the PISA rankings, and there are few graduates at doctoral level and fewer in S&E programmes.

APPENDIX C: BRAZIL

C.1- KEY INDICATORS

Recent Economic Performance

Strong reform efforts and changes to macroeconomic policies have effectively helped Brazil lift its population out of poverty and maintain growth in most sectors during and post the world financial crisis in 2008. In fact, Brazil managed to weather the financial crisis much better than other countries and even started to see improvements in their economy by 2009, years ahead of other developed countries. According to the OECD's Territorial Reviews: Brazil 2013 report, "in 2009, its economy shrank by only 0.2 percent, as opposed to the average contraction of 3.9 percent in OECD countries. The labour market remained resilient, and unemployment fell from 7.9 percent in 2009, below the OECD average value in 2009 of 8.3 percent." (32). Recent years have pointed to some declining growth of Brazil's economy. According to the OECD, growth in Brazil slowed in 2011 (2.7 percent) and 2012 (1.5 percent) but is expected to rebound in 2013

Key Indicators: Economic & Innovation

According to the World Economic Forum's Global Competitiveness Index Report for 2012-2013, Brazil is a transitioning economy, moving from an efficiency-driven one to innovation-driven. Out of 144 countries ranked, Brazil was listed as number 48 (or the top 33 percent) in the overall index for competitiveness. ThESE rankings come from three main overarching sub-indexes, basic requirements (73 out of 144), efficiency enhancers (38/144), and innovation and sophistication factors (39/144). These sub-indexes are made up by another 12 factors that determine the WEF's rankings.

Under basic requirements, Brazil scores 79 out of 144 for institutions, 70 out of 144 for infrastructure, 62 out of 144 for macroeconomic environment, and 88 out of 144 for health and primary education. As this indicates, at least for basic requirements, Brazil is underachieving in this index, and as will be discussed later, a reason why education and research and development are two of the major weaknesses in Brazil's science, technology and innovation systems. Where Brazil is doing better is in its efficiency enhancers and innovation and sophistication factors. Under efficiency enhancers, Brazil ranks (out of 144) 66 in higher education, 104 in goods and market efficiency, 69 in labor market efficiency, 46 in financial market development, 48 in technological readiness and 9 in market size. The latter three highlighted in this section are all in the top 33 percent of country rankings. For innovation and sophistication factors, Brazil scores 33 for business sophistication and 49 for innovation. While these rankings in and of themselves are not sufficient to offer a basis of comparison, they do help us see the general direction that Brazil is heading, where they have a strong foothold, and where they need to continue to develop. In terms of their standings as compared to other BRICS, Brazil comes in second place after China (28).

The World Intellectual Property Organization's Global Innovation Index 2012 claims that, "Brazil, … offers a distribution of strengths and weaknesses... in Institutions, Infrastructure, and both Market and Business sophistication. It comes far behind in Human capital and research (at a level similar to that of China), and last among BRICs in Knowledge and technology outputs. It achieves second place among BRIC countries, after India, on Creative outputs" (32). In the long term, this means that Brazil needs to remain competitive and address issues they have if they are to remain a BRICS country.

C.2- CURRENT AND PAST INNOVATION INITIATIVES

Current Innovation Initiatives

In the past decade, Brazil has enacted several pieces of legislation to promote an innovation atmosphere and introduce changes to the system. One of the major pieces of legislation at the turn of the century was the Innovation Law of 2004. This piece of legislation was designed to promote university-industry research relationships and promote shared use of R&D infrastructure as well as allow government grants for innovation in firms and increase mobility of researchers in the system. The following year, Brazil enacted Good Law in 2005 that provides fiscal incentives for private firms to invest in more R&D and allow them to hire more masters and PhD students.

The Innovation Law of 2004 and Good Law of 2005 were followed by the Growth Acceleration Plan for Science, Technology and Innovation in 2007. "The objective of the plan is to articulate five policies and programs (Growth Acceleration Plan and Infrastructure, PITCE, Agricultural Development Policy, Health Development Policy and Education Development Policy) that will establish economic policy and economic growth in the country. The plan has four general strategic priorities... a) Expansion and consolidation of the National S, T & I System b) Promotion of technological innovation in companies c) Research, Development and Innovation (RD&I) in strategic areas and d) ST&I for social development" (Sennes 17-18).

Soon after, the Production Development Policy was enacted in 2008 to provide sustainability for economic growth by increasing investments and economic growth rates. "Twenty-five priority sectors and three large support programs were established for these sectors: a) Programs to strengthen competitiveness: Standardized Capital Goods, Customized Capital Goods, Automotive Complex, Service Complex, Civil Construction, Leather, Footwear and Artifacts, Aeronautical Industry, Naval Industry, Wood and Furniture, Plastics, Agroindustrial System, Personal Hygiene, Perfumery and Cosmetics; b) Mobilization programs in strategic areas: Nanotechnology, Biotechnology, Defense Complex, Health Industry Complex, Energy, Information Technologies and Communication; and c) Programs to consolidate and expand leadership: Cellulose, Mining, Steel, Textile Industry, Apparel and Meat" (Sennes 19).

In addition to legislation, private companies have attempted to enter the Brazilian market, mostly in the form of public-private partnerships and cluster cities. In 2010, IBM opened research labs in Brazil; in 2011 the Chinese company ZTE announced its investment in a technology park in Campinas and Germany opened a public research institute. Other European countries, including Norway and Finland are also in talks to establish collaboration centers.

Most recently, on August 2, 2012, President Rousseff launched the Greater Brazil Plan The Greater Brazil Plan "that aims to improve the competitiveness of national industries in the context of a strengthening currency and increased international competition. The plan sets several targets, including raising the total investment share of GDP by 3 percentage points to 22.4 percent of GDP from 2010 to 2014 and fostering innovation activities of Brazilian companies" (OECD Economic Survey). According to the OECD report, the main new measures announced are as follows:

- Financing and investments from the national development bank (BNDES) to promote innovation will be increased. BNDES will also provide more working capital to SMEs, with such credit lines increasing from BRL 3.4 billion to BRL 10.4 billion.
- A preferential treatment of up to 25 percent price differential may be granted to domestic products in public procurement under conditions to be specified.
- A range of measures is aimed at encouraging Brazilian exports and protecting the domestic market. Anti-dumping cases will be processed faster. A reduction in the number of goods subject

to automatic import licenses is envisaged. Finally, Brazilian exporters will be reimbursed for several taxes incurred along the value chain until end-2012. (OECD Economic Survey)

Past Innovation Initiatives

Innovation policies and initiative prior to the mid-1980s in Brazil are fairly limited in scope and application. During the military regime, international policies were highly protectionist in most sectors of the Brazilian economy and allowed for little flow of information between Brazilian enterprises and those residing outside of the country. Before the fall of the military regime however, the administration did put in place some agencies that dealt with innovation initiatives and property rights. In 1976, the National Institute of Industrial Property (INPI) was created to help national firms deal with their intellectual property stemming from the industrial sectors.

After the fall of the military regime, the new Brazilian government began to address some of the issues that had been greatly ignored by the previous administrations. In 1985, the Brazilian Ministry of Science and Technology (MCT) was formed to help implement national innovation policies. And by the late 1990s, the Sectoral Funds for Science and Technology was created (in 1999) which were met to serve as financing tools for research, development and innovation (Sennes 17). To date, the Sectoral Funds are responsible for fourteen sectors: Aeronautics, Agribusiness, Amazon, Waterway, Biotechnology, Energy, Space, Water Resources, Information Technology, Mineral, Oil and Natural Gas, Health, Land Transportation, Telecommunications. "These funds have guidelines and budgets defined by managing committees with representatives from productive, academic and governmental sectors. However, since these are non-reimbursable resources, only science and technology institutions, that is, universities and research institutes, can receive the funds" (Sennes 16). Because of the nature of the funds' distribution policies, "only about 40 percent of the authorized resources were actually distributed"... in 2003, the government began to address this issue to that by the year's end, "...this percentage increased to over 90 percent" (MCT, 2008 qtd in Sennes 17).

In addition to the INPI, 2003 saw the Enactment of the Industrial, Technological and Foreign Trade Policy (PITCE) whose main objective was to promote competition among Brazilian firms and their international counterparts, build innovation practices and help diversity Brazilian products. "PITCE established four priority sectors (pharmaceuticals and medications, semiconductors, software and capital goods) and it gave innovation a more systematic connotation, mainly stimulating interaction between the productive and academic sectors. Since then, new laws and programs have been launched aimed at strengthening the national system of Brazilian innovation" (Sennes 18).

C.3- INTERVIEW NOTES

Conversation with Jorge Duran, Director, Science and Technology Office at the Organization of American States

Meeting: April 12, 2013

- According to Dr. Duran, Brazil has not participated in the last three science and technology meetings organized by the OAS.
- "Brazil has an excellent climate for SMEs and technology development"
    - all Latin American countries are moving in the direction because they have recognized STEM as promoters of growth.

- The key to growth is innovation and these countries, including Brazil, need to develop a culture of innovation.
- Latin American countries are gaining the tools they need to formulate policy recommendations and implement them in country, Looking forward, organizations like the OAS will have to shift their work to provide case studies and facilitate engagement between the countries as opposed to provided direct policy recommendations

APPENDIX D: KAZAKHSTAN

D.1 Innovation Institutions

Ministry of Education and Science is responsible for Kazakhstan's education system, and government funded and conducted scientific research (Salimov). The Ministry has responsibility for environment to space sciences, though its research funding is not very board. While the Ministry has inherited strong primary and secondary education infrastructure from the Soviet Union, the yearly intake for major universities (big three) in 2004 was only around 5,000 (Matthews). It also is responsible for the Bolashak Scholarship program, where it pays for tuition and living expenses for Kazakh students to study aboard and return to work in Kazakhstan for five years. To date, over 6,000 scholarships have been awarded to Kazakh students (Kazakhs are overrepresented in the scholarship due to fluency in the Kazakh language being a key eligibility criteria).

National Innovation Fund/National Innovation System: The NIF is a combination of four local venture funds in Kazakhstan on a public-private partnership (Salimov). These venture funds are Centras JSC, Delta Technology Fund JSC, High Technology Fund Areket JSC and Logycom Perspective Innovations JSC. The NIF looks at companies developing prospective technologies with good export potential. The Fund also looks at regionally Design Bureaus in transport mechanical engineering in Astana, mining and smelting technology in Ust-Kamenogorsk, petroleum equipment in Petropavlovsk. The NIF provides a "angel investor" for domestic Kazakh technology and innovation companies by giving them loans on favorable terms in order to take risky but high reward business and

National Agency for Technological Development is responsible for the two current tech transfer centers dedicated to managing technology received from France and South Korea. There may be interest in setting up more centers dedicated to China, Germany and Japan, especially in light of Kazakh interest in developing uranium ore processing technology and existing production of communication equipment with ZTE. NATD technology transfer centers with France and South Korea have provided Kazakhstan with alternatives to Russian technology, especially in military areas (artillery and helicopters). One of the more successful tech transfers has been the facilitation of the Kazakh modification of the EC-645 scout attack helicopter (its civilian model, the EC-145, is already produced by Kazakhstan Engineering) (Kucera). There is also government interest in applied research on power generation, satellite technology and water purification technology.

The NIF's regional Design Bureaus have already produced technological products appropriate for Kazakhstan's current level of industrial development, including licensing those products for production in other CIS member states like Russia and Belarus (Global Trade Alert). The Technology Parks have also enabled coproduction agreements with China's ZTE and Eurocopter to produce components and whole systems for both export and Kazakh markets (Kucera). Astana needs to assure foreign partners that their intellectual property rights will be protected and investments governed according to the rule of law.

D.2 Past and Current Innovation Initiatives

- World Bank- Technology Commercialization Project is currently underway, with a projected completion date of 2015. It involves a total funding of $75 million to help 21 groups of Kazakh scientists conduct 3 year R&D projects and is conducted in conjunction with the Ministry of Science and Education. It is hoped that the project will increase Kazakh familiarity with the peer review process and develop links with international science.
- The World Bank has also taken the lead in developing major projects to fill out gaps in Kazakhstan's infrastructure development. The $2.125 billion South-West Roads Project provides for the rehabilitation of 1,062 km of Soviet era roads starting 2010.
- NATD technology transfer centers with France and South Korea have provided Kazakhstan with alternatives to Russian technology, especially in military areas (artillery and helicopters). One of the more successful tech transfers has been the facilitation of the Kazakh modification of the EC-645 scout attack helicopter (its civilian model, the EC-145, is already produced by Kazakhstan Engineering). There is also interest in power generation, satellite technology and water purification technology.
- Law on State Support to Industrial Innovative Activity (2012) provides financing for "innovative" industrial activities. The beneficiary must create new innovative industrial projects or modernize existing facilities in the priority sectors like aerospace, information technology, pharmaceuticals, petrochemicals, batteries and food processing.
- Business Roadmap 2020 was set in 2010 to promote growth in non-energy sectors of Kazakhstan's economy and is run by the Entreprenuership Development Fund. By Jan. 2013, it has helped create 31,000 jobs and paid out $162 million.
- Strategy of Industrial-Innovation Development for the Republic of Kazakhstan 2003-2015- aims to double energy efficiency in terms of GDP productivity and move Kazakhstan from a extraction based economy to a processing economy, while laying the foundations for innovation in the Kazakh industries through technology cluster and foreign investment/partnership.
- Technology Parks are set up to facilitate technology transfer and foreign investment. The Alatau IT Technology Park has investment and participation from Microsoft, HP, Siemens, Cisco Systems, Thales and was negotiating for involvement from Samsung, LG, Oracle, Sun Microsystems as of 2008. Also, the Almaty Technology Park is dedicated to helping foreign investors find Kazakh business partners. Two more dedicated technology parks are being created for biotechnology and petroleum production equipment.
- State Program of Forced Industrial Innovation Development covers the Design Bureaus in the NIF. Current technologies include the joint development and production of mining ventilation fans and grain hopper train cars. Given the large petroleum industry, it is likely that petroleum production equipment will become a focus of major resources.

D3: Innovation Gaps

Weakness in STI Activity: Kazakhstan is on a sound middle economy, efficiency driven development path but its STEM indicators lag far behind those of the OECD, other major CIS members like Russia and Ukraine or major developing economies like China and India. Currently, R&D as a share of Kazakhstan GDP is only 0.23 percent in 2011. This is only 10 percent of the OECD average of GDP dedicated to research, suggesting chronic underinvestment in both basic and applied R&D, especially in value creation in advanced sectors like aerospace and information technology. For 2012, the WEF Global Competitiveness Index ranking put Kazakhstan 72nd out of 142 countries surveyed. This means that Kazakhstan's dependence on the production of natural resource commodities makes it highly dependent on global prices, a proposition which is especially unhealthy given increases in the global supply of fossil fuels in the past five years.

APPENDIX E: MEXICO

E.1 - INTERVIEW TRANSCRIPTS

Molano, Manual - Adjunct Director General, Instituto Mexico para la Competitividad (IMCO). Personal Interview. 15 March 2013.

Q1: What do you see as the key strengths of Mexico's innovation system?

The Mexican manufacturing base is a critical strength. It provides a platform for innovation and the vehicle to move up the value chain. See the MIT's "Atlas of Economic Complexity" to get an idea of Mexico's export sophistication - Mexico has been moving up the value chain every decade for the last half-century. Mexico has "best in the world" manufacturing of automobiles, bridges, appliances, electronics, etc.

Mexico also has enclaves of high-tech, world-class manufacturing. However, these sectors have not acted as leaders for other sectors to follow; there has been little spillover to other sectors.

Q2: How can MX capitalize on these strengths?

No direct answer.

Q3: What do you see as key weaknesses of Mexico's innovation system?

State sanctioned (oil & gas) and de facto monopolies (telecommunication). The Mexico should enact economic reforms to introduce competition into these markets. These monopolies, for example, have kept competitive pressures out of Mexico's oil and gas sector. Thus, this sector has not evolved - namely to natural gas extraction. The shift of the U.S. - MX's largest trading partner - is going to be damaged by the U.S.'s shift away from oil.

Strong labor unions (public and private) are a problem for MX as well.

Mexico has been great at making efficiency gains. However, not creating new knowledge.

Universities are too focused on theoretic science and academic publishing; there is little entrepreneurial activity by university researchers.

Talent: This is a “blind spot” in Mexico’s innovation policy. Mexico is not developing enough homegrown talent and it not doing enough the keep or attract the world's best scientists and engineers. The top scientists in Mexico are internationally mobile and they are not choosing to stay in Mexico. Don’t let the U.S.-Mexico immigration commentary - namely the recent Economist report - fool you. “To be completely frank, these are low-skill workers to will do little to support Mexico’s innovation system.”

Q4: Are there key policies or initiatives best situated to overcome these weaknesses?

What should NOT occur is more of the same. That is, in the last decade Mexico has seen increasing funding of public R&D and the creation of more scientists. However, this has not translated to more patents. University research labs just like lobbyist. If the policy goal is to increase innovative activities (i.e. patents) - this policy is not doing the job.

The private sector needs to take the lead and drive innovation in Mexico. Recently, 3M located a research facility is Mexico to better understand the Latin American consumer. It should be noted that Mexico was not chosen for its innovation assets; Latin America is viewed as a growth market and 3M wanted to tailor its products to this market. Mexico should be looking to attract these kind of activities - with the larger goal of creating knowledge spillovers.

Q5: Are there other countries - that have been in a similar position as Mexico in the past - that policymakers, academics, advisors, etc. look to for "best practices" in innovation and/or economic growth?

Canada has a program to reverse the “brain drain” wherein it entices the world’s best talent in a particular field by building the best labs in the field and offer these scientists high salaries. It is a “if you build it, they will come” approach.

Many of the innovation pundits in Mexico speak of South Korea is a good example.

Q5: How closely are science, technology, and innovation (STI) policies tied to 6years political cycle?

This is not considered a problem in Mexico.

Q6: Has President Pena Nieto made public his STI agenda?

No detailed information was provided on this topic.

Q7: Can you direct me to other resources that may be of assistance?

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Gallegos, Rodrigo - Director for Technology & Sustainability Projects, Instituto Mexico para la Competitividad (IMCO). Personal Interview. 15 March 2013.

Q1: What do you see as the key strengths of Mexico's innovation system?

Mexico, particularly, it's manufacturing sector is ranked 20th most complex economy is the world (MIT's Observatory of Economic Complexity). This is a national asset and a platform for growth and innovation.

There are more engineers per capita than Brazil.

Q2: What do you see as key weaknesses of Mexico's innovation system?

There are two tiers of innovation weaknesses. The first tier is framework conditions: education, energy, and competition reforms.

- Public research centers and universities are too academically oriented; the research is weighed heavy on basic science. Public researchers need a more entrepreneurial mindset.
- Intellectual Property Rights (IPR) - the legal system and the civil system need to be reformed. The legal system is corrupt and civil society largely does not respect IPR as evidenced by the 57 percent of software in Mexico that is illegal.
- Due to lack of competition (e.g. Pemex) and state-owned natural resources; there is little innovation in the energy sector. Though largely accessing the same oil fields, investors are choosing to invest in Texas and not Mexico bought the oil and gas that take out of the ground in Texas is then privately owned. Any oil and gas below the 1st meter in Mexico is the property of the states. In sum, there is no incentive to innovation in the energy sector.

There are also second tier issues.

- There is very little private sector innovation. This is due to a lack of capital for SMEs as well as a legal system (IP) that does not meet the needs of the SMEs. SMEs need increased access to basic information technologies as well as talent (capacity building). The high level of engineers being produced (more than Brazil and Germany) is a bit misleading. We are getting reports from our large businesses that these engineers are not sufficiently trained. Many of these engineers, in fact, are coming from 2-year technical schools - “fast track” technical schools. SMEs could double or triple their size if they were trained in basic use of ITC. Entrepreneurship has not taken hold in Mexico. This linked to lack of access to capital (VC’s)
- Immigration reforms are needed as well to promote high-skilled immigration.
- Research centers are not autonomous; they are serving the agenda of funders.

Q3: Are there key policies or initiatives best able to overcome these weaknesses?

SMEs need deeper connections to the large global firms in Mexico. Look to national champions to partner with SMEs - learning through pressure to improve quality. There need to be incentives for national champions to be involved, such as fiscal incentives, loan programs - contingent on SME involvement, or recognition through competition.

Q4: Are there other countries - that have been in a similar position as Mexico in the past - that policymakers, academics, advisors, etc. look to for "best practices" in innovation and/or economic growth?

Not Answered.

My research thus far has revealed a large innovation challenge that is facing Mexico. Since 1994 there has been a massive influx of FDI - large attributed to NAFTA. This has resulted in enclaves of manufacturing excellence in Mexico - automotive for example. Moreover, both national R&D (as a percentage of GDP) and the number of researchers have grown tremendously over the last decade. But, Mexican patent activity has stayed flat. FDI, national R&D, and human capital are all theoretical inputs to innovation, yet Mexico has not been able to capitalize on this.

Interestingly, Mexico also has all of the innovation "actors" that - in theory - a country should have. These include a small set of world class universities, public research centers, a small set of globally competitive manufacturing firms, macroeconomic stability, sound IP institutions, etc.

Q5: In your opinion, why can't Mexico capitalize on all these innovation inputs?

Not directly answered.

Q6: Do you see SMEs are being critical to further development on innovative capacity in Mexico? If so, are they specific issues that you can speak to? For example, lack of a mid-skill workforce for the many small manufacturing firms OR access to credit OR linkages (through supply chains for example) of SME to the large multinational manufacturing firms.

Yes, SME's are critical see answers to Questions 2 and 3.

Quijada Torres, Christian - Private Sector Development Specialist, Finance and Private Sector Development, World Bank. Personal Interview. 2 April 2013.

Q1: What do you see as the key strengths of Mexico's innovation system?

No direct Answer.

Q2: What do you see as key weaknesses of Mexico's innovation system?

As always, aggregate funding levels R&D are important and should continue to be a promoted. However, academia needs to be doing more research that is relevant to the productive sector. There are improvements in this area, namely the recently developed (Nov. 2012) of a network of technology transfer offices.

(It was noted that the CONACYT research centers evaluate their researchers based on relevance to the private sector. However, SNI does not have this metric in their evaluation program.)

Q2b - Follow-on Question: How do we begin to change this?

Universities are very independent, so a top-down approach will be difficult in Mexico. It will likely be best to "work with the willing and create successful examples that universities want to emulate."

Q3: Are there key policies or initiatives best able to overcome these weaknesses?

No direct Answer.

Q4: Are there other countries - that have been in a similar position as MX in the past - that policymakers, academics, advisors, etc. look to for "best practices" in innovation and/or economic growth?

Taiwan - their development was largely driven by SME and FDI - similar to Mexico situation. Look to the ITIR was an example of extension service. The other standards as well - Israel, Finland, South Korea, Ireland, China, Spain (1980's turnaround), Singapore, etc.

My research thus far has revealed a large innovation challenge that is facing Mexico. Since 1994 there has been a massive influx of FDI - large attributed to NAFTA. This has resulted in enclaves of manufacturing excellence in Mexico - automotive for example. Moreover, both national R&D (as a percentage of GDP) and the number of researchers have grown tremendously over the last decade. But, Mexican patent activity has stayed flat. FDI, national R&D, and human capital are all theoretical inputs to innovation, yet Mexico has not been able to capitalize on this.

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Q5: In your opinion, why can't Mexico capitalize on all these innovation inputs?

No direct answer.

Q6: Do you see SMEs are being critical to further development on innovative capacity in Mexico? If so, are they specific issues that you can speak to? For example, lack of a mid-skill workforce for the many small manufacturing firms OR access to credit OR linkages (through supply chains for example) of SME to the large multinational manufacturing firms.

Yes, SME's are very import and should be supported. However, this may be more the role of extensive services - likely driven the Secretaria de Economia. An idea building out supply chain be incentivizing global firms to partner with SME's may be difficult for several reasons. SME base technological capabilities are just not high enough to make the partnership worthwhile for the large firm. There other is the risk of supporting already entrenched monopolies.

Also, it is not just large companies that need incentives. If the SME's do see capacity building as important they will not pursue these connection. This is tied to the monopolistic nature of Mexico's economy that disincentives entrepreneurial activities. Hopeful this will get with the economic reforms currently being pursued by the Pena Nieto administration.

Education is also a huge component here.

APPENDIX E.2: INNOVATION INSTITUTIONS

All information is section, unless otherwise noted, was taken directly from the "OECD Review of Innovation Policy: Mexico" published in 2009.

<u>Government:</u>
Mexican STI governance is large decentralized with no functional separation of responsibility for STI policy design, finance, and implementation between Ministries and CONACyT at the federal level or between the federal and state STI governmental actors. Mexican STI governance is roundly criticized for in-efficient coordination, weak evaluation procedures, and insufficient funding.

General Council on Scientific Research and Technological Development
This is the government body ultimately responsible for the design and implementation of STI policy in Mexico. However, this is formal distinction that does not hold true in practice.

National Council for Science and Technology (CONACyT)

CONCACyT has, in practice, the authority to ensure inter-ministerial co-ordination of the design, financing, and implementation of S&T policy. Part of CONACyT is a national network of 27 CONCACyT research centers.

Advisory Forum for Science and Technology (FCCyT)
This is an independent civil organization with its own budget. It is made of representatives from business and academia and charged with advising the President, the General Council on Scientific Research and Technical Development, CONACyT, and Congress on national issues related to science and technology.

State S&T Councils
Each state has S&T Council to understand local STI needs and develop and implement STI policies responses.

CONCACyT Regional Offices
These regional offices are each responsible for several states and - in cooperation with each state's S&T Council - develop regional and local STI polices.

The National Council of Science and Technology
This organization was established to coordinate priorities of implementation of STI policies between state and federal STI government actors.

Federal Ministries
Six federal ministries (Education, Energy, Agriculture, Health, Economy, and Environment) and CONACyT account for over 95 percent of STI spending in Mexico. This does not include tax expenditures for STI related tax incentives administered by the Ministry of Finance.

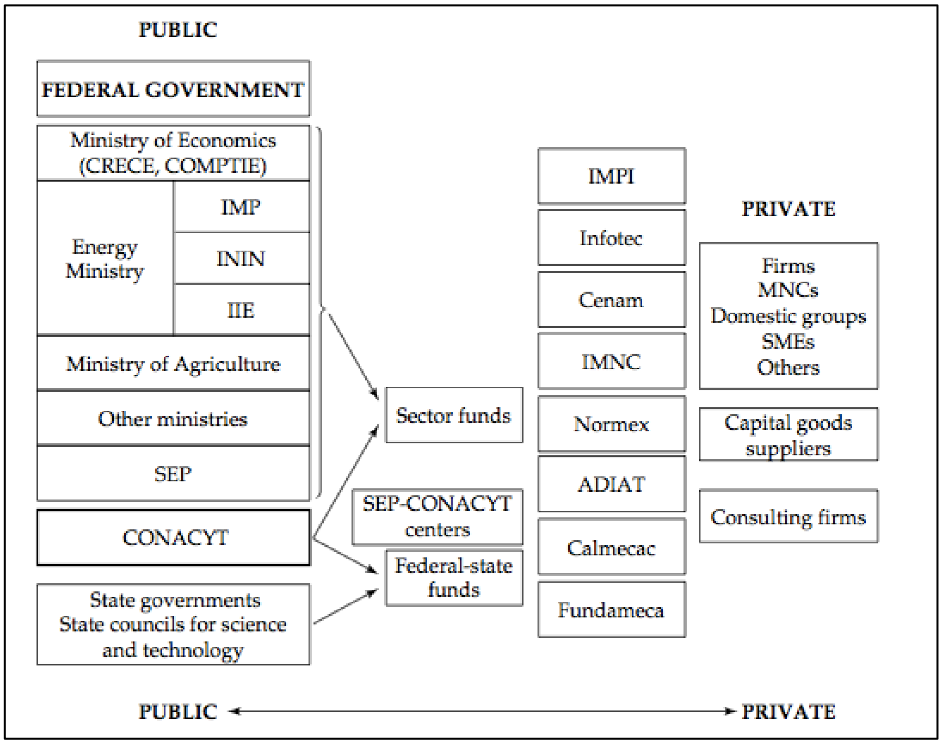

Figure 5: Organizations Involved In Innovation (Dahlman and Kuznetsov 47)

Business Sector

Though improving over the last decade, Mexico still has one of the lowest levels of business R&D (BERD) as a percentage of GDP in the OECD area. This is largely due the lack of innovative capacity in the micro-enterprises and SMEs that predominate Mexico's productive sector. SMEs in services and LMT tend not to be an innovative as larger firms and Mexico's industrial structure is largely comprised on these types of organizations. The BERD that is performed is dominated (more than 80 percent) by the manufacturing sector. However, the number of firms involved in technical innovation (25 percent) is well behind advanced countries such as Germany (65 percent) and has remained roughly constant over the last decade. Moreover, the majority of innovation is not R&D; firm expenditures are dominated by the acquisition of technologies related to innovation in products and processes. Innovation tends to be more common in firms serving local markets and firms connected to global supply chain. Mexican subsidiaries of multinational companies do not act as innovation platforms. Multinationals have historically used Mexico for low-cost, large-scale productive that are close to major markets such as the U.S. This is not to say such upgrades are non-existent. Finally cooperation of innovative firms is low, with less than 20 percent engaging in collaborative R&D (other firms, HEI's, of PRI) - not surprisingly - these collaborations are limited to the few large, innovation firms. The most commonly cited barriers to innovation - within firms that innovation - is concerns over financing.

Public Research Centers

There are two sets of Public Research Centers (PRC) - those managed by CONACYT, of which there are 27, and a several, more that are supervised by other ministries. The PRCs are not only engaged in research - part of their core mission is the diffusion and adoption of science and technology methods. Thus, the PRC also perform training and extension activities. The PRC are large autonomous in terms of budget management as well as the management of technical, operative and administrative aspects. Recently, funding arrangements have shifted away from institutional funding and more towards competitive funding. This has led PRC to focus on fee-for-service activities, increasing their interaction and co-operating with the private sector. Nonetheless, in 2007 more than two-thirds of PRC funding was institutional. Though a core mission of PRC is technology diffusion, they are considered to have more of an academic orientation. There is reflected in the 70 percent of researchers with a 70 percent and the fact that 60 percent of researchers are registered with the SNI. So, between the academic and sophisticated focus of the PRC and the lack of absorptive capacity of the SME, little cooperation occurs between the PRCs and the private sector.

Higher Education Institutes (HEI's):

Mexico's higher education system consists of universities, technological institutes, state educational institutions, and normal schools (for the training of teachers). Almost one-half of research activity in the HEI sector is concentrated in just four institutions - National Autonomous University of Mexico, the Center for Research and Advanced Studies, the Metropolitan Autonomous University, and the National Polytechnic Institute. The percentage of industry funding in university research labs is well below the OECD average.

Human Resources:

At all stages of education attainment, Mexico fares poorly by OECD standards. Interestingly, Mexico spends more on education (as a percentage of all public spending and as a percentage of GDP) than most other OECD countries. However, absolute spending relative to other OECD countries is relatively low. Though Mexico still ranks low in university-level attainment growth rates have been impressive - and there are no signs this trend will not continue. It should be noted, however, that MX has a very low emphasis on vocational training. This should be considered an urgent issue in Mexico as these programs focus on the practical and technical skills that could quickly enhance the performed of Mexico manufacturing firms. More to this point - despite the growth in tertiary education, many graduates are having a hard time finding work. This may be due to large percentage of degree granted in social sciences, business, law, and services. The current economy unfortunately is not supply these types of jobs.