Technology Transfer Institutions in China:
A Comparison of Value Chain and Organizational Structure Perspectives

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ABSTRACT
This Chapter summarizes the development of Chinese technology transfer mechanisms and compares them to foreign examples. It is based on a survey of seven Western China technology transfer institutions using strategic management theories: value chain analysis and type of organization structure. We also examine the impact on operational performance that is generated by engaging policy makers and managers in the work of technology transfer to provide new ideas and methods, and analyze the basis for assessing the operational performance of these institutions.

INTRODUCTION AND BACKGROUND
On March 5, 2016 at the Fourth Session of the 12th National People’s Congress of the People’s Republic of China, the Premier of the State Council reiterated former President Hu Jintao’s mandate to accelerate the transformation of China’s socialist market economy by executing technology transfer: “We will implement the strategy of innovation-driven development, see that science and technology become more deeply embedded in the economy, and improve the overall quality and competitiveness of the real economy.”¹ Historically, most of China’s economic development has been along its coast; as a Western province, Sichuan’s regional innovation capability ranked No. 16 in the country.² To promote sustainable economic development, the primary challenge facing the provincial government is to enhance its innovation capacity, transforming from “manufactured locally” to “created locally.” To further this objective, the Sichuan Provincial Science and Technology Department stressed the need to increase major

¹ For instance, see http://www.china.org.cn/china/NPC_CPPCC_2016/2016-03/18/content_38056401.htm.
scientific and technological achievements by creating special industry funds to foster new strategic products, support enterprises, accelerate the establishment of mechanisms for enterprise-led industrial research and technology, encourage enterprises to become more innovative, invest more in R & D, create scientific research organizations, and transform its technology into economic achievements.

BUILDING CHINA’S INNOVATION PROWESS

Over the three decades since implementing policy reforms and opening up its economy, China has maintained an annual average economic growth rate of approximately 10% and in 2010 became the world’s second largest economy. China’s R&D expenditures have been increasing, reaching 1.98% of GDP in 2012 edging the European Union’s 1.96%. R&D expenditures climbed to 2.1% by 2015 and plans on reaching 2.5% by 2020. Although enterprises have become the primary vehicle for China’s innovation system, it still lacks innovative capacity particularly in knowledge-intensive high-tech industries. Moreover, foreign invested enterprises control more than 80% of high-technology products entering China. In order to boost its innovation capacity, China made scientific and technological innovation an important component of its national development strategy and proposed guidelines that would make “independent innovations and leapfrog advances in key areas of science and technology while supporting development and guiding the future” (see http://www.chinaun.org/eng/zt/sdren/P020120608816288649663.pdf page 33).

China hopes to transform from being a world processing center of labor-intensive products into an innovative country with indigenous intellectual property rights. Technology transfer is an important part of implementing this innovation strategy as it is
key for enterprises to achieve technological innovation, enhance their core
competitiveness, and for innovation achievements to become productive forces in the
economy. However, for a long time technology transfer has been a weak link in China’s
national innovation system, lacking good institutions, mechanisms, and a favorable
policy environment. These are major obstacles to China’s enterprises improving their
ability to develop innovations with Chinese characteristics appropriate to their needs.
Therefore, an urgent strategic task to build an innovative country is to accelerate the flow
of knowledge and technology transfer to improve the national technology transfer system
and to create an effective operational mechanism for technology transfer. This requires
complete commitment from government, universities, research institutions, and
intermediaries.

DEVELOPING TECHNOLOGY TRANSFER INSTITUTIONS IN CHINA

There are numerous types of technology transfer institutions in China. The first
technology transfer service institutions were established in the early 1980s. After 20
years of development, China has begun to establish a fairly complete technology transfer
system under the guidance and management of the Ministry of Science and Technology.
Additional support comes from National Technology Transfer Centers, National
Technology Transfer Demonstration Institutions, the Regional Technology Transfer
Union, Industry Technology Transfer Alliances, local and other types of technology
transfer institutions, and a set of legislation. What has been the impact of all these
institutions and activities?
According to the 2015 Statistical Bulletin of National Economic and Social Development, China spent 1.422 trillion RMB in 2015 on R&D, or 2.1% of its GDP. This is a 9.2% increase over the prior year’s 1.3016 trillion RMB which was 2.09% of its GDP. These investments increased published scientific papers and patents. By the end of 2015, the number of filed patent applications reached 2.799 million pieces with a 18.5% increase than 2014. The number of granted patents climbed up to 1.718 million pieces with a 31.9% increase than 2014. Further, the transaction value of China’s technical markets increased 14.7% from 2014 to 0.9835 trillion RMB in 2015. In 2014, there were 74,275 high-technology enterprises in various development areas throughout the country. Of the 3,677 R&D institutions in China in 2014, 2,957 (80%) were at the local level. At the same time, 63,676 enterprises – 17% of all engaged in R&D – spent an average of 0.84% of their sales on this activity, resulting in increased new product sales and exports, with high-technology products comprising 28% of trade.

In 2008, the Ministry of Science and Technology identified 76 institutions to be the first batch to explore different modes of technology transfer and build a new technology transfer system. These were comprised of the Regional Technology Transfer and Services Alliance, Regional Comprehensive Technology Transfer Institutions, Industry or Professional Technology Transfer Institutions, and Technology Transfer Institutions of Universities and Research Institutes, including Sichuan Provincial Science and Technology Advisory Service Center, Sichuan Technology Limited Liability Company,

and Sichuan University’s National Technology Transfer Center. This selection recognizes the important roles of government, universities, scientific research institutions, intermediary institutions, and private enterprises in creating a national system of effective technology transfer. These institutions are expected to work on technical fields related to key areas such as agriculture, manufacturing, energy resources, marine, transportation development, modernizing services (e.g., applying information technologies to improve business models and management for finance, insurance, computing software, etc.), health and environmental protection all of which are based on the National Mid-Long Term Science and Technology Development Plan (2006-2020), national economy, and people’s livelihood issues. These institutions are also hope to promote the transfer and diffusion of industry common technology and key technology arising from national major projects. By the end of 2015, the country identified 453 National Technology Transfer demonstration institutions (see Figure 1 for their distribution). While this reflects the diversification of technology transfer institutions, nonetheless more than half are university- and research-institute based.

Figure 1: National Technology Transfer Demonstration Institutions

Source: Data collected from 2016 Annual Report on Statistics of China Technology Market; percentage of each type of technology transfer institutions (TTI) to total is calculated by the authors.
According to the 2016 Annual Report on Statistics of China Technology Market, China’s technology transfer demonstration institutions up until now, have covered 30 provinces, autonomous regions, and municipalities (out of 31 total). The most dynamic regions transferring innovation and technology are Beijing, Jiangsu, and Shanghai, which also rank as the top three with 58, 45, and 26 TTIs, respectively. Overall, Eastern China has 275 demonstration TTIs, accounting for 61% of the total. Moreover, this region has advantages in its quantity and quality of universities and research institutes, strong research and development capabilities, and active technology trading of 1,164 billion RMB in 2015 that accounted for 59% of the total. The Eastern region also contains seven of the top ten provinces and municipalities in terms of registered technology contract volume: Beijing, Jiangsu, Shanghai, Guangdong, Tianjin, Shandong, and Liaoning. Beijing is China’s largest technology provider and absorber with a registered technology trade volume of 460 billion RMB in 2015. In contrast, Sichuan leads in the West with a registered technology trade volume of only 57.6 billion RMB. This uneven distribution of technology transfer demonstration institutions and traded technology volume reflects the unbalanced development among China’s various regions.

In China, there are traded contracts for technology development, technology transfer, technology consulting, and technology service. Technology service, that includes technological training and technological intermediary services, passed technology development in 2013 and has maintained its lead since. Technology development contracts, comprised of commissioned development contracts and joint

development contracts, have increased their traded volume. Technology transfer contracts include technology secrecy trading (the most important), patent, licensing, software copyright, and design copyright. Technology consulting plays a minor role. Domestic firms are the largest technology buyers and sellers, accounting for 53.9% and 69.7%, respectively, of the total traded technology contract volume. In contrast, foreign invested enterprises account for 9% and 12%, respectively, as buyers and sellers focusing on electronics and IT, followed by advanced manufacturing, technology related to city construction and safety, as well as social development.6

According to the 2016 Annual Report on Statistics of China Technology Market, national technology transfer demonstration institutions employed 38,081 staff at the end of 2015, with 82.5% holding at least a bachelor degree and 11.1% qualified as technology brokers. This signifies that the technology transfer institutions in China have evolved from simply registering technology trade information to becoming a more professional technology transfer player. These institutions contributed a total of 127,249 technology transfer projects valued at 178.9 billion RMB. Among them, 19,076 projects were financed by public funding with commercialization valued at 22.6 billion RMB. Of these, 2,667 were “big value” projects (more than 10 million RMB per project) with a trading volume of 59.7 billion RMB that included 2,218 international technology transfer projects with a turnover of 5.7 billion RMB. They also organized technology training for 441,457 people, served 321,067 firms, and provided solutions to 188,250 problems faced by firms. Further, these institutions were granted 34,851 patents. These facts signify that

national technology transfer demonstration institutions have increasingly become an important intermediary to promote entrepreneurship, innovation, and commercialization of research findings. They played a pivotal role in making technological achievements productive economic forces, but China still needs to strengthen its efforts to promote the commercialization of its emerging strategic industry technologies.

Overall, after twenty years of development China’s technology transfer mechanisms have been able to achieve considerable progress both in its quantity and in transferring its technology achievements. Yet, some obvious deficiencies remain. First, regional distribution is unbalanced with the Central and Western Regions lagging far behind in technology transfer and economic development; these regions must improve their technology transfer institutions. Second, financial services and the management of technology transfer agencies remain weak, affecting the efficiency and effectiveness of technology transfer. We next compare China’s approach to the West, then examine how these problems can be remedied by value chain analysis and appropriate design of the organization’s structure.

COMPARING CHINA AND THE WEST

There are three similarities between Chinese and Western technology transfer institutions (see Table 1). First, returns on newly-invented technology investment are very uncertain. The technology transfer agency can classify the invention by market potential and market prospects. This professional assessment provides symmetric information to both buyers and sellers, potentially reducing uncertainty about the technology and thereby enhancing the efficiency of its transfer.
Second, China’s and Western technology transfer institutions are similar in their function. Institutional technology transfer agencies promote the transformation of university scientific research. The close links between the agency and university researchers increase information symmetries thereby enhancing the university’s reputation and protecting its intellectual property rights.

Last, both have three operational phases: discovery and evaluation of scientific and technological achievements, transforming scientific and technological achievements, and industrializing the results and obtaining feedback.

<table>
<thead>
<tr>
<th>Table 1: Comparing Chinese and Western Technology Transfer Institutions</th>
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<tbody>
<tr>
<td>Similarities</td>
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<tr>
<td><strong>Foundation Purpose</strong></td>
</tr>
<tr>
<td><strong>Function</strong></td>
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<tr>
<td><strong>Primary Responsibility</strong></td>
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<tr>
<td>Differences</td>
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<tr>
<td><strong>Top-Level System Design</strong></td>
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<tr>
<td><strong>Rules and Regulations</strong></td>
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<tr>
<td><strong>Performance Objectives</strong></td>
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<tr>
<td><strong>Source of Funding</strong></td>
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</table>

Although there are similarities between Chinese and Western technology transfer institutions, four large differences remain that help explain why China lags the West.

First, most Western countries have created their technology transfer systems on the national level. China established various regional technology transfer centers under the guidance of Torch Center (http://www.chinatorch.gov.cn/english/index.shtml) that lacks any overarching guidance at the national level. Moreover, many Western countries have
set up national-level associations of universities that provide guidance from a more holistic and professional perspective. For example, Italy’s University Technology Transfer Association holds various national and even international events, prompting the government to develop national norms and institutions for transferring technology and exploring solutions to common problems facing Italian university technology transfer activities.

Second, China has less sophisticated rules and regulations for its technology transfer institutions. Western countries, in addition to introducing laws and regulations at the national level to promote technology transfer, had many universities establish rules and regulations for their main technology transfer issues: “patent license,” “establishing spin-off companies,” and “joint business-community developments.” While Chinese technology contract law was promulgated in 1987 with a number of laws and regulations introduced gradually afterwards to promote the transformation of scientific research, regulatory systems for university technology transfer activities are still lacking.

Third, Western universities measure their technology transfer performance based on obtaining research funding agreements, license revenues, and invention and patent applications. In China, rather than technology transfer license agreements it is more common to cooperate in establishing joint laboratories or research institutions. Performance is measured by the signing of contracts for technology development, technology transfer, the amount of technical services, and pure patent licensing.

Last, China’s and Western technology transfer mechanisms differ in their sources of funding. Western technology transfer mechanisms are mostly funded from school investment as the mainstay, supplemented by government investment, to get income by
offering products and services as an important supplement. In China, the source of capital and technology transfer mechanism largely depends on government grants and administrative expenses allocated to universities.

**COMPARING CHINA’S TECHNOLOGY TRANSFER AGENCIES**

It is important to enhance regional innovation capability to build a strong country. According to the *Regional Innovation Capability of China Report 2015*\(^7\), Sichuan’s innovation capacity ranked No. 16 in 2015, dropping by 7 compared to the 2010 data. Sichuan clearly lags the innovation capability of the Eastern Jiangsu, Guangdong, Beijing, Shanghai, Zhejiang, Shandong, and Tianjin. As the major science and technology province in Western China, one of the priorities of the Sichuan provincial government is to enhance its innovation capability and narrow the gap with the Eastern provinces. By promoting technology transfer from foreign sources to local organizations, the provincial government expects to solve key technical problems facing local enterprises, improve the industrial structure in Sichuan, and enhance the innovation capacity of its regional enterprises. Supporting institutions include the National Technology Transfer Center, Sichuan University, Sichuan Western International Technology Transfer Center, and a variety of other corporate technology transfer mechanisms and non-profits affiliated with the municipal government.

In fact, to implement its strategy of becoming an innovative economy, Sichuan has made it clear that its technology transfer activities are the province’s No. 1 project. It intends to do this by including Party committees, appraising government’s objectives and

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performance, accelerating the establishment of a number of market-oriented operations, making diversified investments, and creating a platform to develop professional management and transform technological achievements. This new approach to quickly make Sichuan Province a vital economic center is a major initiative that will accelerate scientific development. Given such great significance, technology transfer mechanisms in the province must accelerate scientific and technological innovation by altering government policy and integrating technology into the local economy.

Has this mosaic of technology transfer bodies and activities achieved the objectives set in the early years of their operation? Can they help to enhance Sichuan’s regional innovation capability? Researching these questions has both theoretical and practical value, but also complement the existing domestic and foreign literature on technology transfer. We next examine how value chain analysis and organization structures can facilitate this transition.

**The Value Chain Perspective**

In strategic management, the value chain generally refers to how company activities can create value for their customers. The organization of these activities determine the level of a company’s market competitiveness. Therefore, the value chain is often used as an analytical tool to compare competitive advantages between organizations. For a technology transfer institution, its value creation activities include scientific research, technology assessment, patent application assistance, market demand identification, scientific research results (including signing contracts for technology transfer, technology licensing, pure patent licensing, joint development with companies, and new business creation), and providing service (i.e., technology consulting service).
The value creation of supporting activities includes organization size and expertise, the funding source, and the relationships among enterprises, technology transfer agencies, and researchers (see Table 2).

Table 2: Value Chain of Technology Transfer Institutions

<table>
<thead>
<tr>
<th>Primary Activities</th>
<th>Supporting Activities</th>
<th>After Sales Service</th>
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<tbody>
<tr>
<td>Discover S&amp;T Achievements</td>
<td>Size of technology transfer institution</td>
<td></td>
</tr>
<tr>
<td>Assess S&amp;T Achievements</td>
<td>Expertise of technology transfer institution</td>
<td></td>
</tr>
<tr>
<td>Assist Patent Application</td>
<td>Funding source of technology transfer institution</td>
<td></td>
</tr>
<tr>
<td>Identify Market Need</td>
<td>Relationship among enterprises, technology transfer agencies and researchers</td>
<td></td>
</tr>
</tbody>
</table>

To understand the primary and supporting activities of these institutions and whether they have the appropriate organization structure to support their activities, we developed a survey and sent it to technology transfer institutions located in Sichuan, Yunnan, Chongqing, and Shaanxi provinces in Southwest China during the period October 2012-March 2013. The purpose was to suggest policy recommendations as to how the Sichuan government can make its TTIs become regional pioneers. Further, the West has become China’s economic growth engine as it catches up to the East.

Technology transfer activities keep increasing along with both domestic and foreign investments, especially in Sichuan province. However, it is very difficult to obtain data and ultimately we received valid questionnaires from only the following TTIs: New Rural Development Research Institute of Sichuan Agricultural University, Sichuan Western International Technology Transfer Center, Sichuan Science and Technology Exchange Center, National Technology Transfer Center of Sichuan University, Zigong City Productivity Promotion Center, Yibin City productivity Promotion Center, and Yunnan Institute of Science and Technology Development (Modernization of Traditional Chinese
Medicine Science and Technology Industrial Based Construction Service Center). All but the last one are in Sichuan.

As Table 3 at the end of this Chapter shows, the seven technology transfer institutions differ in size, staffing, education level, and attitude towards firms and researchers, which led to differences in the value creation of their primary activities. In the 2009-2013 period, the New Rural Development Research Institute of Sichuan Agricultural University, National Technology Transfer Center of Sichuan University, Yibin City Productivity Promotion Center, and the Yunnan Institute of Science and Technology Development were all involved in technology transfer through signing various types of contracts, while the other three technology transfer institutions did not have these activities; rather, they focused more on tapping the market demand and relevant information, disclosure of relevant national technology transfer related policies and regulations, and promoting scientific and technological exchanges and cooperation.

Also in Table 3 we note that Sichuan University’s National Technology Transfer Center creates the most value as the total amount of its technology transfer contracts is the highest among the seven technology transfer institutions. It does not take advantage of its size but has obvious advantages in staff who have science and engineering professional knowledge and postgraduate education. In the value chain, researchers are the source of value creation. The Center employed 12 science and engineering staff with 8 involved directly in the technology transfer process that helped to evaluate the technical level of scientific research. In addition, this institution emphasized developing and maintaining its enterprise and scientific research personnel, establishing joint laboratories and research institutes with other enterprises, had very frequent telephone and e-mail
contact with researchers, and visited their laboratories. While enterprises demand technology, researchers provide technology and Sichuan University’s TTI fully demonstrates its role as a bridge between these two sides.

Sichuan University’s National Technology Transfer Center consists of three offices: The Integrated Information Management Office is responsible for receiving and evaluating patent applications; the Office of Common Technology Project Development is responsible for tapping market demand for patent commercialization; and the Technology Transfer and Intellectual Property Management Office assists in patent application and service after sales. The strong linkage between the Center and its researchers is helpful in improving its operating performance. During our on-site interview, we found that it has more open communication with its researchers than the other technology transfer institutions have. As the Center relies on Sichuan University which has excellent human resources and research capabilities, its annual average technology transfer value reaches around 800 million RMB and has been awarded Excellent National Technology Transfer Demonstration Institution by the Torch Center of Ministry of Science and Technology.

The example of Sichuan University’s Technology Transfer Center indicates that having comprehensive supporting and primary activities will improve operating performance. This is mainly because technology transfer institutions with complete value chains have stronger capability to monitor their value-added process of technology transfer, related information flow, risk, and resources. Apart from the completeness of the value chain, the commitment of scientific and technical personnel to participate in value creation activities has an important effect on the performance of these institutions. The
core purpose of their value chain is to convert scientific research to economic benefits, with the technical content of scientific research being a key factor affecting the conversion rate. As the ones undertaking research projects, scientific and technical personnel are not only essential in assessing the technical content of scientific research but also are the most knowledgeable about the scientific and technical applications. Therefore, involving scientific and technical personnel in the value chain activities is helpful for each party to understand technical specifications, applications, and other commercialization aspects as well as to enhance the operational efficiency of the technology transfer institution.

Finally, inviting scientific and technical personnel to participate in the value chain’s primary activities is an important incentive for them to upgrade the performance of their technology transfer institution, such as giving them more opportunities to participate in R&D, technology commercialization, manufacturing, after sales service, and empowering them to improve their sense of ownership. There are ways for China’s technology transfer institutions to improve their value chain, especially by motivating their researchers to be actively involved in the technology transfer process so as to improve the real conversion rate.

Since the overall performance of China’s TTIs depends on the individual operation of each one, it is important to ameliorate the value chain deficiencies of individual TTIs. On the one hand, the complete extent of the value chain to these organizations has an important influence on overseeing all technology transfer activities in the process of adding value and all related information flow, risk, and resource capacity. On the other hand, the research and development side of scientific and technical
personnel have the best understanding of the actual level of technology so they should be placed well in the TTI’s value chain. Thus, the degree of scientific and technical personnel engagement in the value chain is very important. To ensure the value chain’s contribution to performance, TTIs need to employ high quality staff who possess interdisciplinary knowledge and provide their staff effective incentives for R&D or other related technology transfer activities.

The Organizational Structure Perspective

Successful technology transfer requires input of several key elements such as technology, funds, information, professional staff, and so on. With the development of the technology trade market, technology transfer institutions are facing more complex management and operations challenges, making it all the more important to coordinate these resources. In addition to improving their value chain activities, technology transfer institutions can adjust their organizational structure accordingly.

The organizational structure of most Chinese technology transfer institutions are designed by function that usually have an Administration Office, a Consulting Department, an Information Department, a Marketing Department, and a Human Resources Department, among others. With the increase of technology transfer business and the accumulation of experience, some colleges and universities with a technology transfer institution are moving to the matrix structure to make its operations more market-oriented and to offer professional services. The longitudinal organizational structure design is similar to the functional organizational structure as both contain a Project Department, Consulting Department, Information Department, and various other functional departments. In addition to the functional dimension, this structure can also be organized by regional or
technology field dimensions (see Figure 2). These two kinds of matrix structures have different characteristics as shown in Table 4.

Figure 2: Characteristics of Matrix Organization Structure

<table>
<thead>
<tr>
<th>Type</th>
<th>Matrix structure based on region</th>
<th>Matrix structure based on technology field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicability</td>
<td>Different regions and industries have different technical demands; technology transfer targets each region respectively</td>
<td>Technology transfer targets all geographic areas and industries and does not consider the diverse demands of areas and industries</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Example</th>
<th>Xi’an Jiaotong University, East China University of Science and Technology</th>
<th>Massachusetts Institute of Technology, Oxford University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advantage</td>
<td>Staff has good and stable connections with each region from regional governors to enterprises; better for building social networks and understanding local rules and regulations</td>
<td>Staffing employees with technological expertise; very useful to trace the development of cutting-edge technology and to better understand market need and technology application prospects</td>
</tr>
<tr>
<td>Disadvantage</td>
<td>Staff may not be familiar with technology</td>
<td>Lack good connections with local governors and firms</td>
</tr>
</tbody>
</table>


Some Chinese technology transfer institutions organize as a divisional structure when their business volume reaches a certain level. That permits them to set up a local division based on the geographic region (e.g., Northern, Southwest, or European Division). Each division is set up with an Administrative Personnel Department, Information Department, Counseling and Legal Department, Finance Department,
Assessment Department, etc. The divisional organizational structure can also be based on the technology field (e.g., Information Technology Division, Biomedical Division, Energy and Environment Division, New Materials Division). Each division then sets up its internal functional departments, such as the Administrative Personnel Department, Information Department, Counseling and Legal Department, etc. It is possible for the matrix structure to integrate a divisional organization structure, such as departments based on technology fields in a regional divisional organization structure or functional departments in technology divisions.

Of the various organizational structures, the matrix is the most flexible and has a quick response to changing environment. It maintains close contact with the relevant authorities and combines centralization and decentralization. With increasing technology transfer projects and greater management complexity, technology transfer institutions with a matrix organizational structure will have more experience and achieve better performance. The divisional organizational structure emphasizes decentralization, requiring technology transfer institutions to reach a certain stage of maturity namely excellent internal management, professional staff, strong independent ability, and so on. Therefore, technology transfer institutions at different development stages should adopt the relevant type of organizational structure, as the effect on organization performance can be vastly different.

All of the seven technology transfer institutions that responded to our survey have a functional organizational structure. The directors of these institutions come from local Science and Technology Department/Bureau or universities. Decision-making power is concentrated in the hands of functional department managers. Except for the Zigong
Productivity Promotion Center, the employees of the remaining six technology transfer institutions participate in various levels of decision-making.

**CONCLUSIONS AND POLICY IMPLICATIONS**

Our review of national technology transfer demonstration institutions shows that East China has more institutions and traded volume compared with other regions, reflecting their superior dynamism. This is in accordance with the uneven regional economic development. Enterprises are the largest players in the technology market, followed by research institutions and universities. Through our comparative analysis of seven technology transfer institutions’ value chains and organization structures, university technology transfer institutions perform better than the other five technology transfer institutions. This is because they have more staff and emphasize connections with firms and researchers. Further, the incentive mechanism provided by Sichuan University to its TTI staff plays an important role in outperforming the other six TTIs. Comparing Chinese to Western TTIs, we find similarities in the foundation purpose, function, and primary responsibilities but differences in system design, rules and regulations, performance objectives, and source of funding. Although Chinese TTIs have made significant progress, many problems remain especially compared with Western technology transfer institutions. We conclude this Chapter by offering policy implications to help Chinese TTIs improve their productivity.

*Establish a National Technology Transfer Administrative Agency.* Technology transfer institutions are part of China’s national innovation system and their performance certainly influences economic competitiveness. Although 453 national technology transfer demonstration institutions were operating at the end of 2015, there is no national-
level administrative agency or network to manage and coordinate these institutions. Therefore, we propose the central government create an administrative institution to guide, monitor, and evaluate TTIs. The new institution will promulgate technology transfer guidelines and related national policies, as well as coordinate labor, information, and resource sharing as well as offer solutions to disputes and disagreements arising from technology transfer activities. It will also contribute to raising the overall image of Chinese TTIs on the world stage. Various TTIs will perform under the guidelines of the administrative institution that will make the domestic technology transfer market more transparent and efficient, helpful in attracting more foreign firms to get involved in technology transfer activities in the Chinese technology market.

*Improve the Implementation of Technology Transfer Legislation.* A common global approach to developing science and technology as an intermediary industry is to establish legislation, provide policy guidance, and promote and guide these intermediaries so they cooperate with firms, research institutes, and universities to accelerate technology transfer. Big challenges remain for China’s policy makers, including: how to appropriately implement the established rules, regulations, and guidelines; clarifying the legal status, rights, and obligations of various shareholders in the technology transfer process; and coordinating dispersed technology markets in different regions and making

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them perform more efficiently. At the same time, governments must introduce relevant incentives that reward accredited technology trading parties, institutions, and individuals as well as establishing technology market development funds to ensure technology transfer contracts will continue to grow. Local governments at all levels should actively cooperate with each other, following national-level guidelines, rules, and regulations that are locally adopted.

Adjust Relevant Organizational Structure of Technology Transfer Institutions. The appropriate organizational structure is one of the key factors that ensure high performance of technology transfer institutions. There is no “one size fits all” organizational structure. Technology transfer institutions should choose their appropriate organizational structure based on their actual stage of development so as to successfully facilitate technology transfer. The functional organizational structure is suitable for technology transfer institutions at the early development stage; the matrix organizational structure reflects the combination of organization centralization and decentralization that is suitable for technology transfer institutions at a growth stage; and the divisional organizational structure emphasizes decentralization and independence that is suitable for technology transfer institutions at a mature stage.

Strengthen the Network of Technology Transfer Institutions. As we have discussed before, there is a big difference among regions where technology transfer institutions are located. Central and Western economic development has lagged far behind the Eastern region. It is of great significance to enhance cooperation by networking technology transfer institutions across and within regions to better use their resources, benchmarking best practices, solving conflicts, and eliminating barriers. In fact, some regions have
already done this such as the Beijing Technology Transfer Innovation Service Alliance, the Northeast Technology Transfer Services Alliance, and the Yangtze River Delta Technology Intermediary Union. Eleven regional technology transfer centers met in Shanghai in May 2016 to found the China Technology Transfer Alliance. But these organizations have not yet formed a substantive cooperation and sharing mechanism or are just starting so it will take some time to see how these alliances operate. For this reason, we recommend that government should take a lead, provide necessary financial support, and use a membership-based approach to build technology transfer institution alliances.

In closing, we offer an example in Germany’s Steinbeis Technology Transfer Center (http://www.steinbeis.de/en/). It is a comprehensive service organization and unites 360 different types of technology transfer centers across the country. It has established a nationwide network of services and reaches an annual revenue of over a billion euros. It has developed into the largest and most unique technology transfer service organization in Germany. The former Chairman of the Board summarized the organization’s success as due to being a network. Germany has the same aspirations as different regions all over the world, the Center’s advantage coming from consolidating customer services and responding to the market to attract a large number of customers and develop significant demand, thus creating a lot of wealth.9 This is similar to the results and recommendations we offer to China’s technology transfer institutions.

<table>
<thead>
<tr>
<th>New Rural Development Research Institute of Sichuan Agricultural University</th>
<th>Sichuan Western International Technology Transfer Center</th>
<th>Sichuan Science and Technology Exchange Center</th>
<th>National Technology Transfer Center of Sichuan University</th>
<th>Zigong City Productivity Promotion Center</th>
<th>Yibin City Productivity Promotion Center</th>
<th>Yunnan Institute of Science and Technology Development</th>
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<tr>
<td><strong>Auxiliary Activity:</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Size of TTI</strong></td>
<td>16</td>
<td>20</td>
<td>40</td>
<td>14</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td><strong>Staff expertise and average education background</strong></td>
<td>1 staff (science and engineering), 3 staff (business); postgraduate</td>
<td>2 staff (science and engineering), 2 staff (business); bachelor</td>
<td>10 staff (science and engineering), 5 staff (business); bachelor</td>
<td>12 staff (science and engineering), 0 staff (business); bachelor</td>
<td>7 staff (science and engineering), 2 staff (business); bachelor</td>
<td>2 staff (science and engineering), 21 staff (business); bachelor</td>
</tr>
<tr>
<td><strong>Source of funding</strong></td>
<td>University</td>
<td>Initial funding from government and private firms with a ratio 1:3, current funding self-operating</td>
<td>Government</td>
<td>Initial funding from the Ministry; current funding from share remittance from transferred project</td>
<td>Institution itself</td>
<td>Initial funding from government; current funding from fiscal appropriation</td>
</tr>
<tr>
<td><strong>Relationship with firms and researcher</strong></td>
<td>Very important</td>
<td>Extremely important</td>
<td>Very important</td>
<td>Extremely important</td>
<td>Firms extremely important; researchers very important</td>
<td>Firms very important; researchers medium important</td>
</tr>
<tr>
<td><strong>Primary Activity (from 2009-2013, Monetary unit: 10,000 yuan):</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discover S&amp;T achievements</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Assess S&amp;T achievements</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Patent application assistance</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Market need identification</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Contract value of technology development</td>
<td>5,516</td>
<td>0</td>
<td>0</td>
<td>241,240</td>
<td>0</td>
<td>1,090</td>
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<tr>
<td>Contract value of technology transfer</td>
<td>1,563</td>
<td>0</td>
<td>0</td>
<td>14,348</td>
<td>0</td>
<td>2,431</td>
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<tr>
<td>Contract value of technology service</td>
<td>15,339</td>
<td>0</td>
<td>0</td>
<td>163,722</td>
<td>0</td>
<td>56</td>
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<tr>
<td>Contract value of patent licensing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12,182</td>
<td>0</td>
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