

# CBBC Research & Consultancy

## China Market Overview for Scottish Higher Education Institutions

CBBC

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## EXECUTIVE SUMMARY

Providing an overview of trends in the Chinese education market and how they might indicate opportunities for Scotland in as vast and diverse a country as China is clearly an ambitious task. CBBC has nonetheless attempted to deliver upon this brief by addressing it in two distinct parts.

The first part of this report covers sections 1-6 and aims to provide an overview of the key macro-economic drivers for changes to the education sector in China and how they have been affecting Higher Education Institutions' (HEIs) modes of engagement with China. With an explicit preference to look beyond Tier 1 cities, the second part, covered in section 7, adopts a regional perspective to highlight a selection of thematic clusters where Scotland's own strengths could be well received.

### Part I – Education Sector Trends and Macro-Economic Drivers

This part of the report will show that China's higher education system is entering a new phase, with a focus on quality and on innovation as well as an increase in internationalisation both within China and overseas.

Whilst the higher education market continues to expand within China, major policies released over the past 12 months clearly state China's intention to join the world's top nations in science and innovation.

This is illustrated in the objective to have six Chinese universities joining the leading group of universities globally by 2020, with some of these institutions ranked among the top 15 in the world by 2030. The Times Higher Education World Reputation Rankings 2016 gives an indication of the progress made to date: Tsinghua University ranked 18<sup>th</sup> and Peking University ranked 21<sup>st</sup>.

Other major strategic objectives include boosting the Study in China brand and hosting 500,000 foreign students by 2020 and expanding and exerting greater influence abroad.

Section 1 provides a basic outline of China's principal macro-economic policies:

- The 13<sup>th</sup> Five-Year Plan, and its focus on innovation-led development
- Education blueprint to the 13th Five year Plan
- 'World Class 2.0' the successor to '211', '985', 'C9'
- Made-in-China 2025
- The Belt & Road Initiative

Several inter-regional initiatives are also outlined as examples of major domestic policy plays where the education sector is seen to play a crucial role. HEIs engaging in such regions are advised to be well aware of such context in order to leverage them most effectively. Local Chinese partners will usually be keen to align and articulate their own activity with such policy and it may be wise to follow suit.

Section 2 looks at a number of aspects affecting student recruitment and mobility, from economic drivers and demographics to subjects studied and what attracts students to the UK and Scotland. Chinese universities aim to create a pipeline of Chinese talent with both an international mindset but also local expertise. The student mobility levels for Chinese students remain high as the number of international

students studying at Chinese universities is increasing. Spending on education is forecast to continue to increase but competition from both Chinese and overseas institutions for that share of spending is also increasing.

Section 3 reviews the latest TNE policies and environment and concludes that the overall landscape for TNE collaborations will continue to be favourable. However, greater attention will be paid to quality and the diversification of subject areas.

Section 4 focuses on training, another area that offers opportunities for universities as China moves to address its current skills gap.

Section 5 addresses a central theme of the current landscape: Innovation. Innovation is core to China's key policies and there is much potential for Scottish universities to further develop their activities in this space. The UK-China Innovation is GREAT Showcase and Pujiang Innovation Forum that took place at the end of September in Shanghai, attended by UK Minister of State for Universities, Science, Research and Innovation, Jo Johnson and Government Chief Scientific Adviser Sir Mark Walport, highlighted the sheer scale of the opportunity. We expect the R&D and Innovation agenda to gain even more importance in the China strategy of many universities.

Closely linked to the innovation agenda and acting as a bridge between teaching and research activities is entrepreneurship. Chinese universities are increasingly instructed to provide entrepreneurship support and we see opportunities for Scottish universities in developing that agenda in their discussions with existing or potential partners. In addition to entrepreneurship discussions, a number of entrepreneurship competitions are emerging some addressed at graduates, some targeting early-stage start-ups, presenting an opportunity for Scottish universities to engage with existing students and Alumni.

Finally, we finish Part I with a very brief section 6 on operating in China simply to highlight a few points around legal and IP issues that may arise when engaging with the Chinese education market.

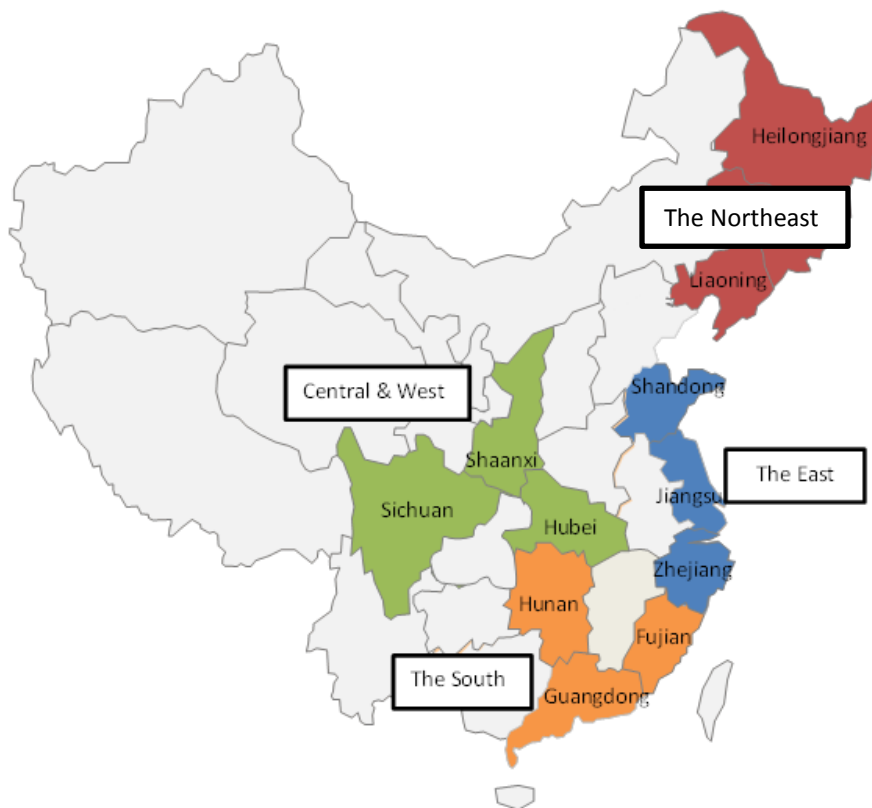
## Part II

Whilst impossible to explore every one of China's provinces, CBBC was tasked with looking beyond well-trodden paths in Tier 1 cities such as Beijing and Shanghai, to identify alternative clusters which match Scotland's own strengths.

As such, a broad selection of academic and industrial clusters has been identified from across China for their relevance to Scotland's strengths. They have been divided into four main geographical sections: the Northeast, the East, Central & West and the South. This selection is not designed to be exhaustive; a near impossible feat when dealing with China, but hopes to offer examples and ideas of where Scottish HEIs with certain niche strengths might find synergies, both geographically and thematically.

For each geographical region, a brief synopsis of their respective industrial fabric is provided, followed by a short list of key companies and universities in relevant priority sectors.

Further to this, a handful of individual interviews have been conducted with academics and cluster representatives with the purpose of acquiring anecdotal evidence of live opportunities for collaboration in their respective geographies.



### ***The Northeast***

Hit hard by the economic and industrial rebalancing currently underway, this region is acutely aware of its need to move up the value chain, and places innovation at the heart of this. The Northeast Old Industrial Base Revitalisation Plan aims to build the northeast region into an internationally advanced high-end equipment manufacturing R&D base. In order to upgrade the sector, international cooperation and expansion are being strongly encouraged by the government.

Overall, three thematic areas may be prioritised in this region, as follows:

- Advanced Equipment manufacturing
  - Key companies and universities present in this region are listed
- Pharmaceuticals
  - The city of Tonghua is highlighted as a hub of such activity, with details of pharma companies and key universities listed. E.g. Tonghua Maoxiang Pharmaceutical, which has an active interest in stratified medicine.
- Oil & gas
  - Focus on the Panjin cluster in Liaoning, identifying several sector-specific research institutes and vocational colleges of interest.

### **Other live opportunities for collaboration**

As well as heavy industry, the Northeast also has a lot of agriculture, and certain programmes in institutions such as Liaoning University have courses in Food Science and Engineering, which would be worthy of further investigation by Scottish HEIs with specialisation in this area.

In Creative Industries, Luxun Academy of Fine Arts in Dalian has programmes in animation that would also warrant exploration for HEIs with strength in this area.

The Dalian University of Technology highlights its own interest in forging international partnerships in entrepreneurship education.

Historical ties to Scotland in the region were also uncovered in the form of the China Medical University (CMU), Shenyang, an integral part of which was established by Scottish missionary Dugald Christie in the late 19<sup>th</sup> Century. From our experience, such historical ties can offer a convenient narrative for establishing current ties where there is synergy in relevant thematic areas.

### ***East China - Shandong, Jiangsu, Zhejiang***

Key thematic areas for Scottish HEIs to consider in East China:

- Ocean and maritime science
- Aquaculture
- Biopharmaceuticals
- Medical device development
- Nanotechnology
- Marine Sciences & Engineering
- Oil & Gas

### **Shandong**

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Given the diverse and long-term links between Scotland and Shandong, ranging from inter-governmental agreements, university collaboration, through to Scottish business investment in the region, there is a strong foundation on which Scottish HEIs can build.

Three thematic areas that may be prioritised in this region are as follows:

- Marine science
- Marine engineering
- Aquaculture

Two key industrial clusters are identified in the report, the Blue Silicon Valley and Qingdao West Coast New District, where dozens of marine-related national-level institutes are establishing campuses as Qingdao strengthens its reputation as the key zone for marine science in China.

Plans are also afoot to set up a state-of-the-art processing zone for marine functional food, marine drugs, marine cosmetics, and marine medical dressings within five years. Scottish universities with experience in advanced aquaculture could benefit from new opportunities arising in this region.

### Jiangsu

Jiangsu has been a key hub for Chinese economic development since the economic reforms, due to its location in the Yangtze River Delta. Jiangsu is home to world-leading multinationals in the fields of electronic equipment, biopharmaceuticals and textiles.

In recent years the Jiangsu government has made great effort in improving the current industrial base and welcomed the development of new industries. It is home to many development zones that aim to increase Jiangsu's foreign direct investment, domestic investment, international trade and technological cooperation and innovation.<sup>1</sup>

One such development zone is the Suzhou Innovation Park (SIP), and its Bio Bay initiative, which since its inception in 2007 has successfully established a full gene industrial chain, from gene testing services, gene diagnostic reagent and drug discovery to genetically engineered drug research.

Taizhou is a second Jiangsu city identified in the report with an industrial cluster of interest in this field: the China Medical City.

### Zhejiang

Zhoushan and Ningbo have been profiled as particularly dynamic and synergistic regions of Zhejiang for Scottish HEIs to consider.

The Zhoushan Marine Industry Cluster, for example, is one of 15 provincial clusters in Zhejiang province. By integrating Zhoushan marine science city and other surrounding islands, the cluster is focused on developing marine energy, port logistics, coastal and marine tourism, modern fisheries, aquatic product processing and marine biotechnology.

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<sup>1</sup> China.nlbassade.org

Several key universities are identified in this region, which, like Shandong, have significant expertise in marine sciences and engineering and great scope for working together with Scotland, as is already the case in several instances. The Scottish Aquaculture Innovation Centre (SAIC) should be of particular relevance here.

### ***South China – Guangdong, Fujian, Hunan***

A large economic base, South China's provinces of Guangdong, Fujian and Hunan cover a variety of broad sectors. However, a few priority thematic areas that have been identified are:

- Advanced materials and industrial design
- Environmental Protection
- New energy automobile
- Biopharmaceuticals
- Aquaculture
- Healthcare
- Big Data
- Robotics

#### Guangdong

In the Guangdong section, plans of a detailed provincial development plan outline the broad ambition for the region. Particular focus is given to opportunities in Life Sciences and Biopharma, before showcasing three potential models of collaboration including establishing Scottish spin-outs in China, a joint venture university or applying for joint funding for research projects with Chinese universities.

#### Hunan

For Hunan, the Changsha High-tech Zone is profiled as it is a key cluster in the region where their sectoral focus is on:

- Advanced equipment manufacturing
- Electronic and internet technology application
- New materials
- New energy
- Biopharmaceuticals and healthcare
- Modern service industry

#### Fujian

Universities and businesses in Fujian are particularly interested in developing aquaculture technology in relation to onshore salmon farming and believe Scottish universities could be of help introducing the relevant technology here. Other areas of interest include seaweed farming.

The elderly care sector is of strategic importance in Fujian. Companies are looking for research and development projects in dementia, specifically monitoring and wearable devices for patients. Scottish universities would have the opportunity to demonstrate their technology in this area at a high tech science park in Fujian that specialises in dementia research.

In regards to big data, specific opportunities are available for Scottish universities with strength in e-commerce infrastructure. Fujian province is looking to establish online platforms to facilitate its international seafood and beef trading and would seek international collaboration to assist them in doing so.

### ***Central and West China – Hubei, Shaanxi, Sichuan***

The central and western China section covers the provinces of Hubei, Shaanxi and Sichuan and includes the following thematic areas:

- Sensors and Imaging
- Optical communications
- Laser technology
- Consumer Electronics
- Integrated circuits
- Physics
- Life Sciences and Healthcare
- Crop research
- Creative Arts

#### Hubei

Wuhan in Hubei province is famous for its educational resources and high number of students. One of its industrial clusters, the Wuhan East Lake High-tech Development Zone, is profiled, and key opportunities have been identified in the first five of the above listed areas.

The region has already seen some very successful projects in the field of optoelectronics and optical communications, some already in collaboration with Scottish HEIs.

Several private sector companies working in these key areas are listed in the report and many Wuhan-based universities highlight their existing TNE and exchange opportunities.

#### Shaanxi

Another of China's education hubs – third only to Beijing and Shanghai nationwide, it's capital Xi'an boasts a plethora of HEIs in strategic industries.

In Shaanxi province there is a particular focus on sensors and photonics. The region has a base that works specifically on voltage sensitivity, thermal sensitivity and automobile electronics.

Shaanxi province is a good base for life science development. Currently, there are eight HEI's with life science disciplines and four research institutes for biological science. This is reflected in the Yangling Agricultural Hi-tech Industrial Demonstrative Zone, which is profiled in the report.

Based at Yangling, the Northwest Agriculture and Forestry University (NWFU) offers good synergies with Scotland's strength in crop research, soil and water science and is organising an event in November 2016 focused on precision agriculture and big data, at which a delegation from the UK will be present.

## Sichuan

The report centres on Chengdu and opportunities for Scottish HEIs in:

- big data
- healthcare
- life sciences
- Gaming and software development.

Regarding healthcare and life sciences, Chengdu is home to nearly 400 biomedical enterprises that cover various aspects of the industry, including modern applications for Traditional Chinese Medicine (TCM), synthetic drug production and pharmaceutical research. Many of these are located within the Chengdu Hi-tech Zone, some of which are listed in the report.

Various specific needs for new discoveries in oncology and cardiovascular drugs and synthetic pharmaceuticals are also listed as live opportunities for reference.

In Creative Industries, Sichuan has a long history in fine arts education, which continues to this day, but there is now a distinct focus on combining hi-tech industries with creative arts like gaming, animation and the performing arts. The Sichuan Film and Television University (SFU) is singled out as a particularly active player internationally, and a longer list of creative industry HEIs is also included, along with a series of major gaming houses.

There is an additional commentary on various models of cooperation open to Scottish universities interested in working together with Chinese companies to develop technology in 3D and interactive gaming and in Chinese investment in their research projects.

## Next Steps

As will be seen, many of the current macro-economic policies and operational trends outlined in Part I of this report are reflected in the focus of clusters and operation of HEIs discussed in Part II. In the context of where Scotland is strong itself, we see marine sciences, energy, aquaculture, and life sciences come up in several of the different provinces as priority sectors, reinforcing the case for Scottish HEIs and Innovation Centres in these areas to pursue links with China if they have not yet been established. The need for 'advanced/robotic equipment manufacturing' is another recurring theme in China as it seeks to optimise and modernise its manufacturing might, certain elements of which Scotland may be able to deliver.

Another underlying theme to much of the industrial upgrades is environmental concerns. Scotland's own experience of environmental protection should power a wealth of collaborations with China as they seek to address their own environmental issues to become a low-carbon, sustainable economy.

There are also countless niche opportunities for Scottish HEIs in digital healthcare, financial services, forestry, gaming and animation, to name but a few, and on which CBBC stands ready to support any individual institutions who may wish to explore them in any greater detail.

## **1. OVERVIEW OF KEY POLICIES**

The first steps towards a socially and economically appropriate Chinese higher education system began in 1986 with the implementation of the 'Provisional Regulations Concerning the Management of Institutions of Higher Learning' by the State Council, China's central administrative authority. These education regulations were a response to the 'Four Modernizations', a cornerstone of Premier Deng Xiaoping's reform policy launched in 1978, requiring great advances in agriculture, industry, defence, and science and technology.

The regulations initiated vast changes in administration and adjusted educational opportunity, direction, and content. With the increased independence accorded under the education reform, universities and colleges were able to choose their own teaching plans and curricula; to accept projects from or cooperate with other socialist establishments for scientific research and technical development in setting up "combines" involving teaching, scientific research, and production; to suggest appointments and removals of vice presidents and other staff members; to take charge of the distribution of capital construction investment and funds allocated by the state; and to be responsible for the development of international exchanges by using their own funds.

The impact of these initial regulations and policy development over the last 20 years has been to increase access to higher education. In this respect the regulations and policies have worked. The number of institutions has more than tripled from 900 in 1984 to over 2,800 in 2015, and annual enrolment has increased from 430,000 to over 7 million in the same period.

The problem with a focus on enrolment numbers has created problems. The first, unemployment of graduates, which in the first six months after graduation is generally believed to be around 30%, would tend to show over capacity yet further demand continues. The second is related to the quality and focus of teaching. The experience and level of education of teaching faculties has not kept pace with the rapid expansion and there tends to be an imbalance between courses undertaken and what existing industries demand and can absorb or what may stimulate entrepreneurship.

There are issues too with the structure of educational institutions. There has been a focus on the creation of a small number of 'world leading' universities which is a project still in development and has risked leaving others languishing in mediocrity.

Opportunities for overseas higher education institutions may initially lie in the drive to attract foreign lecturers and professors to fill faculty skills gaps. It would be natural for this to lead to joint syllabus and economic project development. The challenge will be identifying the suitable partner institute by subject, influence of the faculty, and reach which the Chinese university has beyond their own city or province.

### **The 13th Five-Year Plan and the National Innovation-Driven Development Strategy Outline**

In March 2016, the Central Committee of the Chinese Communist Party issued the 13th Five-Year Plan, which will run until 2020. As China's main national economic and social development plan, ambitious targets for the development of education and innovation are included. In May 2016, the Government published its first strategic movement as part of the 13th Five-Year Plan: the 'National Innovation-Driven Development Strategy Outline'. The Outline emphasises innovation in order to drive sustainable economic growth with a key focus on innovation in science and technology.

The Outline proposes a three-step strategic target. In the first step, by 2020, China will become an innovative country, creating a more optimized environment for innovation, making more complete policies and regulations encouraging innovation, more strict intellectual property protection, creating a value-oriented culture advocating innovation and entrepreneurship. In the second step, by 2030, China will be a forerunning innovation-oriented country. By then, China will lead the world in a number of strategic areas, and boast world leading academic institutions whose original output will boost scientific and technological development and the progress of human civilization. In the third step, by 2050, China will build the world's scientific and technological innovation powerhouse. By then, an innovative institutional environment, market and culture will have been optimized, respecting knowledge, advocating innovation, protection of intellectual property rights and tolerance and pluralism will have become a common concept of a value-oriented society.

Specific missions within the Outline include:

Intellectual Property Rights - improving the environment for the creation, application, protection and management structures

Emerging Technological Focus - Information networks; Smart green manufacturing; Modern agriculture; Energy; Environmental protection; Oceanic industries; Space industries; Health and other Service Industries.

The requirement for China's higher education sector is to stimulate mass innovation by producing graduates established in the latest technologies and equipped with a keen sense of entrepreneurial spirit.

#### **Education blueprint to the 13th Five year Plan**

The document entitled "Guidelines on Works in Opening Up the Education Sector in the New Era" and published in August 2016 further confirms China's international strategy on education with the main objectives as follows:

- focus on partnerships: Chinese HEIs and vocational colleges are strongly encouraged to partner with foreign institutions (including educational programmes and branch campuses overseas) and enterprise
- attract more international students to study in China
- boost the quality of international education provision

#### **'211', '985', 'C9'**

Since the 1990s the Chinese government has centred strategic planning, funding and preferential policies on certain academic disciplines, facilities and research projects, in selected universities. University projects which have been supported include; the '211 Project' the '985 Project', and the 'C9 League' (synonymous with Ivy League or Russell Group).

The '211 Project' was initiated in 1995 by China's Ministry of Education (MoE) with the intent of raising the research standards of high-level universities and cultivating strategies for socio-economic development. Approximately US\$2.2 billion was allocated during the first phase of the project, from 1996 to 2000.

China today has more than 117 institutions of higher education designated as '211 Project' institutions for having met certain scientific, technical, and human resources standards and offering advanced degree programmes. '211 Project' schools take on the responsibility of training four-fifths of doctoral students, two-thirds of graduate students, half of students from abroad and one-third of undergraduates. They offer 85% of the state's key subjects, hold 96 percent of the state's key laboratories, and utilize 70% of scientific research funding.

The name "211 Project" comes from an abbreviation of the 21st century and 100 – the approximate number of participating universities.

The '985 Project' was first announced by CPC General secretary and Chinese President Jiang Zemin at the 100<sup>th</sup> anniversary of Peking University on May 4<sup>th</sup>, 1998 to promote the development and reputation of the Chinese higher education system. The project involves both national and local governments allocating large amounts of funding to certain universities, in order to build new research centres, improve facilities, hold international conferences, attract world-renowned faculty and visiting scholars, and help Chinese faculty attend conferences abroad.

When first announced in 1998, the project funding was made available to an elite group of 9 universities. In 2009 these 9 universities were classified as the 'C9 League'. By the end of the second phase of the project, 39 universities were sponsored. In 2011 the project stopped accepting new universities.

The 'C9 League' includes: Fudan University; Harbin Institute of Technology; Nanjing University; Peking University; Shanghai Jiao Tong University; Tsinghua University; the University of Science and Technology of China; Xi'an Jiaotong University; and Zhejiang University. These institutions were selected as the first batch of the '985 Project'

In October 2015, the MoE announced that although a number of key universities and key disciplines had made significant progress and had led to a better level of quality within China's higher education, these projects had lacked competition and created duplication of effort. Therefore to strengthen the integration of resources to drive innovative from world-class universities these programmes would end and be replaced by the "World Class University and Discipline 2.0" or 'World Class 2.0' scheme.

### **'World Class 2.0'**

This scheme encourages China to improve teaching quality and innovation in higher education institutions. The aim is to establish a number of world-class universities and first-class disciplines over the coming three decades, in order to improve the strength and international competitiveness of China's higher education. The scheme aims to turn China into a powerful player in higher education and provides strong technical and intellectual support to enable its economic transformation.

It will concentrate on boosting the research base of China's top nine universities and aim to get six universities into the leading group of universities globally by 2020, with some of these institutions ranked among the top 15 in the world by 2030.

Whilst it reaffirms support to world-class universities and those that are already in the 985 and 211 programmes, unlike the previous programmes, World Class 2.0 will introduce competition and non-985 and 211 universities will be able to compete for funding if their academic disciplines or programmes meet top national standards.

World Class 2.0 also plans the establishment of hubs for international collaboration with overseas universities close to existing top university campuses to support the internationalisation drive that will ensure the best universities achieve world-class status. Outstanding young researchers and academic leaders will also be sent to study overseas to help speed up the development of world-class teaching practices in Chinese universities.

A number of cities and provinces, including Shanghai, Zhejiang and Guangdong, have started funded initiatives based on World Class 2.0.

Reforms in the plan ask Chinese universities to improve internal governance structures and performance management; accelerate talent training and collaborative science education; strengthen innovation and entrepreneurship education improve links with industry and research institutes; promote international exchanges and cooperation with world-class universities and academic institutions, to strengthen international collaboration and attract foreign students.

The scheme has been implemented this year and will be reviewed every five years, in line with the National Five-Year Plan. World Class 2.0 is highly relevant to overseas HEIs in the collaboration opportunities it provides across the internationalisation agenda.

### **Comprehensive reform of education**

High quality education and education equality are desired by both the general public and the government. In 2015, the Chinese government began a comprehensive reform of education, emphasising the importance of improving higher education quality at the national strategy level. These reforms were in conjunction with other national strategies and economic development needs.

In addition to setting a target for quality education, efforts are being made to promote higher education in Central and Western China in an attempt to narrow the gap between regions and between rural and urban areas. One aim is to transform 600 regional based undergraduate universities into higher vocational technical colleges or colleges of applied sciences, in order to produce more technically skilled and trained graduates to meet the demands in the job market.

According to the MoE, the 600 universities to be transformed as part of the initiative will be identified on a voluntary basis, rather than through selection. The Association of Universities (Colleges) of Applied Sciences was set up recently, under the guidance of the MoE. To date, 150 universities and colleges have joined the Association as members and all of them are willing to make the transformation. Tianjin University of Technology and Education, the leading university within the Association, is confident that more universities and colleges will join the Association in the near future.

### **Made in China: 2025 Strategy**

The manufacturing industry is at the core of China's economy, but is not yet at the highly advanced levels seen in other parts of the world. So China is implementing the Made in China 2025 Strategy (MIC 2025), which sets a clear ambition to become the world's manufacturing leader within the next 3 decades. The first aim is to form a number of multinationals and industrial clusters by 2025, so as to significantly enhance China's status internationally in both the industrial sector and the value chain.

Announced in May 2015, MIC 2025 advocates five basic policies in its overall implementation, including promoting a people-oriented and talent-developing philosophy throughout the process. This policy lays



the groundwork for the other four policies; encouraging innovation, improving the quality and efficiency of manufacturing, enforcing green manufacturing methods, and optimising the structure of China's manufacturing sector.

Without well-educated and adequately trained individuals, the necessary talent for the current progressive market will not be realised. Quality higher education factors into these specific national strategies, by bridging the gap between the training and development of those individuals who will fuel the innovation and efficiency desired for the future of the manufacturing industry.

For more information on MIC 2025 and which specific sectors are being targeted, please see the CBBC report on the topic [here](#).

### **The Belt and Road**

The Belt and Road (B&R) initiative refers to China's Silk Road Economic Belt and the 21st Century 'Maritime Silk Road' initiative, announced by the Chinese government in March 2015. To successfully move forward with B&R, there is a need to develop a strong talent base that is proficient in foreign languages, familiar with international law, embraces an international vision and has the capability to grasp opportunities and take a proactive attitude in the context of global competition. A 'Talent-Priority' strategy should become a priority for China.

Also relevant to higher education is the construction of disciplines within institutions, which match national target areas as mentioned in the B&R initiative. It covers a wide range of areas including; diplomacy, culture, security and economy. In relation to the economy, it could comprise sectors of infrastructure, energy and resources and finance.

The B&R framework includes an element focused on joint education programmes that has contributed to a growing network of more than 2,000 such links between Chinese and overseas institutions.

In response to B&R many higher education institutions have also established think tanks to analyse the initiative and to calculate their own response and offer guidance to local and regional government.

Whilst the B&R strategy is still at early stage, we can reasonably expect that it will lead to a significant increase in new ventures between Chinese universities and foreign partners. As with other major government policies, Scottish universities that frame their own projects in the context of B&R will often more readily win support from their Chinese counterparts.

For more information on B&R please see [here](#).

### **Development Strategies for Western Regions and the Rise of the Central Region**

Economic development in China's Western provinces has lagged significantly behind the coastal areas. Since 1949, the central government has been directing development programmes for China's Western regions and is determined that this strategy is key for China's continued growth. The national strategy covers a wide range of geographic areas and industries; 12 provinces, autonomous regions, municipalities and numerous sectors, which would acquire improvement opportunities through this programme.

Since a majority of these provinces have an underdeveloped education sector, the government has advocated developing the region's higher education sector while also encouraging universities and colleges across China to export talent in order to support progress in regional cities. The government has also issued a series of preferential and encouraging personnel policies towards higher education graduates who want to work in the Western regions.

In 2009, The Rise of the Central China Plan was released by the State Council. It sets out the clear goal of transforming central China into a production base for grain, energy and raw materials, equipment manufacturing and high technology, with additional focus on developing the region into a major transport hub. Six provinces are included in the central region plan; Shanxi, Anhui, Henan, Jiangxi, Hubei and Hunan. Each, based on their historic industrial development and transport links, has their own targets to prioritise alongside the wider industrial focus as mentioned above.

The key to success will be a three pronged approach to modernisation, innovation and education.

### **Revitalisation Strategy for the Northeast Industrial Base**

The Northeast is one of China's key industrial hubs and an essential base for heavy industry and agriculture. The region boasts rich natural resources, a group of major industries and good infrastructure. Talent, science and education in this region have great potential, however, recent international and national economic pressures have led to sluggish economic growth and the closure of some technically and management outdated businesses.

On 26th April 2016 the CPC Central Committee and the State Council released its Opinion on the Overall Revitalisation of the Old Industrial Base in the Northeast Region. It proposes that by 2020, the Northeast's economy will be maintaining a mid to high growth rate and should be synchronised with the national pace. From 2020 to 2030, plans are for the Northeast to be revitalised entirely and become one of the major economic supporting belts for the entire nation.

On 10<sup>th</sup> May 2016 the National Development & Reform Commission (NDRC) proposed a new, three-year rolling plan with some major projects designed for this strategy. According to NDRC, the objective is to help the region transform and develop its economy. The government will invest RMB 1.6 trillion centred on the three-year plan and 130 major projects related to infrastructure and other fields will be carried out.

### **Integration of Beijing-Tianjin-Hebei Regions**

On 30<sup>th</sup> April 2015, CPC Central Committee Political Bureau released the Beijing Tianjin Hebei Coordinated Development Plan. The plan is a major national strategy aiming to remove from Beijing certain functions that are not directly related to the capital city. It intends to make breakthroughs in key areas related to the coordination of each city's transportation systems, their ecology and environmental protection, industrial upgrades and to form a new growth pole in the region.

According to the Ministry of Finance's estimate and the current progress of this initiative, it is likely to inject RMB 42 trillion worth of investment into these regions over the next five years. The likelihood is that Beijing-Tianjin-Hebei will become a favoured region for investment capital.

The national strategy makes it clear that the region should further boost the advantages of traditional industries, while also promoting the service economy, knowledge economy and green economy. Strategic emerging industries such as aerospace, bio medicine, energy conservation and environmental protection

plus advanced manufacturing industries such as high-end equipment and ICT should all maintain a strong focus.

Higher education institutions in this region, especially provincial universities and colleges, should make an effort to partner and cooperate with those industries that have been identified as advantageous to the region. By working closely with these industries, university graduates can be trained with the skills needed to fill industry jobs as they continue to develop. Universities are the engine of economic growth and urban development and innovation. Through this strategy, Beijing, Tianjin and Hebei higher education institutions will further strengthen cooperation and coordinated development.

### **Yangtze River Economic Belt Development**

The Yangtze River Economic Belt is China's new strategy based on promoting regional openness and development. Once developed, it will be a fluvial economic belt with global reach, a synchronised development belt among the Eastern, Central and Western development regions, a comprehensive opening-up belt along the coast, river and regional border lines and a demonstration belt for ecological construction.

The Yangtze Belt covers 11 municipalities and provinces; Shanghai, Jiangsu, Zhejiang, Anhui, Jiangxi, Hubei, Hunan, Chongqing, Sichuan, Yunnan, Guizhou, encompassing a geographic area of 2 million km<sup>2</sup>. Though there are differences in economic level and standard of living in these provinces the total population of 40% of the whole of China also generates 40% of China's GDP.

In May 2015, based on the State Council's Yangtze River Economic Belt Integrated Three-dimensional Transport Corridor Plan (2014 - 2020), NDRC issued a budget plan for its construction; meaning a special budget from the central government has been granted for its development.

The Yangtze Belt region is one of China's most important industrial corridors with a cluster of the most developed modern industries. Located in the region are some significant industrial advantages in the steel, automobile, electronics and petrochemical industries; along with many other energy intensive and large capacity high-tech industries and large enterprises.

The Yangtze River Belt differs from other regions because of size (length and number of combined provinces) and economic disparity between east and west. It will be interesting to see how efficiently education institutes may operate across the breadth of the whole region.

## 2. STUDENT RECRUITMENT and MOBILITY

### Economic Drivers

China is well known as a country for household spending on education. A recent survey by the McKinsey Global Institute (MGI) published in April 2016 forecast that China's working age consumers (15 to 59 years) will grow by 20% - an additional 100 million people - and that their per capita consumption is expected to double.

As China's young people are spending more years in school and education spending is growing, China is expected to spend 12.5% of overall consumption growth on education between 2015 and 2030<sup>2</sup>.

CBBC discussed the regional differences and economic drivers in student mobility with the MoE.

Whilst the MoE does not have records on student mobility for each region in China, a white paper published in 2015 by New Oriental, a leading Chinese education institution, gives a more detailed picture of China's Study Abroad market. New Oriental researched 25 cities; Beijing, Tianjin, Shijiazhuang, Taiyuan, Qingdao, Jinan, Hefei, Nanjing, Shanghai, Xiamen, Hangzhou, Zhengzhou, Wuhan, Changsha, Guangzhou, Shenzhen, Shenyang, Harbin, Changchun, Kunming, Chengdu, Chongqing, Xi'an, Lanzhou and Urumchi, surveying students that were planning to study abroad. The majority of the 3,700 respondents were students in the East, North and Mid-South of China, indicating active study abroad activities in these three regions<sup>3</sup>.

New Oriental provides broad data on the study abroad market. However, in order for Scottish universities to target particular regions, a study of more detailed regional data is required.

The MoE and CBBC discussed the correlation between regional wealth levels and students travelling abroad. As Chinese families' disposable income rises, so does the possibility of increased interest in international education. Chinese families regard spending on education as an important element of their family finances. Scottish Universities wishing to assess potential growth areas in student mobility could analyse disposable income as an indicator of potential target areas.

The following charts on the next page illustrate per capita consumption expenditure, as well as historical and forward looking spending on education spending.

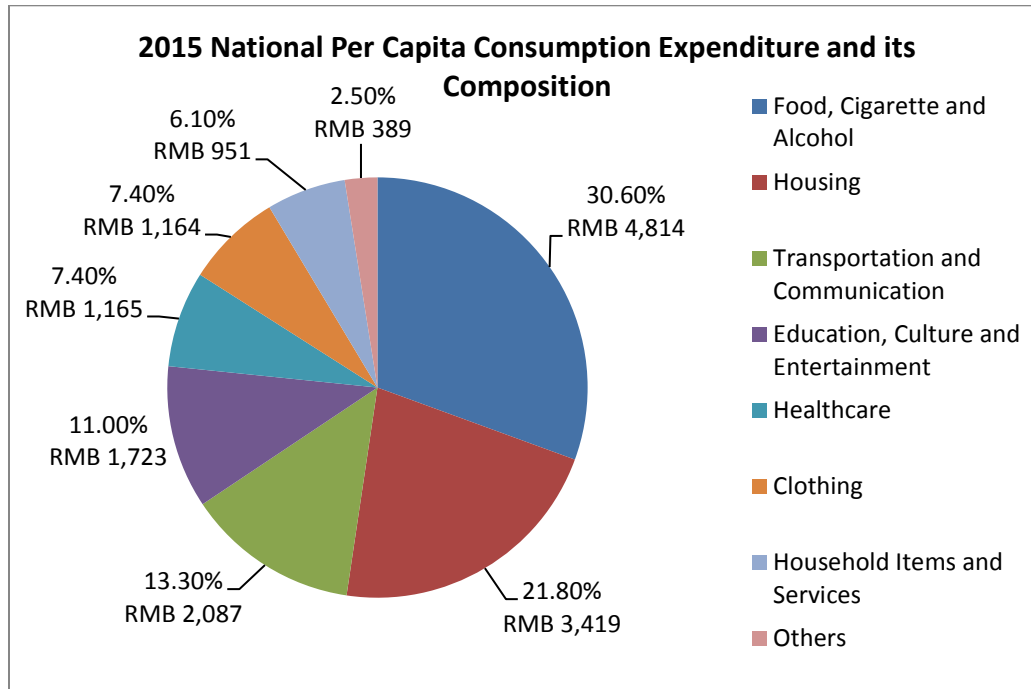
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<sup>2</sup> <http://www.mckinsey.com/global-themes/urbanization/urban-world-the-global-consumers-to-watch>

<sup>3</sup> <http://qoabroad.xdf.cn/201506/10294727.html>

The chart below shows that education, culture and entertainment is the fourth largest area of spending, after the essentials of food, housing, transport and communications. As the Chinese middle class grows, delivering educational opportunities for young Chinese will remain an important area of spending.

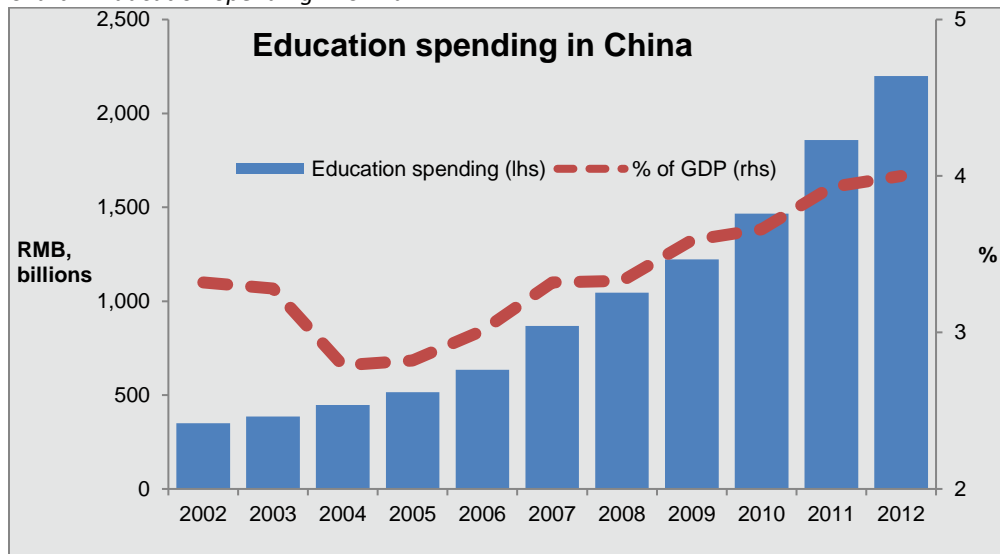
Chart 3: 2015 Per Capita Consumption Expenditure and Composition



Source: National Bureau of Statistics [http://www.stats.gov.cn/tjsj/zxfb/201602/t20160229\\_1323991.html](http://www.stats.gov.cn/tjsj/zxfb/201602/t20160229_1323991.html)

The following two charts show past and future trends in education spending in China. Scottish universities should be confident that, in general terms, Chinese expenditure in education will continue to grow.

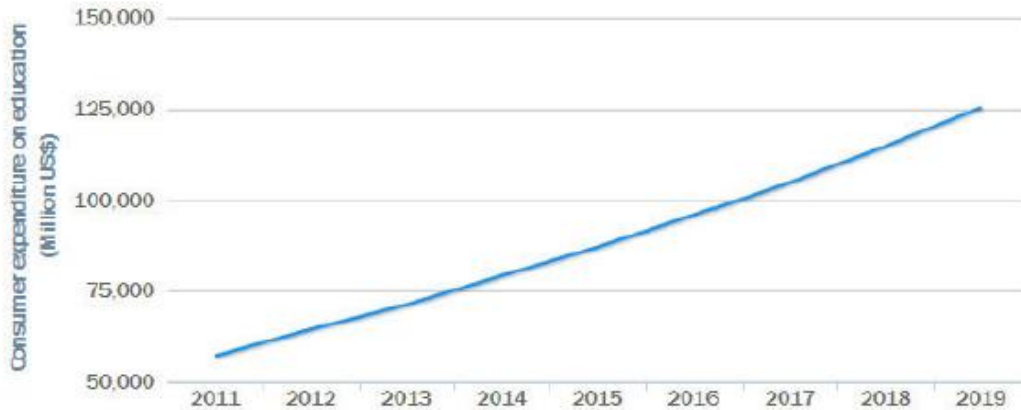
Chart 4: Education Spending in China



Source: British Council, Education UK Market Update

## Forecast for China Consumer Spending on Education

Chart 5: Forecast for Consumer Spending on Education in China



Source: Euromonitor

Source: *British Council Country Brief 2015*

Whilst current data forecast overall strong growth in education spending, competition both globally and domestically to get a share of that spending is also increasing.

Increase in the quality of teaching, greater investment in research in top Chinese universities and an increase in international joint institutes with leading international universities in China has resulted in an increased choice for parents and students in China's domestic education market.

As competition and consumer choice in China increases, Scottish universities must remain closer to the changing customer needs and focus on key growth niches that will give them the greatest return on their investment of time and costs.

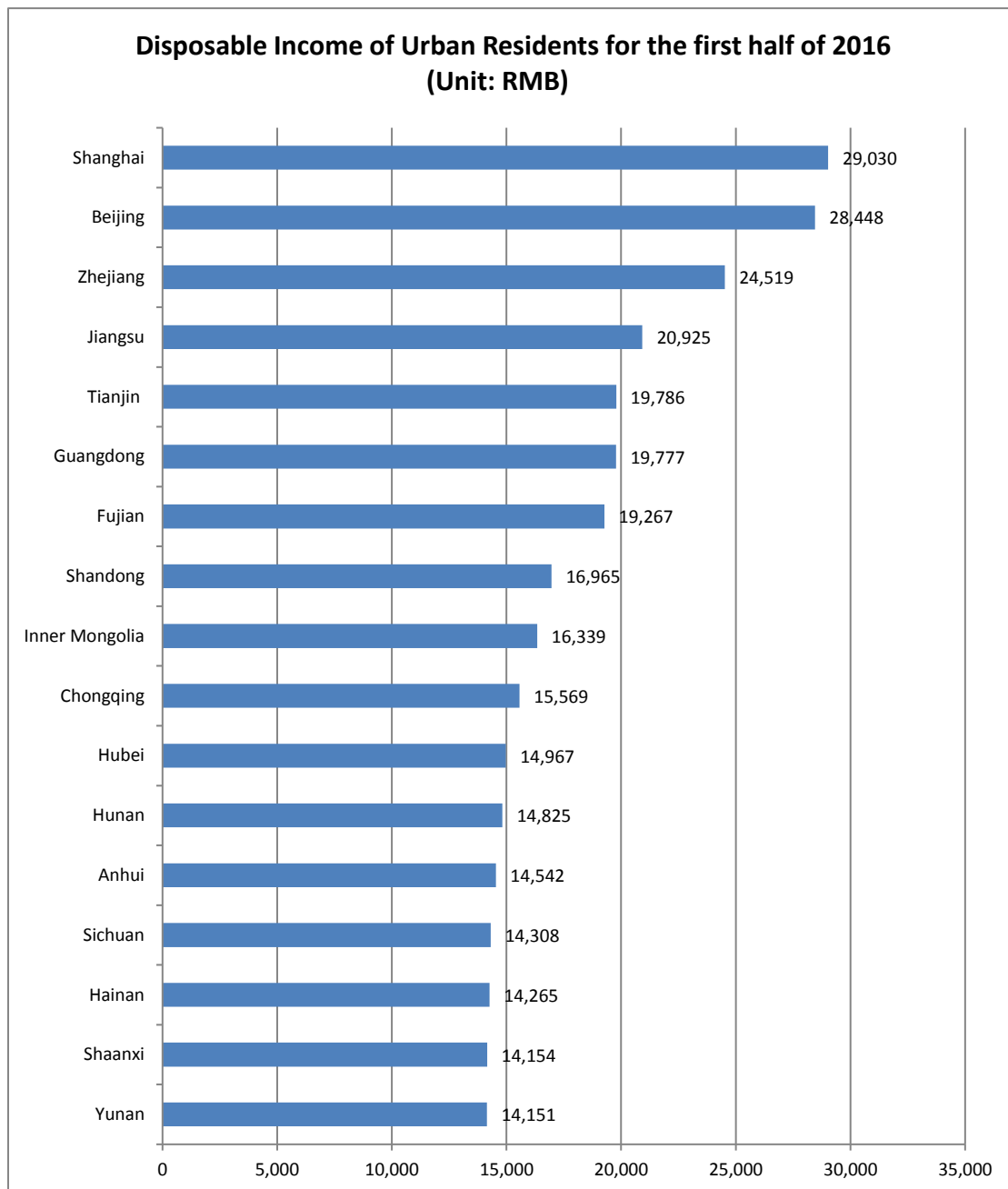
When assessing which regional niches to focus on for student mobility, Scottish universities could focus on regional disposable income levels. On 29<sup>th</sup> July 2016, all provincial bureaus of statistics, except Shanxi, Ningxia, Xinjiang, Tibet, Heilongjiang, Jilin and Liaoning, released data on disposable income for both urban and rural residents covering the first two quarters of 2016. The average disposable income for urban residents is RMB 16,957; while the average disposable income for rural residents is RMB 6,050.

Clearly, international education is a premium product and requires a certain level of funding on the part of the student and family. Scottish universities should therefore focus on the urban areas of China, which have higher disposable income levels. Scottish universities should also assess the level of domestic and international competition within these areas, comparative to their university ranking and specialist skills.

Shanghai, Beijing, Zhejiang, Jiangsu and Tianjin are the provinces and municipalities with the highest levels of disposable income. Scottish universities with the highest ranking levels, or that have a unique international education proposition, should focus on these areas.

Smaller Scottish institutions or universities that are relatively new to the market could benefit from the fact that China's educational market is vast and there will be opportunities to co-operate with the range of different Chinese institutions that aspire to developing their international proposition.

Chart 6: Disposable Income of Urban Residents January-June 2016



Source: <http://mt.sohu.com/20160729/n461719043.shtml>

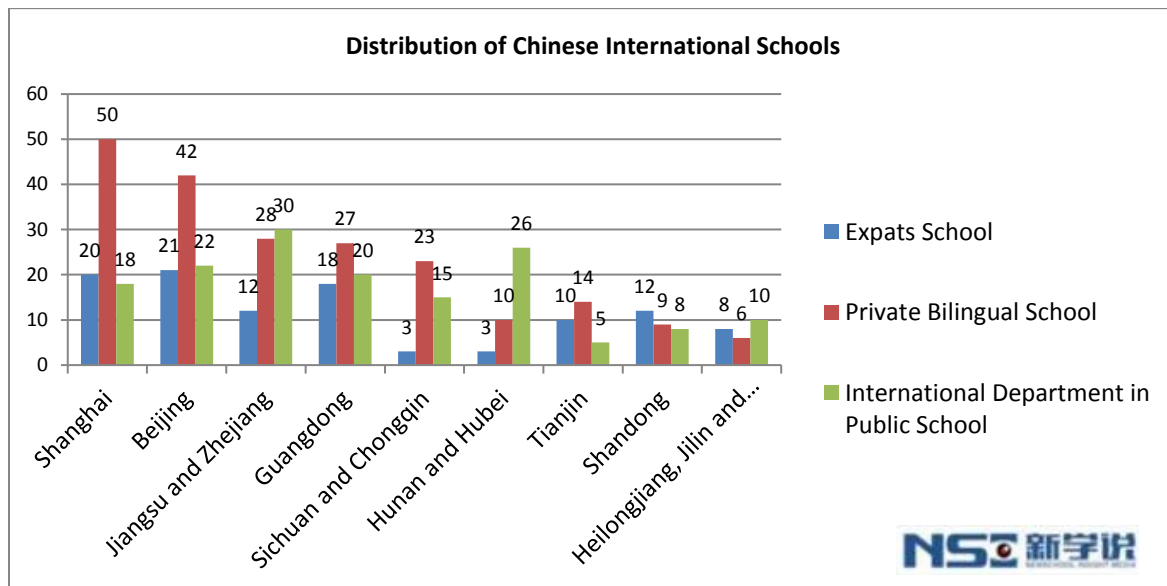
### Distribution of International Schools

One source of students that are preparing specifically for university abroad is that of international and bilingual schools. The bilingual schools market is currently a relatively small community of students. It covers schools in China that accommodate both international and Chinese students, preparing them for international qualifications such as A-level and IB.

Based on higher disposable income levels, however, the appeal of international education and the UK system of education is increasing. CBBC predicts the number of bilingual schools will increase over the next 5 to 10 years, providing a pipeline of Chinese students interested in studying abroad.

NSC's 2015 China International Schools Development report stated that at the end of 2015 there were 597 international schools in China which included; 116 expatriate schools, 225 international departments in Chinese public schools and 256 private bilingual schools. A representation of the distribution of these schools across China is presented below. According to this data, Shanghai, Beijing, Jiangsu, Zhejiang and Guangdong have the highest number of international schools.

Chart 7: Distribution of International Schools



Source: <http://toutiao.com/i6265041583368831490/>

Students studying an international curriculum at international and bilingual schools are not eligible to apply for further education at Chinese universities, as they would not have completed the Chinese exam system (Zhongkao, *Gaokao*). This means that most students graduating from international high schools will be looking to overseas institutions for higher education.

There is also a growing market for schools that offer the dual curriculum, where students prepare for both foreign (A-Level, IB) and China's Zhongkao and *Gaokao* examinations. These schools accept both expatriate children and PRC Nationals.

Over the next few years CBBC expects strength growth in international schools of different types (bilingual, dual curriculum and to a lesser extent international) in Tier 2 and 3 cities and would recommend that Scottish universities monitor the development of that market which may feed into their recruitment or even TNE strategy.

CBBC recently published a report on the China International Schools market which can be found [HERE](#)

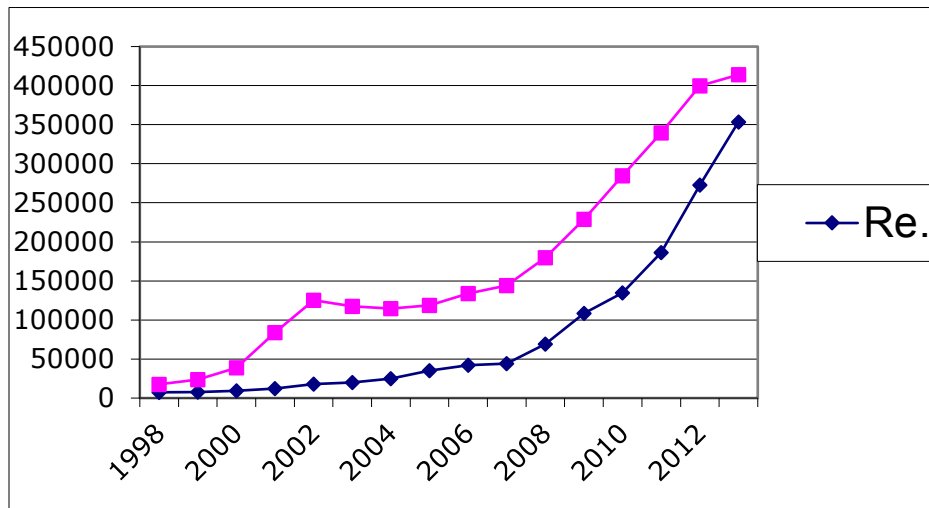


### Chinese students overseas

According to the MoE, in 2015, 523,700 Chinese studied overseas, an increase of 13.9% from 2014. This is the second consecutive year with growth levels below the 19.1% average annual growth over the past four decades.

409,100 returned to China from overseas study, some of them attracted by the prospects of the current job market in China. This represents an increase of 12.1% from 2014.<sup>4</sup>

Chart 1: Chinese students studying overseas and returning to China for work



Source: British Council, Education UK Market Update

### Distribution of Study Abroad Agencies

According to the 2015 Study Abroad Agency Survey (Individuals) published by the China Education Association for International Exchange, 84.85% of respondent's chose to use a study abroad agency when applying for schools overseas; the remaining 15.15% chose to do it on their own.<sup>5</sup> CBBC reviewed the location of study abroad agencies and identified the regions with the most study abroad agencies, which would suggest those areas also have higher demand for studying abroad.

In February 2016, study abroad agencies were recognised by the MoE in the following regions:<sup>6</sup>

- **East China** 135  
Shandong 96, Jiangsu 28, Anhui 5, Zhejiang 22, Fujian 25, Shanghai 16
- **North China** 127  
Beijing 78, Tianjin 21, Hebei 9, Shanxi 8, Inner Mongolia 11
- **Northeast China** 54  
Liaoning 28, Jilin 16, Heilongjiang 25
- **South China** 51  
Guangdong 39, Guangxi 7, Hainan 5

<sup>4</sup> <http://edu.sina.com.cn/a/2016-03-17/doc-ifxqnski7676550.shtml> and <http://monitor.icef.com/2016/04/a-record-number-of-chinese-students-abroad-in-2015-but-growth-is-slowing/>

<sup>5</sup> <http://liuxue.yjbys.com/news/196403.html>

<sup>6</sup> <http://www.jsj.edu.cn/n3/12075/147.shtml>

- **Northwest China** 44  
Ningxia 6, Xinjiang 13, Qinghai 1, Shaanxi 21, Gansu 3
- **Southwest China** 43  
Sichuan 11, Yunnan 5, Guizhou 1, Tibet 0, Chongqing 26
- **Central China** 41  
Hubei 12, Hunan 8, Henan 17, Jiangxi 4

### **Top Subjects Mainland Chinese Students Choose to Study Overseas**

According to research conducted by New Oriental, the top ten subjects that Chinese students choose to study are; business, engineering, science, computer science, communications, international relations, liberal arts, education, art and law.

Business, science and engineering and IT are the three most popular programmes of choice for Chinese students. However, subjects such as communications, international relations, art and design have been gaining in popularity.

According to New Oriental's survey, the top factors that Chinese students consider when choosing their subject are: personal interest (54%), employability (53%) and admission requirements (29%).

Scottish universities should focus on creating differentiating factors within these core subjects. For example, the market for business courses is saturated, but entrepreneurship and innovation within business are sub-themes that resonate with Chinese students and are considered desirable by future employers.

### **Why Chinese Students Choose to Study in the UK**

The main factor that Chinese students consider when choosing where to study abroad, is the ranking of the institution. According to New Oriental's survey, 51% of interviewees said they would hope to apply for some of the world's top 100 universities, 27% said they would consider applying for some of the world's top 200 universities, but only 14% said they don't consider ranking as a factor in their decision.

When discussing student recruitment in China it is impossible to avoid the ranking discussion and universities should not under-estimate its importance. However, not all students can go to the top universities. Smaller universities should focus on what differentiates them in terms of student experience, employability and subject areas that are of interest to students.

The UK is in a strong position with regards to its renowned academic excellence. UK schools, colleges and universities have a long history of innovation and an international reputation for quality and rigour and it remains the most popular destination after the US.

According to the Organisation for Economic Co-operation and Development (OECD), the UK is the first country in Europe to have achieved a sustainable system for financing higher education. The UK delivers high quality output in research and development and has strong ability in commercialising research. The World Economic Forum Global Competiveness Report placed the UK second in the world for university and business interaction. From 2003 to 2011, 40 university spin-offs were floated on the stock exchange with Initial Public Offering (IPO) value of GBP 1.79 billion and 25 others were acquired for over GBP 3 billion.<sup>7</sup>

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<sup>7</sup> HM Government: Industrial Strategy: government and industry in partnership

### **Why students choose Scotland**

According to the National Student Survey 2014, Scotland's universities have the highest rates of student satisfaction for quality of teaching in the UK. According to Research Excellence Framework (REF) 2014, all of Scotland's universities undertake world-leading research, with 86% of Scottish research judged to have "outstanding" or "very considerable" impact. According to ISB 2013, over 84% of international students recommend Scotland as a place to study, which is above the UK and global average.<sup>8</sup>

This is a core Scottish differentiator that should be fully leveraged from a marketing perspective.

### **Attracting more students to choose Scotland**

Managing the entire student lifecycle; recruitment, study experience in Scotland, employment and alumni networking is critical to the success of Scottish universities attracting Chinese students.

Leveraging its alumni network to highlight the excellence of the Scottish education experience is a powerful means of creating greater awareness in China. Social media such as WeChat is the most effective means of communicating core messages across China, but should not be perceived as a low cost one-off initiative. Marketing communications using social media need to be current, dynamic and interactive. Different strategies need to be adopted for key target groups including; partner universities, agencies, parents and students.

Scottish universities may consider whether they want to come together under a Scottish banner as well having their own individual communication. The Scottish brand already resonates well with Chinese consumers across many consumer segments including; education, tourism, food and drink. A co-ordinated social media strategy would allow Scottish universities of all sizes to create awareness of their programmes and core competencies.

As China produces more qualified graduates, the employment market for young Chinese is becoming more competitive and a qualification from overseas no longer guarantees a good job in China. The employability and entrepreneurship agenda is gaining in importance and the opportunity to engage in internships and entrepreneurial ventures is extremely attractive to Chinese students as they look to build their work experience. Scottish universities that can deliver as much practical work experience as possible within the national visa rules and regulations can gain a competitive edge.

Several universities and groups of universities are working in China to create employability and networking opportunities for Chinese alumni of international universities. Manchester Business School leverages its presence in China to effectively manage the alumni network, which provides value to their alumni and generates positive word-of-mouth for their courses. Some UK universities take advantage of CBBC's Launchpad service to manage recruitment, partner management, social media, corporate relations and alumni activity.

Other universities co-operate with equally ranked international education institutions to create employability and networking opportunities for their alumni. This reduces costs but still gives them the opportunity to stay connected with the university institution and create further opportunities for themselves.

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<sup>8</sup> Scottish Education Sector

## Demographics and provenance

The effect of the one-child policy and the rapid ageing of the population is affecting the number of *gaokao* (university exam) applications which has been in decline since 2008. In addition to changes in demographics, more students are also opting out of the *gaokao* to pursue other study or work opportunities in China or overseas where various international examination qualifications are accepted.<sup>9</sup>

At the same time the percentage of students who successfully passed the *gaokao* increased and reached 76% in 2014.

A combination of a flat or declining pool of applicants and an increased *gaokao* acceptance rate is changing the market in China from a “seller’s market” into a “buyer’s market” with institutions in China no longer able to fill their quotas<sup>10</sup>.

The chart below shows the number of higher education institutions in China by province. Jiangsu, Guangdong and Shandong have the largest number of established HEIs, reflecting a higher demand for tertiary education in these regions.

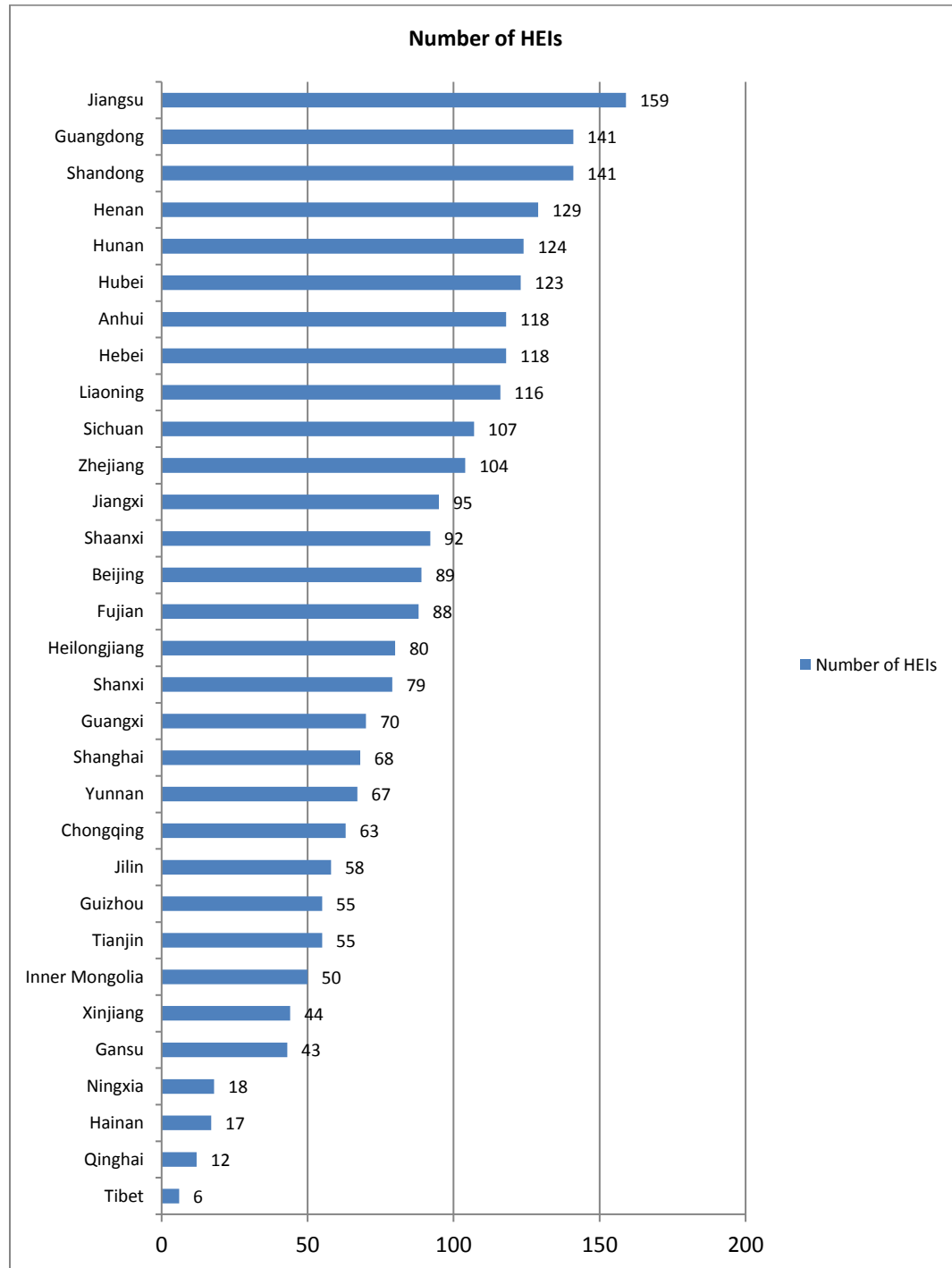
The data shows that East China (Jiangsu, Zhejiang and Shanghai), South China (Guangdong) and North China (Beijing, Tianjin, Liaoning) are densely populated with both physical universities and large talent pools of students. These areas of China remain comparatively wealthy and families here have higher levels of disposable income. Scottish universities should consider this as indicative of where to target their regional focus in China, bearing in mind that competition there is also strongest.

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<sup>9</sup> British Council China Report 2015

<sup>10</sup> <http://monitor.icef.com/2015/08/chinese-universities-increasingly-forced-to-compete-for-students/>

Chart 9: Number of Higher Education Institutions across Chinese regions



Source: <http://www.stats.gov.cn/tjsj/ndsj/2015/indexch.htm>

### 3. TRANSNATIONAL EDUCATION - TNE

TNE is often defined as ‘the provision of education for students based in a country other than the one in which the awarding institution is located’.

TNE programmes provide opportunities for Chinese students who may not have the means to travel abroad to still benefit from having international education credentials.

The UK is generally understood to have the highest volume of HE TNE activity of any country, and this is predicted to grow more quickly than international student recruitment to the UK.

The 2012 QAA review of transnational education in China found most of the TNE to be located geographically in the major urban centres of China's eastern seaboard: Beijing, Shanghai, Ningbo (Zhejiang province), Suzhou (Jiangsu province), and Guangzhou and Shenzhen (Guangdong province)<sup>11</sup>.

According to HESA data, in 2014/15 there were over 56 000 Chinese students studying UK Degrees wholly in China. Over 51 000 of those were studying for an undergraduate degree.<sup>12</sup>

A recent survey by WECD (Warwick Economics and Development) for HEGlobal shows that there are currently 92 TNE programmes in China offered by 16 UK HEIs<sup>13</sup>

Typically more undergraduates than postgraduates are registered. However, the postgraduate TNE market is increasing, particularly in Shanghai and Beijing where access to postgraduate education is more common and the desire to hold an international certificate is greater after completion of initial higher education study.

In the past few years there has been increased TNE activity in many new regions and cities and this trend is expected to continue, with new opportunities for universities who look beyond the traditional areas highlighted above.

Indeed, the recently published “Guidelines on Works in Opening up the Education Sector in the New Era”, the education blueprint to the 13<sup>th</sup> Five year Plan, encourages further cross-border partnerships between Chinese HEIs - and vocational colleges - and overseas partners.

The blueprint also states the intention to reform the programme approval and withdrawal and accreditation procedures for the country’s TNE programmes. However, at the time of writing, no specific timelines for these reforms have yet been released.

There will also likely be increased multi-country collaborations and an example of this is the recent agreement between the University of Sheffield, Nanjing University and Ohio State University whereby the three universities will hold summer programmes to support undergraduate engineering students to work together to innovate, create and commercialise their inventions.

The Ministry of Education in China acknowledges the additional benefits of TNE education to Chinese students. Those students from regional cities that cannot attend the top Chinese universities can instead

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<sup>11</sup> <http://www.qaa.ac.uk/reviews-and-reports/how-we-review-higher-education/review-of-overseas-provision/review-of-transnational-education-in-mainland-china-2012>

<sup>12</sup> <http://institutions.ukcisa.org.uk//info-for-universities-colleges--schools/policy-research--statistics/research--statistics/international-students-in-uk-he/>

<sup>13</sup> Source: WECD, 2014/15 TNE Survey and The Scale and Scope of UK Higher Education Transnational Education available at: <http://heglobal.international.ac.uk/resources/reports-and-publications/the-scale-and-scope-of-uk-higher-education-transnational-education.aspx>

obtain a dual degree or gain international experience through these programmes, increasing their chance for personal development and employability.

Reinforcing their already close collaboration on TNE, the UK and China agreed on principles for the delivery of TNE during the first ever UK-China Education Policy Week in Beijing in March 2016.

The principles include developing regular channels of communication to support sharing of data and information, exploring ways to enhance inter-agency cooperation, and recognising the importance of sharing best practice and experience.

A summary can be found [here](#).

### **Existing TNE models**

It can be challenging to capture the full spectrum of activities being covered by TNE but are traditionally understood to include:

Distance learning; International branch campuses; Partnerships that include franchises and validated centres.

Some models such as branch campuses and distance education programmes provide a greater level of independence whilst other forms of partnerships such as twinning programmes, joint/double/multiple/degree programmes, joint institutes or colleges, co-founded university (bi-national university) and locally supported distance education programme are much more collaborative in their nature.

### **Higher Education Joint Venture Model**

With respect to joint degree programmes there are three main ways the collaborations can be structured.

The joint venture (JV) model typically sees institutions in both countries co-delivering educational programmes in China, with possible opportunity for partial study in the country where the partner university is located. Some of the models currently used do not require the overseas institution to establish a legal entity in China whilst the third model does.

The tables in the following page summarise the current models of operation as well as processes and partners' responsibilities.

The following table provided by Pinsent Masons summarises these current models.

Type of JV	JV Programme	JV Institution		JV Institution
	(non legal entity)	(non legal entity)		(legal entity)
<b>Factor</b>	Not registrable	Not registered	Registered	Must be registered
<b>Term</b>	Normally 3 years	May be up to 50 years but many are 20 or 30 years		Normally 50 years
<b>Capital injection</b>	No requirement by law	No strict requirement in practice	Required to be sufficient for running the institution and the capital injection in cash or kind will be owned by the JV	
	Usually rely on the Chinese partner's facilities			
<b>Minimum number of major courses required</b>	No requirement	Three		
<b>Major formation documents</b>	JV Collaboration Agreement	JV Contract	JV Contract	
		Articles of Association	Articles of Association	
			Documents verifying payment of capital	
<b>Management</b>	Mainly run by the Chinese partner	Joint management committee appointed by the JV partners		Council or Board of directors appointed by the JV partners
<b>Name of JV</b>	Named after the Chinese partner without registration		Own name registered	
<b>Own bank account</b>	No		Yes	
<b>Collect tuition fees</b>	Only by the Chinese partner		JV may collect tuition directly	
<b>Degree / Diploma</b>	Could be either or both of the JV partners', but cannot be a degree/diploma of the JV itself			The JV may issue its own degree/diploma in due course

Courtesy of Pinsent Masons

The table below further outlines some of the main processes and responsibilities of each partner when undertaking a joint venture model of higher education.

	Features	Cooperative Model	Degree-Granting Institution	Quantity	Typical Case			
Joint venture University	<ul style="list-style-type: none"> <li>Sino-foreign joint venture independent legal entity</li> <li>Minimum investment amount of RMB 1.5 billion</li> <li>Usually provides a relatively comprehensive and professional program</li> </ul>	<ul style="list-style-type: none"> <li>In order to ensure effective implementation, the Chinese and foreign parties often contribute shared resources</li> <li>The Chinese side is responsible for the following: <ul style="list-style-type: none"> <li>-Teaching venues and facilities</li> <li>-Administrative approval and registration</li> <li>-Admissions and publicity</li> </ul> </li> <li>The foreign-side is responsible for the following: <ul style="list-style-type: none"> <li>-Curriculum design, length of courses, and content</li> <li>-Experts and teachers</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Graduates meeting the degree requirements are conferred a diploma from the Chinese Ministry of Education</li> <li>-By participating in study abroad or other relevant curriculum, graduates may obtain a diploma issued by the foreign educational institution</li> </ul>	<ul style="list-style-type: none"> <li>3</li> </ul>	<ul style="list-style-type: none"> <li>Xi'an Jiaotong-Liverpool University</li> <li>New York University Shanghai</li> <li>University of Nottingham Ningbo</li> </ul>			
Cooperating Institute	<ul style="list-style-type: none"> <li>Usually under the jurisdiction of a Chinese university's independent institute</li> <li>The joint venture college does not have a separate legal status and must accept the administrative and other jurisdiction requirements of the affiliated university</li> </ul>					<ul style="list-style-type: none"> <li>Fulfill the foreign institution's master's degree requirements</li> <li>The Chinese side generally does not award the graduate with a master's degree. It may reward a graduate certificate or no certificate at all</li> </ul>	<ul style="list-style-type: none"> <li>Approx. 50</li> </ul>	<ul style="list-style-type: none"> <li>Jiangnan University and Lamston College</li> </ul>
Professional Cooperation Project	<ul style="list-style-type: none"> <li>Sino-foreign cooperation is limited to the relevant program, professional cooperation, and exchange of resources</li> </ul>							

Source: Deloitte Reflections on Education and Technological Development in China



Levels of support are also determined by popularity of the subject matter of programmes. China already has an abundance of TNE programmes established in engineering, finance, management, marketing, international trade and business related courses.

It is now much more difficult for programmes in these subject areas to gain approval. Instead collaborations are encouraged in new and niche areas where there is demand in China and where overseas institutions have special expertise.

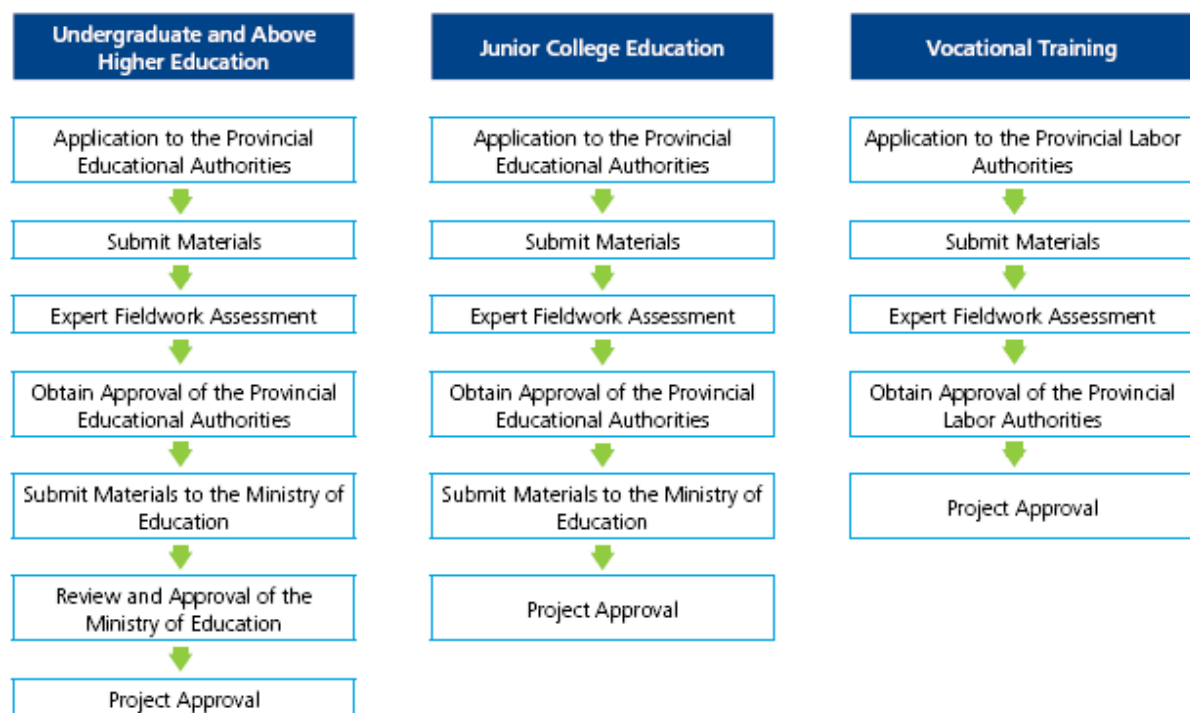
Whilst the ranking of the foreign university will be an important factor in gaining approval, recognised expertise in the subject area will also matter.

Regional opportunities: MoE is encouraging TNE programmes as a priority in West China and Northeast China. This is in line with the Northeast China Development Plan 2030, and the West China Development Strategy<sup>14</sup> Scottish universities seeking cooperation with institutions in these areas may be more likely to gain government support.

#### Joint Programme Collaboration Process

The diagram below illustrates the typical process HEIs must go through to comply with Chinese regulations for establishing joint programme collaboration. Submissions for approval take place twice a year, in spring and autumn.

Chart 12: HEI Processes



Source: Deloitte Reflections on Education and Technological Development in China

<sup>14</sup> <http://news.qq.com/a/20160427/003968.htm>

**Arts - A specific opportunity for collaboration on qualifications**

MoE has expressed a significant interest and need in terms of UK qualifications in the arts. In particular, to offer the internationally recognised Associated Board of the Royal Schools of Music (ABRSM), which is offered in partnership with the Royal Schools of Music in the UK including the Royal Conservatoire of Scotland. MoE wants to use UK international qualifications in the arts as a benchmark for Chinese qualifications, so they can improve China's level in the arts and music. Their end goal is to improve Chinese arts qualifications to the extent that they become internationally recognised to assist their students' application and acceptance into top schools for performing arts.

**Appendix 1 provides a list of current TNE collaborations by top Chinese institutions (the "985" group) with overseas universities.**

#### 4. OTHER TEACHING PROGRAMMES - CPD

##### **Pre-College and Summer School**

This model is designed to cater for students with a lower level of English language proficiency and allows them to improve their level prior to entering higher education. Generally, students will spend a year studying at a Chinese university and then go on to apply to international universities that partner with the Chinese institution.

There is growing popularity for short, summer school type programmes that prepare students for an international education. There are opportunities for Scottish universities to develop such programmes for Chinese students with international aspirations.

##### **Massive Open Online Courses (MOOC)**

The concept of MOOC was developed ten years ago and in the last two years has seen rapid growth of new platforms based in the US, UK and China.

Some UK and Chinese universities, such as the Shanghai International Studies University (SISU), have chosen to invest in MOOCs as a means of increasing brand profile and student recruitment. Other universities have made a strategic decision not to pursue MOOCs, because of the considerable amount of time and cost required to deliver a high quality MOOC.

It is widely acknowledged that MOOCs will not replace traditional teaching methodology. However, the advantage of MOOCs is the ability to reach a wider range of students in China's regional cities, to create greater awareness of the university brand or to compliment traditional teaching. As the technology develops, there may be further opportunities to use MOOC in the corporate space for executive education. The UK Futurelearn platform looks for technological advancement in MOOCs and aims to create bespoke groups within the platform.

MOOCs will not completely change the face of education in China, but remain an important technological development that Scottish universities could leverage for brand building, student recruitment across the country and to complement traditional teaching methods

## Continuing Professional Development in China

The development of the China market into a modern, more open and international environment creates both opportunities and challenges for HR, training and continuous professional development (CPD) professionals. UK training and qualifications institutes and universities are exploring opportunities in CPD in China. The opportunities are broad ranging and success will be in developing a proposition that fulfils the talent gap within specific clusters and subject areas.

CBBC spoke to the Institute of Engineering and Technology (The IET) in Beijing to discuss its approach to the China market. IET focuses its attention on the National Professional Technical Knowledge Update Project as a roadmap and is focused on specific clusters where there may be a talent gap or a specific need for its services. CBBC also discussed CPD opportunities with the Institute of Chartered Accountants of England and Wales, who are building wider links with both UK and Chinese universities and businesses in key target regions to promote CPD and lifelong learning.

## Government policies and regulations regarding CPD in China

### **National Professional and Technical Knowledge Update Project<sup>15</sup>**

In 2011, the Chinese government launched the National Professional and Technical Knowledge Update Project (“the Project”) in light of China’s Medium and Long-Term Talent Development Plan (2010-2020). The project aims to foster a number of high-level, in-demand technical professionals majoring in key areas to promote economic and social development.

#### *Objectives of the Project*

- Focus on 12 key sectors:
  - Equipment manufacturing
  - IT
  - Biotechnology
  - Advanced materials
  - Ocean and maritime science
  - Accounting and finance
  - Environment and ecology
  - Energy and resources
  - Disaster prevention and mitigation
  - Modern transportation
  - Agriculture science
  - Social work

The project will hold 200 seminars at the national level per year, with a target number of 10,000 participants based on these sectors.

- Education and training:
  - 1 million high-level and in-demand technical professionals per year.
  - Training programmes will provide training in 12 key sectors and nine service industries including; modern logistics, e-commerce, law, consultancy, accounting, industrial design,

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<sup>15</sup> <http://www.zsgxgc.gov.cn/zsgx/htmlDocument/category12327/index.html>

- intellectual property right, food safety and tourism with a target number of 800,000 participants per year.
- On-the-job training is also provided to 190,000 participants per year.
- National Continuing Education Bases for Technical Professionals
  - Establishing 200 National Continuing Education Bases for Technical Professionals by the end of 2020, with support and resources from existing educational institutions including higher education institutes, research institutes and large companies.
  - It aims to provide training and materials with professional support from experts, database development, online learning platform building services, carrying out scientific research and emphasising transferring the research results to teaching resources.

As of August 2016, 120 Continuing Education Bases have been established.

#### **Regulation on Continuing Education for Technical Professionals<sup>16</sup>**

On August 3<sup>rd</sup> 2015, China's Ministry of Human Resources and Social Security released the *Regulation on Continuing Education for Technical Professionals*. The provision further explains content and method of continuing education for technical professionals.

Article 21 states that local human resources and social security administration offices at township level or above can build regional or industrial continuing education bases. This will allow for opportunities for joint collaboration on training at local level. .

#### **Recent trends in the CPD market**

According to the 2015 Statistical Bulletin of Ministry of Human Resources and Social Security of China<sup>17</sup>, the National Professional and Technical Knowledge Update Project has been promoted further:

- In 2015, a total of 300 seminars were held, training 21,000 technical professionals.
- In 2015, on-the-job training and training programs for in-demand talent were provided for 1.17 million people.
- In 2015, 20 Continuing Education Bases were built, bringing the total number of established bases in 2015 to 100.
- 400 participants from Xinjiang and 120 participants from Tibet were given special training in 2015.

#### **How international universities are approaching the CPD market in China**

There are various training programmes in China, run in collaboration with international universities in continuing education. These programmes mainly focus on language training and training in basic subjects, aimed at facilitating the needs of people who want to study overseas.<sup>18</sup>

In terms of continuing professional education, international cooperation normally occurs in management sciences and professional certificate areas such as healthcare management certificates, IP management certificates, PMI, CFO and ACCA. International universities can work with professional associations to approach the CPD market in China, including the Institution of Engineering and Technology (IET).

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<sup>16</sup> [http://www.gov.cn/xinwen/2015-08/23/content\\_2918264.htm](http://www.gov.cn/xinwen/2015-08/23/content_2918264.htm)

<sup>17</sup> [http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201605/t20160530\\_240967.html](http://www.mohrss.gov.cn/SYrlzyhshbzb/dongtaixinwen/buneiyaowen/201605/t20160530_240967.html)

<sup>18</sup> <http://www.docin.com/p-1446277988.html>

IET specialises in offering academic accreditation. It works closely with various universities to help organise accreditation advisory visits, which allow courses and qualifications offered by the universities to reach an international standard that is valid for a number of years. IET also helps international universities in China through professional registration. This involves various workshops and training for faculty that maps the programme content against gaps in engineering education. For the regular training and professional development of the faculty, it provides an international benchmark as the standard to achieve and aims to increase both the individual's and the university's credibility.

IET advises that Scottish universities look at the situations at policy level in order to best survey what government initiatives are currently promoted in what area, in order to effectively maximize chances of approval on proposing CPD programmes. Scottish universities should also identify where the employability and skills gaps are at local levels and move forward from there when discussing what programmes to develop.

### **Popular sectors in the CPD market**

Based on the analysis of training programmes and expert resources on the National Continuing Education Public Service Platform (<http://caceeorg.chinahrt.com/>), the current focus is mainly given to the following sectors:

- Electric Power - engineering
- E-commerce - IT
- Hydroelectric - engineering
- Agriculture - engineering
- Construction - engineering
- Biochemistry – life sciences

According to the IET, the main themes within CPD in engineering centre around five main areas; energy, transport, telecoms, electricity and engineering. These areas are also seeing growing research interest, development and investment. Since these areas are so broad, the IET identified that within them, the specialities of renewable energy, railway and intelligent automobiles and 5G were the respective focal points of development.

Across these themes, the common thread is that there are contrasting levels of skills and demand. Universities need to identify partners in niche areas where there is considerable change, usually driven by government policy or market drivers. Within this niche, Scottish universities should look at recruitment trends and skills shortages in these areas and identify where CPD can be most successfully implemented.

Many of these themes also have a strong geographic distinguisher whereby certain Chinese regions are particularly well equipped to encourage continued development. IET gave Chongqing as an example of an automotive hub with a particular focus on intelligent vehicles and Wuhan for specialisation in optics and biometric image processing. Universities should identify particular regional cities that are gaining specialised focus on sectors that they also have strength in.

Scottish CPD departments may also wish to analyse which existing partnerships their university has in China and build, where possible, on these existing relationships rather than start from scratch. A strong existing long-term partnership between the Scottish and Chinese education institution would allow CPD professionals to build trusted China networks more quickly and allow them to identify niche areas in which they can develop a strong CPD proposition within a specific sector niche.

## 5. R&D AND INNOVATION

CBBC believes that as innovation becomes increasingly central to China's means of solving current and future challenges, this is an area that presents substantial opportunities and where Scottish universities will be able to build on their existing collaborations to develop new activities in R&D but also in the commercialisation of research.

This section offers an introduction to the major new policies on innovation in China that will guide Chinese members of the innovation ecosystem: universities and their academic researchers, research centres, science parks, incubators, industry & businesses, private and funding bodies, and government. An explanation to where we think the overall opportunity for collaboration is and why will be presented. The regional part of the report which follows in Section 6 will highlight regional thematic opportunities.

### China's Innovation-driven Development Strategy

#### The Innovation Imperative

In recent decades the Chinese economy has undergone unprecedented economic development and ranks now second after the US. The first phase of this rapid economic growth was achieved by a combination of a huge manufacturing capacity and low production costs. Since the beginning of the new millennium the Chinese government's aim has been to move from "made in China" to "created and designed in China". In the past couple of years this transition has started to gain momentum as China has entered into what is commonly termed 'the New Normal'. The country is shifting from an investment and export led model to one driven by innovation and consumption.

To achieve its goal to double the country's GDP from 2010 level by 2020, the Chinese government forecasts that GDP growth between 2016 and 2020 will need to be maintained at 6.5%-7% and that by 2020, 60% of this will be achieved through scientific and technological progress up from the current 55.1%.

Innovation has clearly been placed at the centre of China's overall development strategy and is seen as the primary driver for growth. This is reflected in the 13<sup>th</sup> Five Year Plan which has innovation as its first core tenet.

In addition, in May 2016 the State Council published the Innovation Driven Development Strategy with the following main objectives:

1. By 2020 to join the world's top innovative nations
2. By 2030 to become a leading country in innovation
3. By 2050 to become a strong global leader and international hub of science and innovation

Key points in the plan include:

- R&D investment:

In 2015, China spent 2.1% of its GDP on R&D (i.e. RMB 1.42 trillion - approx. £150bn). It plans to increase it to 2.5% of GDP in 2020 (this would mean over RMB 2.3 trillion if GDP grows at 6.5%-7%, representing over 60% increase against 2015).

Between 2020 and 2030 the investment in R&D is planned to increase further to 2.8% of GDP.

However the plan also mentions that the focus of resource allocation will move away from R&D to industry, innovation and finance chains.

- Significantly improve indigenous innovation capacity
- The development of a national innovation eco-system where enterprises, research institutes, universities and social organisations will have clearly defined functions.

- The plan mentions improved global cooperation
- Improved measures to motivate researchers will include more flexible management funds, higher rewards and strengthened protection of intellectual property
- 10 Sector priorities:
  - The next generation of IT network technologies
  - Green, intelligent manufacturing technologies
  - Eco-friendly, safe and effective agricultural technologies
  - Secure, clean and efficient energy technologies
  - Environmental protection technologies
  - Advanced marine and space technologies
  - Smart cities and digital technologies
  - Safe and effective healthcare technologies
  - Technologies for modern services
  - Disruptive technologies

Further details on these 10 priorities are available in Appendix 4.

### 13th Five Year Plan on National Scientific and Technological Innovation

CBBC discussed with MoST the 13<sup>th</sup> Five Year Plan on National Scientific and Technological Innovation which is one of the plans for the implementation of the National Innovation-driven Development Strategy and sets out their aims and expectations for the future of research and innovation in China.<sup>19</sup> MoST will be the key in carrying out the projects outlined in the plan.

A number of these projects are related to sector areas in which Scotland has comparable strengths. As part of the Science and Technology Innovation 2030 plan, six major projects have been identified by the State Council; development of aircraft engines and gas turbines, deep space stations, quantum communications and computer science, brain science and research, national cyber security and deep space exploration, orbit service and maintenance systems.

Additionally, nine major programmes cover independent innovation on; plant species, efficient use of coal, smart grids, heaven and earth integrated information network, big data, intelligent manufacturing and robotics, materials development and application, Beijing, Tianjin and Hebei environmental treatment and health insurance, as areas for continued focus and development across China.

Other highlighted thematic areas:

*Table 2: Highlighted Thematic areas*

Thematic Area	Specific Aspects
<b>Modern agricultural technology</b>	Marine farming and freshwater fisheries innovation Safety and welfare of livestock and poultry Breeding and grazing industry

<sup>19</sup> [http://www.gov.cn/zhengce/content/2016-08/08/content\\_5098072.htm](http://www.gov.cn/zhengce/content/2016-08/08/content_5098072.htm)



	<p>Agricultural bio manufacturing Agricultural equipment and facilities Agricultural intelligence</p>
<b>New generation of information technology</b>	<p>High performance computing Cloud computing Artificial intelligence Broadband communications and new networks Virtual reality and augmented reality Smart cities</p>
<b>Advanced manufacturing technologies</b>	<p>R &amp; D on key manufacturing equipment for Micro Electro Mechanical System (MEMS) sensors and industrial sensors Technology research on core parts of industrial sensors, intelligent instrument, integration and application of sensors Strengthen application of industrial sensor technology, in intelligent manufacturing system's construction, and enhance technology innovation capability of industrial sensor</p>
<b>Clean and efficient energy technologies</b>	<p>Renewable energy and hydrogen energy technology Nuclear safety and the advanced nuclear energy Smart grid Building energy saving</p>
<b>Modern transportation technology and equipment</b>	<p>Marine transport Air transport technology and equipment Integrated transportation Intelligent transportation</p>
<b>Modern food manufacturing technology</b>	<p>Processing and manufacturing Mechanical equipment Quality and safety Fresh keeping logistics Nutrition and health</p>
<b>Resource efficient recycling technologies</b>	<p>Oil and gas and unconventional oil and gas resources development</p>
<b>Population health technology</b>	<p>Major disease prevention and control Digital medical equipment Drug quality and safety Modernisation of traditional Chinese medicine</p>
<b>Development and utilisation of marine resources</b>	<p>Deep-sea exploration Marine environmental security Sustainable development and utilisation of marine biological resources Desalination and comprehensive utilisation of large-scale marine engineering equipment</p>
<b>Space exploration, development and utilisation of technology</b>	<p>Earth observation and navigation New spacecraft</p>

### **International Co-operation**

The report also maps areas in which it is specifically looking for international co-operation in science and technology innovation which focuses on the two-way flow of scientific and technological resources and opening up of China's research areas.

- Agriculture and rural development
- Urbanisation and urban development
- Clean energy and renewable energy
- New generation of electronic information and network technology
- Earth observation and navigation
- New materials and advanced manufacturing
- Transportation, resources and environment
- Biology technology
- Marine and polar
- Population and health

Additional goals are to promote the introduction of technology and equipment in the fields of environmental protection, weather prediction, germplasm resources, and solve the major, core and key technical problems.

### **The opportunity for UK-China and Scotland-China collaboration on innovation**

There are a number of reasons why there is ground to believe that is a time of opportunity to deepen collaborations with China in innovation, they are as follows:

- The UK is widely recognised as “punching above its weight” in research and innovation
- It is widely accepted that there is a greater need for countries to work together in research and innovation in order to meet today's and tomorrow's global challenges and this was stressed at the September G20 meeting in Hangzhou
- Talent: China offers a huge pool of well qualified graduates, many of which have acquired a global outlook through period of studies overseas
- Capacity: China has been building facilities to support first class R&D and innovation activities.
- Funding: there is increasing public and private financial support and investment available to commercialise technology
- Increased appetite in early stage technology. Recently there is increased interest in China to look at early stage technology in order to develop these for the China market and for other markets
- Consumers in China are currently more accepting of a technology that may require further adaptations and willing to give their feedback and input for further development. This can provide two advantages, allowing the product to be brought to market more rapidly and to be adapted to fit the exact demand of the market

This opportunity for collaboration was recognised and highlighted during the recent ministerial visit to Shanghai in September 2016:

The UK-China GREAT Innovation Showcase and Pujiang Innovation Forum which took place 23rd-25th September 2016 was attended by the UK's Minister for Universities, Science, Research and Innovation Jo Johnson.

The importance of the UK-China Research and Innovation Partnership Fund, also known as the Newton Fund and set up in 2014, was highlighted. The UK has committed £200m across 37 joint programmes and supported over 220 partnerships and a variety of themes, including healthcare, urbanisation, a changing climate, food, energy, and water, smart cities, sustainable agriculture.

Key points highlighted during the UK-China GREAT Innovation Showcase included:

- **Areas for collaboration** in Energy and nuclear ( clean energy ); Environmental protection ( air pollution control ); Digital, Internet+, IoT+, Smart Cities; Biotech (pharmaceuticals, anti-microbial resistance).
- **Challenges** that UK institutions face in the Chinese market were discussed and include technical barriers, product localisation , IPR, Chinese legal policy
- **Partnerships Models:** PhD exchange and visiting fellowship (through CSC, MOST and Newton Fund); Joint appointments (e.g. British scientists as 100-talent professors in Chinese Universities or vice versa); Joint Centres of Excellence for R&D (through Global Challenges Fund and MOST); Joint Centres for Innovation and Commercialisation (Universities and companies)-taking advantages of strong IP position of UK universities and China's industrial capability; Philanthropic funding for scholarships, fellowships and endowed professorships

Details of the event and related announcements can be found here:

<https://www.gov.uk/government/world-location-news/minister-celebrates-successful-commitment-of-200m-in-uk-china-research-and-innovation-collaboration>

The specific thematic areas of future focus in China highlighted above should help Scottish universities identify areas in which they see their own strength in research, development and innovation reflected. Whilst this is not an exclusive list of all of the areas that will involve international research and innovation, it provides a useful roadmap to explore opportunities with Chinese counterparts or engage with government at a national or provincial level.

Appendix 1 provides a list of current TNE collaborations by top Chinese institutions ( the "985" group).with overseas universities.

Appendix 3 provides further detailed information on Different Models of Research Commercialisation in China, covering:

- The National University Science Park / Incubation Centre
- University-owned Enterprises
- Joint Venture and Licensing
- Technology Transfer Centre Setup
- University Professor Start-ups
- Venture Capital
- Joint Research with Enterprises
- Technology Match-making Conferences
- Technology auction
- Secondary R&D
- Public Technology Transfer Platform

## 6. MODELS OF OPERATING IN CHINA

Whilst not central to the scope of this report, included here are a few brief comments on operational issues that Scottish universities may need to consider when developing their activities in China (spanning from direct recruitment to TNE to research and innovation projects).

### Setting up a legal entity

For some activities, such as a number of TNE programmes, a contractual arrangement between the foreign university and the Chinese partner institution that does not require the setting up of a legal entity may suffice.

It is possible for universities to have staff on the ground without setting up a legal entity by using a 3<sup>rd</sup> party employer, which can enable them to minimise risk and provide flexibility, but at some point a university may decide it needs to set up a legal entity itself. There are a number of options available: A Representative Office, a wholly foreign owned entity (WFOE), a Joint Venture (JV), etc..

Which model is best suited will depend on the nature of the activities that are to be conducted by the legal entity and professional advice should be sought to advise accordingly.

### Foreign NGO Management law

A new Foreign NGO Management law is due to take effect on 1<sup>st</sup> January 2017 and is likely to increase obligations on foreign NGOs.

At the time of writing this report, it may be that HEIs may be exempt from this law but until further details on the implementation of the law are published this cannot be fully confirmed.

Further information is expected to be released by the Chinese government in October 2016.

### Managing Intellectual Property

This is naturally a key aspect of R&D, tech transfer and other innovation-related activities.

CBBC recently published a report on this subject: Innovation & Joint R&D in China Intellectual Property Rights & Legal Guidance

This report can be downloaded here: <http://www.cbcc.org/sectors/innovation-joint-r-d-in-china-toolkit/>

Appendix 4 provides further information on the IP landscape in China.

## 7. REGIONAL CLUSTERS

Whilst impossible to explore every one of China's provinces, CBBC was tasked with looking beyond well-trodden paths in Tier 1 cities such as Beijing and Shanghai, to identify alternative clusters which match Scotland's own strengths.

As such, a broad selection of academic and industrial clusters has been identified from across China for their relevance to Scotland's strengths. They have been divided into four main geographical sections: the Northeast, the East, Central & West and the South. This selection is not designed to be exhaustive; a near impossible feat when dealing with China, but hopes to offer examples and ideas of where Scottish HEIs with certain niche strengths might find synergies, both geographically and thematically.

For each geographical region, a brief synopsis of their respective industrial fabric is provided, followed by a short list of key companies and universities in relevant priority sectors.

Further to this, a handful of individual interviews have been conducted with academics and cluster representatives with the purpose of acquiring anecdotal evidence of live opportunities for collaboration in their respective geographies.

The result is hoped to be a roadmap of clusters and specific thematic opportunities for Scottish universities to explore further.

### . Main thematic areas by region

<b>Northeast China</b>
<ul style="list-style-type: none"> <li>• Equipment manufacturing</li> <li>• Pharmaceuticals</li> <li>• Pharmacology &amp; Traditional Chinese Medicine</li> <li>• Fine chemicals and petrochemicals</li> <li>• Oil and gas engineering</li> <li>• Transportation engineering</li> <li>• Information technology</li> <li>• Robotics</li> <li>• Art Design and Animation</li> <li>• Innovation and entrepreneurship education</li> </ul>

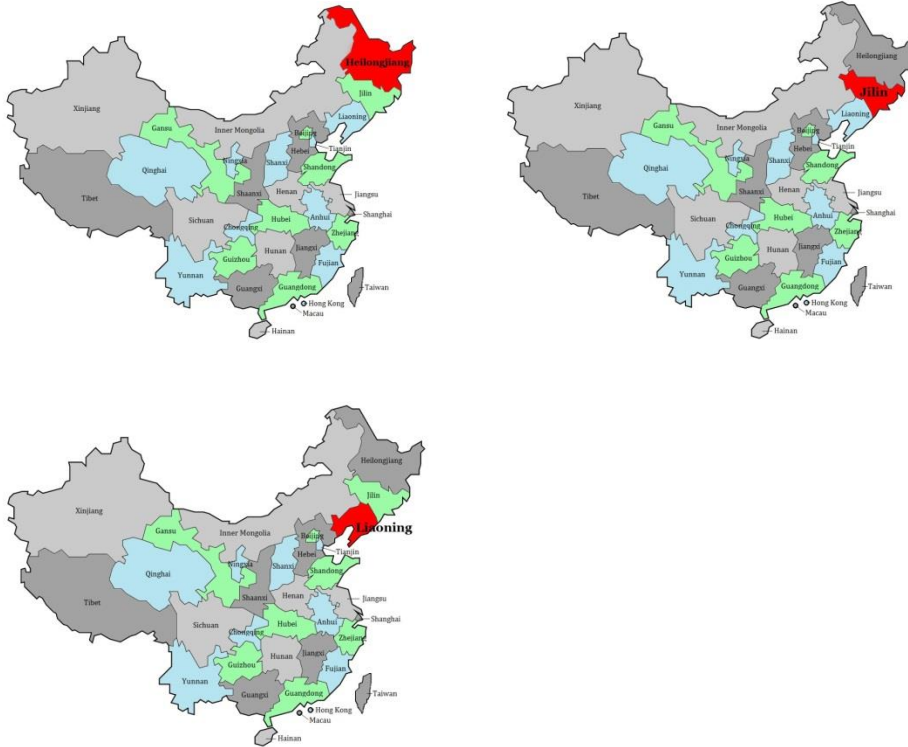
<b>East China</b>
<ul style="list-style-type: none"> <li>• Ocean and maritime science</li> <li>• Aquaculture</li> <li>• Biopharmaceuticals</li> <li>• Medical device development</li> <li>• Nanotechnology</li> <li>• Marine Sciences</li> <li>• Oil &amp; Gas</li> <li>• Healthcare</li> <li>• Shipping engineering</li> <li>• Agriculture</li> </ul>

<b>South China</b>
<ul style="list-style-type: none"> <li>• Advanced materials and industrial design</li> <li>• New energy automobile</li> <li>• Biopharmaceuticals</li> <li>• Aquaculture</li> <li>• Healthcare</li> <li>• Precision medicine</li> <li>• Big Data</li> <li>• Robotics</li> <li>• High-end equipment manufacturing</li> <li>• Advanced chemistry</li> </ul>

<b>Central and West China</b>
<ul style="list-style-type: none"> <li>• Sensors and Imaging</li> <li>• Optical communications</li> <li>• Laser technology</li> <li>• Consumer Electronics</li> <li>• Integrated circuits</li> <li>• Physics</li> <li>• Life Sciences and Healthcare</li> <li>• Creative Arts</li> <li>• Hydraulic engineering</li> <li>• Modern agriculture</li> </ul>

## 7.1 Northeast China

### Heilongjiang, Jilin and Liaoning Province - Equipment Manufacturing, Pharmaceuticals, Oil and Gas



The Northeast region covers the three provinces of Heilongjiang, Jilin and Liaoning. This region neighbours Russia, North Korea, South Korea and Japan and acts as a window to Northeast Asia.

The Northeast region has over 9% of China's population and has rich education resources; with 262 higher education institutions in total (82 in Heilongjiang, 63 in Jilin and 117 in Liaoning), of which include 16 of the 134 top national universities.<sup>20</sup>

#### Main Clusters

##### Shenyang Economic & Technology Development Zone

The manufacturing sector of Shenyang Economic & Technology Development Zone is targeted for future development. An equipment manufacturing cluster within the zone includes the following enterprises:

- Shenyang Blower Group (<http://www.shengu.com.cn/>)
- Shenyang Machine Tool Group (<http://www.symg.cn/>)

<sup>20</sup> [http://www.360doc.com/content/16/0619/17/6324201\\_569054895.shtml](http://www.360doc.com/content/16/0619/17/6324201_569054895.shtml)

- Northern Heavy Industries Group (<http://www.china-sz.com/nhiprofile/>)
- China Grand Enterprises (<http://www.chinagrandinc.com/English>)
- Shenyang BMW (<http://11491219.czvv.com/>)
- Michelin Shenyang Tire (<http://news.cria.org.cn/6/12684.html>)
- Bridgestone (Shenyang) Tire (<http://www.bridgestone.com.cn/>)

### **The Shenyang Yuanda Group and Yuanda Science & Technology Park**

Shenyang Yuanda Science & Technology Park, sponsored by Yuanda Enterprises Group, is a private company that is the largest R&D base in Northeast China. The Park hosts R&D centres, incubation centres, training facilities and businesses covering a wide range of fields including intelligent manufacturing, specifically industrial robotics R&D. The Park aims to establish itself as an internationally advanced research services hub.

Yuanda has set a clear R&D direction focusing on the development of industrial robotics, high-power ultrasonic application, vibration engineering application, system simulation, industrial engineering and industrial information realisation. The firm also has a strong interest in other areas including parts and components for aviation and space equipment, automobile and ship products.

### **The Tonghua National Medicine High-Tech Development Zone**

The Tonghua National Medicine High Tech Development Zone is one of two speciality national medical high-tech zones in China; the other is located in Taizhou, Jiangsu province. Further information is provided in the next section.

#### Key Thematic Areas:

As the industrial cradle of the “New China” and a key national agriculture base, the Northeast has historically enjoyed rich natural resources in wood, minerals and biodiversity. Oil production is particularly prominent, Daqing Oil Field is China’s largest oil production base and Liohe Oil Field ranks third largest nationally.

However, as the Chinese economy enters into the “New Normal”,<sup>21</sup> the Northeast’s economic growth has been lower than the national average in recent years. This is partly because many of the region’s industries are too dependent on natural resources in a declining market. In response, both central and regional government agencies are attempting to boost and transform the regional economy through various policy implementations. Among these is the *Northeast Old Industrial Base Revitalisation*, jointly issued by the Communist Party of China (CPC) and the National Development & Reform Commission (NDRC).<sup>22</sup>

In line with the current focus of this region and with Scottish strengths, the following key thematic areas have been identified for the northeast region:

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<sup>21</sup>The “new normal” means the Chinese economy has entered a new phase that is different from the High-speed growth pattern exhibited in the past. It is a new trend that features more sustainable, mid- to high-speed growth with higher efficiency and lower costs.

<sup>22</sup> <http://cpc.people.com.cn/n1/2016/0427/c64387-28307018.html>

- Equipment manufacturing
- Pharmaceuticals
- Oil & gas

### **Equipment manufacturing**

A key part of the Northeast Old Industrial Base Revitalisation plan is to build the northeast region into an internationally advanced high-end equipment manufacturing R&D base. In order to upgrade the sector, international cooperation and expansion are encouraged by the government.

Equipment manufacturing includes several key subsectors, which are all well established in the North-eastern regions given its long history and significant advantages in this sector. Although these subsectors do not form any specific geographic clusters, there are already some representative enterprises in each subsector. These are outlined in the tables below.

*Table 3: Representative Enterprises*

Company	Website
<b>Intelligent Manufacturing Equipment</b>	
Siasun Robot & Automation	<a href="http://www.siasun.com/">http://www.siasun.com/</a>
Shenyang Machine Tools Group	<a href="http://www.symg.cn/channels/3.html">http://www.symg.cn/channels/3.html</a>
Dalian Machine Tools Group	<a href="http://en.dmtg.com/about1.php">http://en.dmtg.com/about1.php</a>
China First Heavy Industries	<a href="http://www.cfhi.com/en/index.html">http://www.cfhi.com/en/index.html</a>
Wafangdian Bearing Group Cooperation	<a href="http://www.zwz-bearing.com/">http://www.zwz-bearing.com/</a>
Harbin Electric Corporation	<a href="http://www.harbin-electric.com/">http://www.harbin-electric.com/</a>
TBEA Shenyang Transformer Group	<a href="http://www.tbea.com/">http://www.tbea.com/</a>
Neusoft	<a href="http://www.neusoft.com/">http://www.neusoft.com/</a>
<b>Aviation Equipment</b>	
Shenyang Aircraft Cooperation	<a href="http://www.sac.com.cn/">http://www.sac.com.cn/</a>
Shenyang Liming Aero-Engine Group Corporation Ltd	<a href="http://www.lmaeg.com/">http://www.lmaeg.com/</a>
AVIC Harbin Aircraft Industry Group	<a href="http://www.hafei.com/">http://www.hafei.com/</a>
<b>Oceanographic engineering</b>	
Dalian Shipping Industry Company Ltd	<a href="http://www.dsic.cn/home/">http://www.dsic.cn/home/</a>
<b>Rail transit equipment</b>	
CNR Changchun Railway Vehicles	<a href="http://www.crrcgc.cc/ckgf">http://www.crrcgc.cc/ckgf</a>
China Zhongche Dalian Locomotive Vehicle	<a href="http://www.dloco.com/">http://www.dloco.com/</a>

*Table 4: Key Universities Related to Equipment Manufacturing Sector*



University	Website
Harbin Industry University	<a href="http://en.hit.edu.cn/">http://en.hit.edu.cn/</a>
Dalian University of Technology	<a href="http://en.dlut.edu.cn/">http://en.dlut.edu.cn/</a>
Northeast University	<a href="http://www.neu.edu.cn/">http://www.neu.edu.cn/</a>
Jilin University	<a href="http://www.jlu.edu.cn/">http://www.jlu.edu.cn/</a>
Shenyang University of Technology	<a href="http://english.sut.edu.cn/">http://english.sut.edu.cn/</a>
Shenyang University of Chemical Technology	<a href="http://www.syuct.edu.cn/">http://www.syuct.edu.cn/</a>

### Pharmaceuticals

The pharmaceutical sector has developed well in the Northeast region with all three provinces hosting various pharmaceutical companies. In particular, the Tonghua Medicine High Tech Industry Zone, located in Tonghua city in the South-eastern part of Jilin province, is one of only two national high tech zones which specialise in medical services.

Tonghua city historically claims the title of the birthplace of Chinese medicine. In 2013, the State Council approved the upgrading of Tonghua Medicine High Tech Industry Development Zone to the national level.

Based on its strong performance in the pharmaceutical sector, its output accounts for 50% of the whole province of Jilin, the city government aims to build Tonghua into a strategic national base of medicine innovation and production, focusing on areas of Chinese medicine, biomedicine, healthcare and modern medical services. Scientific research and international cooperation are seen as a major path towards this goal.

Tonghua has made significant progress in enhancing the R&D strength of its medical hub. Eight pharmaceutical companies have been confirmed by government authorities as national high-tech pharmaceutical enterprises and 21 national or provincial level technology centres have been established.

There are over 100 pharmaceutical companies in Tonghua. In 2015, 14 of these companies achieved over RMB 1 billion in sales.

*Table 5: Top Five Companies*

Company	Website
Xiuzheng Pharmaceutical	<a href="http://www.xiuzheng.com/">http://www.xiuzheng.com/</a>
Tonghua Dongbao Pharmaceutical	<a href="http://www.thdb.com/">http://www.thdb.com/</a>
Jilin Wantong Pharmaceutical	<a href="http://www.wtyy.com.cn/cn/">http://www.wtyy.com.cn/cn/</a>
Tonghua Golden Horse Group	<a href="http://www.thjm.cn/">http://www.thjm.cn/</a>
Tonghua Maoxiang Pharmaceutical	<a href="http://maoxiang.company.lookchem.cn/">http://maoxiang.company.lookchem.cn/</a>

Specific areas that these enterprises specialize in include human albumin and human glucagon.

Table 6: Key Medicine Related Universities

University	Website
China Medical University	<a href="http://202.118.40.32/info/1224/1043.htm">http://202.118.40.32/info/1224/1043.htm</a>
Shenyang Pharmaceutical University	<a href="http://www.syphu.edu.cn/">http://www.syphu.edu.cn/</a>

## Oil & Gas

There are three oilfields in the northeast region, with one in each province; Daqing Oilfield in Heilongjiang province, Jilin Oilfield in Jilin province and Liaohe Oilfield in Liaoning province.

Daqing is China's largest oilfield, whose crude oil production and gas production ranks number one in China. Petro China, the owner of Daqing, is however planning to decrease its annual production gradually until 2020, when production levels are expected to reach 32 million tons.<sup>23</sup>

Jilin oilfield is considerably smaller. It roughly ranks 11<sup>th</sup> with an annual crude oil output of 3.5 million tons.<sup>24</sup>

Liaohe oilfield plays an important role in regional economic development. It has been explored for over 40 years and has maintained an annual output of 10 million tons for the last 24 years. Liaohe oilfield is located in Panjin city which hosts an oil and gas cluster. Some key enterprises within this cluster are detailed below.

Table 7: Key Oil & Gas Companies, Panjin Cluster

Company	Website
Liaohe Oilfield of CNPC	<a href="http://www.cnpc.com.cn/en/">http://www.cnpc.com.cn/en/</a>
North Huajin Chemical Industries Group	<a href="http://www.huajinchem.com/en/">http://www.huajinchem.com/en/</a>
Liaohe PetroChina	<a href="http://www.cnpc.com.cn/cnpc/lhgy/201404/f6dd092371c745c79591a86b96883.shtml">http://www.cnpc.com.cn/cnpc/lhgy/201404/f6dd092371c745c79591a86b96883.shtml</a>
China Petroleum Liaohe Equipment	<a href="http://cplec.com/bhzb-en/">http://cplec.com/bhzb-en/</a>
Liaohe Oilfield Tianyi Petroleum Equipment	<a href="http://en.tpec.cc/">http://en.tpec.cc/</a>
Liaohe Oilfield Chenyu Group	<a href="http://www.lychenyujt.com/">http://www.lychenyujt.com/</a>
Liaoning Onshore & Offshore Oil Equipment Research Institute	<a href="http://www.lpei.com.cn/">http://www.lpei.com.cn/</a>
Liaoning Huajin Chemicals	<a href="http://www.pvc123.com/b-huajinhuagong/">http://www.pvc123.com/b-huajinhuagong/</a>

<sup>23</sup> <http://news.qq.com/a/20141227/018799.htm>

<sup>24</sup> [http://zhidao.baidu.com/link?url=6naIN1IAXgrfSH3o929SYwGGSg252YkG50SII2rdjJl4mQMupQqb1vmjZ5hMf10mj\\_2GhIR5nRXuZm36DKYIq](http://zhidao.baidu.com/link?url=6naIN1IAXgrfSH3o929SYwGGSg252YkG50SII2rdjJl4mQMupQqb1vmjZ5hMf10mj_2GhIR5nRXuZm36DKYIq)

Panjin Zhongrun Chemicals	<a href="http://6553303.1024sj.com/">http://6553303.1024sj.com/</a>
Liaoning Huafu Oil High Tech Company	<a href="http://hfkj.shop.bxgtd.com/">http://hfkj.shop.bxgtd.com/</a>

In terms of relevant universities, there are three oil & gas speciality higher education institutions in the Northeast region.

*Table 8: Key Oil & Gas Related Universities in the Region*

University	Website
Liaoning Petroleum University	<a href="http://www.lnpu.edu.cn/">http://www.lnpu.edu.cn/</a>
Northeast Petroleum University	<a href="http://202.118.40.32/info/1224/1043.htm">http://202.118.40.32/info/1224/1043.htm</a>
Liaohu Petroleum Career Technical College	<a href="http://baike.baidu.com/link?url=focd17Nck9PHP-MAdI_lgh66QhgdD-OatQWbdsnNXagRCm5qLgYavp_LyhhIfQORd9Hj961Z8gMPGNgzSCAkEK">http://baike.baidu.com/link?url=focd17Nck9PHP-MAdI_lgh66QhgdD-OatQWbdsnNXagRCm5qLgYavp_LyhhIfQORd9Hj961Z8gMPGNgzSCAkEK</a>

## Opportunities for International Cooperation

### University collaboration

Aside from the four universities already listed in the 9-8-5 Project, there are many other top-tier and specialist universities in the Northeast. The following section details key universities in the North-eastern provinces and their main research focus.

#### *Dalian University of Technology*<sup>25</sup>

Dr Weiqiu Zhong, Intellectual Property Management Committee in the Technology Development Academy at Dalian University of Technology, shared his thoughts on the following points with the CBBC for potential cooperation with Scotland.

Dalian University of Technology (DUT) is involved with the newly issued 13<sup>th</sup> Five Year Plan on National Science and Technology Innovation, specifically in the following areas:

- Smart Cities
- Key Equipment Manufacturing
- New Materials
- Water Environment Protection
- The High Efficient Re-Utilisation of Resources
- New Type Urbanisation

Overseas higher education institutions and research organisations would have many opportunities to participate in China's Science and Technology Innovation projects, through partnerships with universities

<sup>25</sup> <http://en.dlut.edu.cn/>

and research institutes. Dr Zhong placed particular emphasis on cooperation in entrepreneurship education which is currently an important aspect of Chinese education. A key objective within entrepreneurship education is to foster students' practical abilities, especially innovative thinking and enterprising mind-sets, and their social and soft skills.

DUT developed the Innovation Experiment School as a base for training high quality, innovative and enterprising talent. The school has 11 classes which 600 undergraduate students are enrolled in every year. Students can apply to enter these experimental classes free of charge. The classes focus on mathematical modelling, mechanical, electrical and software engineering, media technology, Association for Computing Machinery (ACM) International Collegiate Programming Contest, how to innovate and set up businesses, mobile Internet, robotics, smart cars and 3D printing.

The school is interested in cooperating with international universities and has set up a series of national or provincial level establishments such as the National Higher Education Institutions Practice Base. Students have participated in various competitions that have resulted to the granting of over 2,000 patents, with several projects earning investment from venture capitalists. Student start-ups are mainly in the sectors of Internet, electronic information, software, logistics and education.

DUT is open to working with Scottish universities on innovation and entrepreneurship education. Cooperation models are flexible and could be operated through the following mechanisms:

- Jointly training students
- Conducting lectures
- Internship opportunities
- Innovation and entrepreneurship education research
- Providing guidance to university graduates hoping to start their own business

#### *Shenyang Pharmaceutical University<sup>26</sup>*

Ms Yufei Wang, Head of the International Relations Department of Shenyang Pharmaceutical University, explained to CBBC that they would be very open to cooperating with Scottish universities by both teaching and research collaboration.

Shenyang Pharmaceutical University ranks number one in China as a speciality pharmaceutical university. Given this, the only criteria for choosing Scottish universities as potential cooperation partner is the cooperative university should rank within the top five pharmaceutical universities (or of relevant disciplines) in the UK.

The preferred specific thematic areas for cooperation are; pharmaceuticals, pharmacology, pharmaceutical analysis, analysis of traditional Chinese medicine and clinical pharmacy.

Cooperation models include student and teacher exchanges and joint teaching programmes. Ms Wang noted that a joint programme is more likely to be approved by the MoE if the proposed partner is a top ranking Scottish institution.

The same disciplines mentioned above are also the areas for academic and research cooperation. Ms Wang emphasised that the universities professors are first class in China and therefore they would like to work with the top rated professors from Scotland.

#### *Liaoning University<sup>27</sup>*

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<sup>26</sup> <http://www.syphu.edu.cn/en/>

As one of the key national universities and the only comprehensive university in Liaoning province, Liaoning University has 25 academies with 62 undergraduate majors.

It has three national key disciplines; international economy, national economics and finance. Other key areas that match with Scottish strengths include environment ecological engineering, computer science, food science and engineering, medicine engineering, informatics, biology, biochemistry and physics.

Liaoning University has various cooperation programmes with over 90 countries. It has set up the Sun Wah International Business School with De Montfort University that focuses on three majors; business management, accounting and marketing.

#### *Northeast Normal University (NENU)<sup>28</sup>*

NENU is an institution of higher learning under the direct administration of the MOE. It is a comprehensive university covering a wide range of disciplines and has set up various cooperation programmes with over 100 countries, including the UK.

The University is especially strong in education, life sciences including biology, chemistry and cell biology, ecology, engineering and materials science. It's National Engineering Laboratory of Drug Genes and Proteins Screening is a national laboratory and NENU states that it takes a leading role in these disciplines in China.

#### *Dalian Maritime University (DMU)<sup>29</sup>*

Located in Dalian, a coastal city in Northeast China, DMU is a key maritime institution under the Ministry of Communications of China. DMU has an international reputation for excellence as a centre of maritime education and training, as recognised by the International Maritime Organisation (IMO).

DMU consists of 16 educational and scientific research units including:

- Navigation College
- Marine Engineering College
- Information Science and Technology College
- Transportation and Management College
- Transportation Engineering and Logistics College
- Environment Engineering College
- Department of Physics

Control and marine engineering, and traffic information engineering are national key disciplines offered by DMU.

DMU has established cooperative relations with more than 30 international renowned maritime institutions, including those in the UK.

#### *China Medical University<sup>30</sup>*

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<sup>27</sup> <http://www.lnu.edu.cn/>

<sup>28</sup> <http://www.nenu.edu.cn/>

<sup>29</sup> <http://www.dimu.edu.cn/>

Located in Shenyang City, Liaoning province, China Medical University is one of China's earliest higher education institutions in western medicine. The history of the University involved the integration of several schools including Liaoning Medical University, formerly known as Sheng Jing Medical School, which was originally established by the Church of Scotland in the late 19th Century.

The six top research areas for CMU are:

- Basic Medicine
- Clinical Medicine
- Biology
- Oral Medicine
- Public Health and Preventative Medicine
- Nursing

One of CMU's significant partnerships is with the Queen's University of Belfast (QUB) to establish the China Queen's College (CQC). The CQC is a joint college and Sino-foreign cooperative education institution approved by the MOE that offers two majors; pharmaceutical science and pharmaceutical biotechnology. Qualified undergraduates from the CQC will receive BSc diplomas from both the CMU and QUB.

#### *Luxun Academy of Fine Arts (LAFA)<sup>31</sup>*

The LAFA is one of China's nine academies for fine arts. In 2013, LAFA was nominated by the MOE as one of China's first class universities. Three key disciplines include: fine arts, art design and artistic theory. LAFA has two campuses; Shenyang city and Dalian city.

The Shenyang campus is home to 12 departments:

- Chinese painting
- Printmaking
- Oil painting
- Sculpture
- Photography
- Environmental design
- Garment design and dyeing
- Industrial products design
- Art history and theory studies
- Culture communication
- Art and culture studies
- Water-based material painting

The Dalian campus houses two programmes: art design and animation.

The LAFA welcomes new international cooperation opportunities, in addition to their current cooperation with Japan.

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<sup>30</sup> <http://202.118.40.32/info/1224/1043.htm>

<sup>31</sup> <http://www.lumei.edu.cn/>

*Liaoning Shihua University/ Liaoning Oil & Chemicals University (LSHU)*

LSHU was founded in Dalian in 1950 as the first petroleum school of New China. The university has approximately 23,000 students including graduate, undergraduate, vocational school and continuing education students.

LSHU has a provincial level Petrochemical Industry Collaborative Innovation Centre and a Fine Chemical Collaborative Innovation Centre. LSHU has expressed an interest in working with Scottish universities in the future. Potential cooperation models would include 2+2 or 4+0 programmes for undergraduates; 3+2 or 4+1 for undergraduates and the possibility of a joint master's degree. LSHU prefers cooperation in the following subject areas:

- Automation
- Electronic information engineering
- Electrical engineering
- Process equipment and control engineering
- Mechanical design and manufacturing
- Oil and gas storage and transportation engineering
- Water supply and drainage science and engineering
- Building environment engineering
- Energy and power engineering
- Petroleum engineering
- Chemical engineering

Ms Liu believes these disciplines specifically help the university cater to local economic development needs and would benefit the most from international cooperation. LSHU would be interested in exploring research cooperation opportunities with Scottish universities, with the potential for establishing joint research institutes.

*Northeast Petroleum University*

Formerly the Northeast Petroleum Institute and Daqing Petroleum Institute, Northeast Petroleum University was founded in 1960. In 1978, it was regarded as one of the 88 national key universities by the State Council.

A comprehensive university, it specialises in engineering, science, management, culture, economics, law, education and art. It also has a branch campus in Qinhuangdao, Hebei province that runs higher vocational education.

Mr Jianwei Feng, Head of the International Cooperation Department, stated that the university would be open to working with Scottish institutions in both cooperative teaching and specific programmes. The university would prefer cooperation in relation to areas it has particular focus, including:

- Oil and gas well engineering
- Oil and gas field development engineering
- Oil and gas storage
- Transportation engineering

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## **Equipment Manufacturing**

### *Shenyang Yuanda Group and Yuanda Science & Technology Park*

According to Mr Michael Ren, Head of the Cooperation Department at Yuanda, the park has achieved significant success in R&D commercialisation. For example, developing industrial robot, high-power ultrasonic application, vibration engineering application, system simulation, industrial engineering, and realizing the industrial information are just some of their focuses, and many scientific achievements have been made.

Researchers achieving R&D results from the park enjoy continued success throughout the life cycle of their scientific research products, especially with the aid of the Park's various services and facilities such as the Technology Results Trading Platform. Scottish universities establishing a relationship with the park, or an enterprise within it, would also benefit from the strong commercialisation aspect of a partnership.

Mr Ren would welcome discussions with Scottish universities with research strengths in the following fields:

- Industrial robotics
- High-power ultrasonic application
- Vibration engineering application
- System simulation
- Industrial engineering
- Industrial information realisation

### *SME Bureau, Hunnan District - Shenyang City & Innovation & Entrepreneurship Education*

Mr Zhao, Hunnan District's SME Bureau Officer, explained to the CBBC that international cooperation is very much in line with the continued opening up of Shenyang, to demonstrate its continued development. In particular, technical support and cooperation from Scottish institutions would be encouraged.

Hunnan District would be open to working with Scottish universities in the following areas:

- Information technology industry
- Intelligent manufacturing industry
- Biomedical and digital medical
- Civil aviation industry
- New energy vehicles
- Automotive parts industry
- New materials

### *SIASUN Robot & Automation*

SIASUN is a high-tech enterprise with robotics and automation technology at the core of its research. Its work is particularly strong in digital high-end intelligent equipment manufacturing. As a result of its self-innovation and technology solutions, SIASUN has formed nine industrial groups, including the Industrial Robot Group.



Mr Jihong Qiu, General Manager of the robot group, told the CBBC that SIASUN seeks a potential cooperation partner in Scotland or other UK regions which could provide them with advanced technologies in intelligent robotics and robotic manufacturing.

## **Pharmaceuticals**

### *Tonghua City Economic & Technology Cooperation Bureau*

Tonghua City Economic & Technology Cooperation Bureau is the organisation responsible for operating the Tonghua National Medicine High Tech Zone. Mr Jing Xueshun, Head of Tonghua City Economic & Technology Cooperation Bureau, stated that the Bureau and the local government are keen to work with academia, schools and enterprises to promote innovation and the commercialisation of research results. This includes cooperation partners coming from Scotland or other international institutions.

### *Tonghua National Medicine High Tech Development Zone*

Mr Li Jianxin, Consultant at Tonghua National Medicine High Tech Development Zone, stated both the High Tech Zone and Tonghua City government welcome Scottish universities and research institutes to work with them.

If Scottish research institutes or HEIs have specific medicine related research results, Tonghua would be interested in purchasing or investing into later phase clinical testing that would be conducted in Tonghua. As one of only two national pharmaceutical high tech zones, Tonghua believes it can commercialise R&D results more efficiently than elsewhere.

As for stratified medicine, Mr Li recognises that Scotland has significant strengths covering both pharmaceutical development and treatment. While the high tech zone only focuses on developing and manufacturing drugs, Mr Li suggested Scottish universities make initial contact with strong companies in this discipline, including Tonghua Maoxiang Pharmaceutical (<http://maoxiang.company.lookchem.cn/>) who would be potentially interested in working with Scottish universities in stratified medicine especially with links to cancer treatment drugs.

## **Oil & Gas**

### *Panjin Foreign Trade & Economic Cooperation Bureau*

Ms Jingzhu Cao, Director of Panjin Foreign Trade & Economic Cooperation Bureau, discussed her thoughts on potential cooperation opportunities with Scotland. Since Liaohe oilfield's exploration has now entered into its mid-to-late phase, it would be difficult to keep its annual production output above 10 million tons in the long-term.

Panjin has successfully developed technologies with independent IP rights including; self-lifting drilling platforms, drilling rigs, top drive, pumping units and testing equipment. However, Panjin would be open to discussions with Scottish universities regarding low cost and high efficiency technology, used for enhanced oil production.

## 7.2 East China:

### 7.2.1 Shandong Province - Ocean & Maritime Science and Aquaculture



Shandong province is located at the lower reach of the Yellow River and at the mid-north section of the Beijing Hangzhou Grand Canal. It is the northernmost province of China's East Coast.

Shandong is China's third wealthiest province<sup>32</sup> and its population is 97.47 million, the second highest nationally.<sup>33</sup> There are 17 cities in Shandong province, including the capital city of Jinan and the largest city of the province, Qingdao.

Shandong province is the origin of China's Confucian Culture and boasts the Jixia Academy, the world's first officially organised, but privately run, higher education institution. As of 2015, there were 143 higher education institutions in the province with 596,000 students enrolled.<sup>34</sup>

In 2011, the State Council published a Development Plan which marks the Shandong Peninsula Blue Economic Zone as a national strategy. Development of the marine economy, scientific exploration of marine resources and cultivation of marine dominant industries are at the top of government agenda.

#### Main Clusters

##### Blue Silicon Valley

The Blue Silicon Valley is located in Qingdao, one of Shandong province's most important cities. It is positioned as the National Blue Silicon Valley and the Coastal Ecological New City. Qingdao is famous across China for its marine science and technology. Its marine research is ranked first nationally, it owns

<sup>32</sup> [http://www.dzwww.com/shandong/sdnews/201601/t20160128\\_13770628.htm](http://www.dzwww.com/shandong/sdnews/201601/t20160128_13770628.htm)

<sup>33</sup> Shandong Province Statistics Yearbook 2015

<sup>34</sup> [http://www.shandong.gov.cn/art/2016/3/2/art\\_181\\_124.html](http://www.shandong.gov.cn/art/2016/3/2/art_181_124.html)

one third of marine scientific research and teaching institutions, and is the base of the strongest talent in the field. Qingdao is home to The Ocean University of China, Chinese Academy of Sciences' Institute of Oceanology, 1 national and 17 provincial key marine laboratories.

Table 9: Key universities and research institutes in Blue Silicon Valley

University	Website
Ocean University of China	<a href="http://www.ouc.edu.cn/index.psp">http://www.ouc.edu.cn/index.psp</a>
Shandong University, Qingdao	<a href="http://www.sdu.edu.cn/">http://www.sdu.edu.cn/</a>
Tianjin University's Qingdao Marine Engineering Institute	<a href="http://www.tju.edu.cn/kxyj/kyjg/xwjd/201411/t20141104_247766.htm">http://www.tju.edu.cn/kxyj/kyjg/xwjd/201411/t20141104_247766.htm</a>
Institute of Oceanology, Chinese Academy of Sciences	<a href="http://english.qdio.cas.cn/">http://english.qdio.cas.cn/</a>
National Deep Sea Centre	<a href="http://www.ndsc.org.cn/">http://www.ndsc.org.cn/</a>

One of the valley's missions is to build an international marine science and technology education centre and it is willing to strengthen international cooperation. Qingdao Marine National Laboratory has worked with the UK's National Oceanography Centre; and research organisations in the valley and is already involved in major global marine science and technology activities.<sup>35</sup>

### **Qingdao West Coast New District**

In 2014, State Council produced a further notice which proposed the establishment of the Qingdao West Coast New District (a new Huangdao District in Qingdao). This was approved and became the ninth National New District.

The New District enjoys an advantageous geographic position, located in the Beijing-Tianjin-Hebei metropolitan area and in the middle of the Yangtze River Delta region. The New District has advantages in marine science and technology, including hosting 200 R&D institutes, 24 of which are national bases.

The New District hosts nine higher education institutions, with a student enrolment of 150,000. Constructing the New District into an international marine talent port is considered highly achievable.

Table 10: Universities Located in the New District

University	Website

<sup>35</sup> [http://news.xinhuanet.com/tech/2015-04/10/c\\_1114930643.htm](http://news.xinhuanet.com/tech/2015-04/10/c_1114930643.htm)

China University of Petroleum (East China)	<a href="http://www.upc.edu.cn/">http://www.upc.edu.cn/</a>
Shandong University of Science & Technology	<a href="http://www.sdust.edu.cn/">http://www.sdust.edu.cn/</a>
Qingdao University of Technology	<a href="http://www.qtech.edu.cn/">http://www.qtech.edu.cn/</a>
Beijing Film Academy Modern Creative Media College	<a href="http://www.bfamcmc.edu.cn/">http://www.bfamcmc.edu.cn/</a>
Qingdao Huanghai University	<a href="http://www.huanghaicollege.com/">http://www.huanghaicollege.com/</a>
Qingdao Binhai University	<a href="http://www.qdbhu.edu.cn/en/home/">http://www.qdbhu.edu.cn/en/home/</a>
Qingdao Harbour Vocational and Technical College	<a href="http://www.qdgv.com/">http://www.qdgv.com/</a>
Qingdao Ocean Shipping Mariners College	<a href="http://www.coscoqmc.com.cn/">http://www.coscoqmc.com.cn/</a>
Qingdao Technical College	<a href="http://english.qtc.edu.cn/">http://english.qtc.edu.cn/</a>

The New District intends to become a strategic hub for developing the marine economy and the main point of marine related activity in China. In addition to agglomerating several industrial clusters, in areas such as advanced manufacturing, shipping logistics, ship engineering and electronics, Qingdao West Coast New District also wants to set up a national ecological protection zone.

Due to its unique features, this area is promoting a marine biological industry based upon algae. The plan is to set up an intensive, professional production and deep processing zone of marine functional food, marine drugs, marine cosmetics, and marine medical dressings within five years. There is also an agricultural industry cluster in the New District; Strawberry Base in Hongshiya Lei Jia Zi Dian and Blueberry Base in Zhangjialou, Zangan, Liuwang and Baoshan Town.

*Table 11: Companies Located in the New District*

Company	Website
Double Star	<a href="http://www.doublestar.com.cn/">http://www.doublestar.com.cn/</a>

Qingdao Haixi Heavy Industry	<a href="http://www.qdhxzg.com/">http://www.qdhxzg.com/</a>
Wuchang Shipbuilding Industry Group	<a href="http://www.wuchuan.com.cn/enwuchuan/">http://www.wuchuan.com.cn/enwuchuan/</a>
Qingdao Haixi Marine Diesel	<a href="https://www.qmdltd.com.cn/ch/about.asp">https://www.qmdltd.com.cn/ch/about.asp</a>
Defontaine (Qingdao) Machinery	<a href="http://www.defontaine.com/">http://www.defontaine.com/</a>
Qingdao Beihai Shipbuilding Heavy Industry (BSIC)	<a href="http://www.bhshipyard.cn/en/Introduction/Introduction1/">http://www.bhshipyard.cn/en/Introduction/Introduction1/</a>
China International Marine Containers (CIMC)	<a href="http://www.cimc.com/en/">http://www.cimc.com/en/</a>
WABCO	<a href="http://www.wabco-auto.com/wabco/#">http://www.wabco-auto.com/wabco/#</a>
Saint Gobain Sekurit	<a href="http://www.glass.cn/c_saintgobin/">http://www.glass.cn/c_saintgobin/</a>
Qingdao Iron & Steel Group	<a href="http://www.qdsteel.com/human.asp?mc=zhaop">http://www.qdsteel.com/human.asp?mc=zhaop</a>
Port of Qingdao Group	<a href="http://www.qdport.com/">http://www.qdport.com/</a>
SGMW	<a href="http://jy.bhcyzb.com/pin/6732.html">http://jy.bhcyzb.com/pin/6732.html</a>
BMSCN	<a href="http://www.bmscn.com/">http://www.bmscn.com/</a>
Gather Great Ocean Algae Industry Group	<a href="http://www.judayang.com/">http://www.judayang.com/</a>

### **Key Thematic Areas**

A historically agricultural region, the provincial government also promotes the development of marine science and marine economy in Shandong.

### **Marine Science**

In 2014, the National Marine Science and Technology State Laboratory was established in Qingdao. It is the first and only national level marine science laboratory in China. Its establishment has further strengthened ocean science research and a marine talent pool in Shandong.<sup>36</sup> The laboratory is within Qingdao Blue Silicon Valley, which will be introduced in greater detail later in this report.

### **Aquaculture**

On July 2016, the Shandong Provincial Government published an agreement on the Provincial Development and Reform Commission's *Sea Granary Construction Plan (2015-2020)*. The plan aims to turn the province into a national production and supply base of high quality aquaculture products, a pilot

<sup>36</sup> [http://www.shandong.gov.cn/art/2014/1/20/art\\_322\\_753.html](http://www.shandong.gov.cn/art/2014/1/20/art_322_753.html)

zone of fishery transformation and improvement, a fish science and technological innovation pilot base and a fishery ecological demonstration zone.<sup>37</sup>

In order to build a strong science and technological support system for the implementation of the plan, the provincial government has called for all relevant research resources, including from higher education institutions and research organisations, to be combined.<sup>38</sup>

Education and professional training for fishery talent, as well as incentive mechanisms for fishery science and technology innovation and intellectual property rights protection, are also encouraged.

## **Opportunities for International Collaboration**

### **University collaboration**

Mr Weidong Li, Deputy Director, International Cooperation Department, Ocean University of China, provided CBBC with suggestions for Scottish universities seeking future cooperation with the University.

Ocean University has already worked with a number of overseas universities and research institutes, including some from the UK. However, as they have not yet established a joint programme with any UK institutions. Mr Li would welcome Scottish university partnerships in both joint teaching and joint research programmes.

The University will take into account the overall ranking and reputation of Scottish universities and their particular strengths in top disciplines in the UK. Disciplines considered include: marine science, ocean ecology and environment, and aquaculture, but other disciplines would also be considered.

In terms of cooperation models, Mr Li welcomes individual universities or research institutions from Scotland to directly approach them. All levels of undergraduate, Master and PHD for cooperation will be considered.

### **Business Opportunities**

#### *Blue Silicon Valley*

Mr Mosong Cheng, Head of the Administration Bureau at Blue Silicon Valley, Qingdao stated that since Qingdao Marine Science & Technology National Laboratory has established strategic cooperation relations with the UK National Oceanology Centre,<sup>39</sup> it would be possible for relevant marine research organisations in Scotland to set up strategic cooperation with marine science institutes in Qingdao.

Several national level marine research organisations are located in Qingdao, including the National Deep-Sea Centre<sup>40</sup>, the Qingdao National Centre for Marine Equipment Quality Supervision and Inspection Group,<sup>41</sup> the National Underwater Heritage Protection Centre Beihai Base,<sup>42</sup> Ministry of Land and

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<sup>37</sup> [http://sdgb.shandong.gov.cn/art/2016/8/24/art\\_4563\\_5127.html](http://sdgb.shandong.gov.cn/art/2016/8/24/art_4563_5127.html)

<sup>38</sup> [http://district.ce.cn/newarea/roll/201501/05/t20150105\\_4267665.shtml](http://district.ce.cn/newarea/roll/201501/05/t20150105_4267665.shtml)

<sup>39</sup> <http://noc.ac.uk/>

<sup>40</sup> <http://www.ndsc.org.cn/>

<sup>41</sup> <http://www.chinaqdmei.com/>

<sup>42</sup> <http://www.cach.org.cn/tabid/169/InfoID/1460/frtid/169/Default.aspx>

Resources' Submarine Combustible Ice Laboratory<sup>43</sup> and the Marine Corrosion Protection Key Laboratory.<sup>44</sup> Various forms of cooperation with Scottish research establishments and enterprises would be welcomed by these organisations.

Shandong University's Science & Engineering Campus is over 100 years old and is located in Qingdao Blue Silicon Valley. The National Key Laboratories of Biological Technology and Computer Technology are also located on the campus and collaborative research and teaching with Scottish institutes, within these fields of work, are a possibility.

Qingdao Robotfish Marine Technology<sup>45</sup> specialises in underwater robot development and Tyndall National Laboratory<sup>46</sup> has already established strong R&D research cooperation. Additionally, thermoelectric power generation and wave power generation technologies in Qingdao are advanced and a strong international partner in this field is encouraged.

#### *Qingdao West Coast New District*

Mr Xuefeng Guan, Head of the Commercial Bureau at Qingdao West Coast New District, has cited the following preferred areas for cooperation:

- High tech areas
- Modern service industry
- Marine economy
- High end manufacturing
- Ecology and environment
- Marine biology
- Aquaculture
- Special agriculture
- Green food processing
- Healthcare

In particular, Mr Guan noted the need for deep sea drilling technology and he would be particularly interested in working with Scottish universities with expertise in this field.

He also suggested Scotland focus on the following key sectors within the New District; Qingdao International Economic Cooperation Zone, Modern Agricultural Demonstration Zone and Ocean High Tech Zone.

The Ocean High Tech Zone has set up the following sector parks:

- Aviation industry
- Marine biology
- Marine engineering and equipment
- Nutrition food industry
- Biomedicine and automotive industry.

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<sup>43</sup> <http://www.mlr.gov.cn/zwqk/>

<sup>44</sup> <http://www.sunrui.net/>

<sup>45</sup> <http://www.chinarov.com/about.php>

<sup>46</sup> <http://www.tyndall.ie/>

Scottish universities should consider targeting these specific sectors.

All nine universities in the New District have worked with overseas schools and accumulated mature cooperative experiences. They are all interested in exploring more cooperative opportunities.

Possible cooperation models include:

- One-to-one direct cooperation between universities in Scotland and each of the nine universities in Qingdao West Coast New District
- Cooperation between research institutes from each side
- Cooperation between enterprises from each side
- Among industries/businesses, academia and universities under overall coordination by government agencies

#### *Qingdao International Economic Cooperation Zone*

Mr Hui Zhao, Public Relations Department of Qingdao International Economic Cooperation Zone, provided further feedback on potential cooperation between Scotland and the International Economic Cooperation Zone.

He said there are already a Sino-German Ecopark, a Sino-US New Energy Industrial Park and a Sino-Korean Innovation Park in the International Economic Cooperation Zone. Given their positive experiences working internationally, they would be interested in setting up a similar park with Scotland and would provide the necessary support.

A development plan is currently in progress for a Sino-German Dual System Engineering University. The Chinese partner is Qingdao University of Science & Technology, and the German side is made up of the University of Applied Sciences Jena, University of Applied Sciences Koblenz and the University of Applied Sciences Bielefeld and Paderborn. The University will cover ten disciplines including: mechanical engineering, electrical engineering and automation, electronic and information engineering, energy and power engineering.

Should Scottish universities be interested in establishing a similar kind of cooperation programme, they could start by liaising with a specific local university in Qingdao and establish a relationship within the international zone to benefit from government assistance.

Thematic areas for cooperation could be in the sectors of environmental protection, new energy application, electric vehicles and supporting industries, helicopters and supporting industries, Airbus H135 helicopter assembling line maintenance and training.

Additionally, if a city from Scotland is interested in forging a Twin City relationship with Qingdao, Mr Guan believes this type of relationship could help promote all round cooperation and would contribute to future success in business cooperation developments.

There may also be interest from Qingdao to invest in Scottish businesses which manufacture high tech products, and opportunities for collaboration in high value added products from Scotland sold to the China market



## 7.2.2 East China: Jiangsu



Jiangsu Province is situated in the middle of China's east coast and borders Shanghai and Zhejiang, Anhui and Shandong. It is also the most densely populated province in China with a total population of 79.8 million covering 102.6 km<sup>2</sup>.<sup>47</sup>

Jiangsu has been a key hub for Chinese economic development since the economic reforms, due to its location on the Yangtze River Delta. Jiangsu is home to world-leading multinationals in the fields of electronic equipment, biopharmaceuticals and textiles.

In recent years the Jiangsu government has made efforts to improve the current industrial base and welcomed the development of new industries. It is home to many development zones that aim to increase Jiangsu's foreign direct investment, domestic investment, international trade and technological cooperation and innovation.<sup>48</sup>

In 2015, there were 134 colleges and universities with approximately 1.8 million students in Jiangsu Province, totalling around 10% of total university students in China. The province is a major benefactor for foreign students in China, with 15 Chinese Government Scholarship Programmes and with international students' enrolment growing by nearly 15% annually.<sup>49</sup>

### Suzhou

Suzhou is located in the middle of the Yangtze River Delta Region and in the South of Jiangsu province. In 2015, Suzhou's GDP reached RMB 1.45 billion, a 7.5% increase from 2014. In 2015, PGDP was RMB 136,300<sup>50</sup> and the permanent resident population was approximately 10.61 million. By the end of 2015, 148 of the World Top 500 Enterprises had offices or investments in Suzhou.<sup>51</sup> Suzhou is located approximately 40 minutes by train from Shanghai and its economy has been built on manufacturing, with international and domestic companies based there.

<sup>47</sup> Jsyt.gov.cn

<sup>48</sup> China.nlabassade.org

<sup>49</sup> Jsyt.gov.cn

<sup>50</sup> [http://www.suzhou.gov.cn/xxgk/gmjjhshfztjxx/ndqmjjhshfztjisifb/201601/t20160118\\_668508.shtml](http://www.suzhou.gov.cn/xxgk/gmjjhshfztjxx/ndqmjjhshfztjisifb/201601/t20160118_668508.shtml)

<sup>51</sup> <http://www.suzhou.gov.cn/szgl2016/>

## Main Clusters

### Suzhou Industrial Park (SIP)

SIP was established in 1994 as a flagship project between the Chinese and Singaporean government and is located in the eastern part of Suzhou. By 2014, it had attracted more than 5,200 FDI projects and 91 enterprises from the Global Fortune 500 list had invested 150 projects in SIP.<sup>52</sup> In 2015, the GDP of SIP reached RMB 207 billion, of which 3.35% was investment into R&D. The total volume of foreign trade was RMB 494.5 billion. By the end of 2015, there were 356 R&D institutes, 554 high-tech enterprises and more than 20 innovation centres.

Table 12: Key Universities & Research Institutes Associated With SIP

University	Website
Suzhou University	<a href="http://www.suda.edu.cn/">http://www.suda.edu.cn/</a>
Suzhou Institute for Advanced Study	<a href="https://www.ias.edu/">https://www.ias.edu/</a>
Suzhou High tech Research Institute of Nanjing University	<a href="http://www.nju-sz.cn/">http://www.nju-sz.cn/</a>
Xi'an Jiaotong University Suzhou Academy	<a href="http://www.xjtusz.cn/xjtu/login.asp">http://www.xjtusz.cn/xjtu/login.asp</a>
Suzhou Research Institute of South East University	<a href="http://szyjy.seu.edu.cn/11380/list.htm">http://szyjy.seu.edu.cn/11380/list.htm</a>
Suzhou Research Institute of Wuhan University	<a href="http://www.whusuzhou.com/index.html">http://www.whusuzhou.com/index.html</a>
Suzhou Research Institute of Sichuan University	<a href="http://www.scuszi.com/">http://www.scuszi.com/</a>
Xi'an Jiaotong Liverpool University	<a href="http://www.xjtlu.edu.cn/zh/">http://www.xjtlu.edu.cn/zh/</a>
Suzhou Centennial University (joint programme with HK University)	<a href="http://www.hkuspace.edu.cn/">http://www.hkuspace.edu.cn/</a>
NUS Suzhou Research Institute	<a href="http://www.nusri.cn/">http://www.nusri.cn/</a>
Suzhou Research Institute of Shandong University	<a href="http://www.suz.sdu.edu.cn/">http://www.suz.sdu.edu.cn/</a>
Suzhou Biomedical Research & Development Centre	<a href="http://www.sibrc.org/">http://www.sibrc.org/</a>

In June 2007, SIP established the Suzhou Bio-bay to promote biotechnology and nanotechnology, which includes the Suzhou Nanotech National University Science Park. It now has 394 enterprises, with 105 focusing on drug discovery, 99 on medical devices and 44 on biotechnology. Gene Pharma<sup>53</sup> is its leading enterprise and Suzhou Bio-bay has formed a full gene industry chain from gene test service, gene diagnostic reagent and drug discovery to genetically engineered drug research.

Table 13: Leading Enterprises Associated with Bio-bay

Company name	Website
Roche Diagnostics	<a href="http://www.roche-diagnostics.cn/Pages/default.html">http://www.roche-diagnostics.cn/Pages/default.html</a>
Gene Pharma	<a href="http://www.genepharma.cn/">http://www.genepharma.cn/</a>

<sup>52</sup> [http://www.sipac.gov.cn/zjyq/ygqk/201603/t20160311\\_416382.htm](http://www.sipac.gov.cn/zjyq/ygqk/201603/t20160311_416382.htm)

<sup>53</sup> <http://www.genepharma.cn/>

BeiGene	<a href="http://www.beigene.com/">http://www.beigene.com/</a>
ZAI Lab	<a href="http://www.zailaboratory.com/">http://www.zailaboratory.com/</a>
Innovent Biologics	<a href="http://www.innoventbio.com/en/">http://www.innoventbio.com/en/</a>
Stainwei	<a href="http://www.stainwei.cn/">http://www.stainwei.cn/</a>
Alphamab	<a href="http://www.alphamab.com/en/index.html">http://www.alphamab.com/en/index.html</a>
Brunswick Laboratories	<a href="http://www.brunswicklabs.com/">http://www.brunswicklabs.com/</a>
Genewiz	<a href="https://www.genewiz.com/">https://www.genewiz.com/</a>
Edding Pharm	<a href="http://www.eddingpharm.com/">http://www.eddingpharm.com/</a>

### **The Suzhou Institute of Biomedical Engineering and Technology (SIBET)**

SIBET is the only institute within the Chinese Academy of Sciences that focuses on bio-pharm, specifically the development of bio-medical instruments, bio-medical reagents and bio-materials.

It was established in 2011 with the aim of meeting the needs in biomedical products in China and to stimulate the development of biomedical engineering technology through establishing platforms for the innovation and transformation of medical instruments.

The institute has seven laboratories which focus on medical optics, technology of vitro diagnosis, medical imaging, medical acoustic technology and rehabilitation medicine engineering. Currently, major target breakthroughs include blood immunity analysis technology and super-resolution microscopy optical techniques.

SIBET has joint R&D centres with international universities, including Johns Hopkins University in the US, and also works in cooperation with enterprises including Foreal Spectrum, Inc. The institute looks to international collaboration and employee exchange and training programmes as a means of improving the quality and standard of their practices and projects.

### **Key Thematic Areas**

#### **Medical device development**

Within medical device development, Suzhou specialises in optical instruments, inspection instruments, imaging devices and ultrasound.

#### **Nanotechnology**

Ms Margaret Xue, Suzhou Dushu Lake Higher Education Town Administrative Office, stated that there is a clear focus on bio-pharm in Suzhou and the park was set up in order to attract bio-pharm companies for cooperation and collaboration. It is also interested in the commercialisation of international technologies and the establishment of joint research programmes with foreign institutions.

## Opportunities for International Collaboration

### University Collaboration

#### *Soochow University*

Soochow University in Suzhou is a well-established multi-disciplined university established in 1900 that accommodates 50,000 students on over 100 undergraduate programmes, 200 Masters programmes and 100 PhD programmes. Its aim is to develop teaching, research and international co-operation to become a first-class university in China and build an international reputation. This vision requires a commitment to world class research and a desire to further expand its international network.

The CBBC met with Huang Xing, Director of International Office and Dean of Overseas Education, to discuss opportunities with Scottish universities. Soochow University has several international collaborations, mostly from the USA, Canada, Australia and Europe including Manchester University and the SANGER Institute in the UK.

Soochow University is keen to develop relationships with Scottish universities for TNE programmes, faculty exchange and research. It is open to discussing partnerships in student exchange on a 2+2 or 3+2 Bachelors or Masters programme. The university also accommodates 2,000 international students each year, on both Bachelor programmes and language learning programmes, with students coming from 60 different countries. It aims to increase the number of international students to 4,000 by 2020 and it is keen to explore further co-operation in multiple disciplines.

In terms of scientific research, Soochow University has joint laboratories and research programmes in nanotechnology with Waterloo University in Canada, radiation medical sciences with Ontario, Canada and gene research with the SANGER institute, Cambridge, UK.

The university would be interested in further international cooperation with Scottish universities in the following thematic areas:

- Nanotechnology
  - Suzhou's focus on the development of the nanotechnology sector is a core element of the region's economy
  - Soochow University has developed research facilities in nanotechnology with international universities
  - The local nanotechnology industry cluster within the region is Nanopolis (<http://www.nanopolis.cn/indexenglish.html>)
  - Soochow University is open to establishing a wider network of international partners in nanotechnology and, as this is an area of Scottish strength, would be open to co-operation with specialist universities in terms of research development
  
- Medicine
  - Soochow University discussed clinical medicine, pharmaceuticals, bio medicine and public health as a specific theme in which Suzhou universities, Scottish universities and Scottish Innovation centres could co-operate

China is very aware of the challenges of population and the need to develop systems, technologies and scientific breakthroughs in medicine to achieve its national and provincial healthcare goals. Scotland's strength in research in medical sciences, stratified medicine, health and well-being would complement the capabilities and objectives of the university.

### **Business opportunities**

#### *Suzhou Industrial Park*

Suzhou Industrial Park has already cooperated with international universities including UCLA, National University of Singapore and Monash University to set up joint research institutes. The park is open to considering proposals from Scottish partners.

SIP's existing collaborations largely came about as a result of the return of Chinese alumni, equipped with strong project concepts. The international and Chinese universities discussed combining resources in order to continue collaborative research, through establishing joint research centres which also receive support and preferential policies from municipal governments. The university partnerships further cooperate with local industries and companies, within the industrial zone, for commissioned research and technology development.

One way in which SIP and its affiliated institutions work with international universities is through providing training and guest lecturing at universities, in order to build credibility and reputation. Scotland could use these opportunities in order to better communicate its strengths to the Suzhou market. Ms Xue recommends this as a good starting point for Scottish universities, because establishing a joint research centre requires a stronger partnership and takes time to develop.

#### *Suzhou Dushu Lake Science and Education & Innovation District*

The CBBC interviewed Jiang Wei Ming, Deputy Secretary and Executive Vice Chairman of the Suzhou Dushu Lake Science and Education & Innovation District Administrative Administration Committee, to understand Suzhou Education & Innovation hubs priority themes.

Vice Chairman Jiang stressed that Suzhou's future strategy is based on three pillar sectors: bio Science, nanotechnology and cloud computing. Suzhou Innovation Park works proactively with international universities and companies to develop eco-systems and value chains which encourage the development of R&D commercialisation in this area.

Its aim is to develop domestic and international capabilities within the cluster and it is willing to support international collaboration and tech transfer through funding and facilities support. Suzhou's education and research capability is based around the SIP business park, Suzhou Bio Bay and Nanopolis nanotechnology centre.

The CBBC discussed Scottish strengths in TNE education and innovation and potential partners within the Suzhou education cluster. Vice Chairman Jiang recommended Central Academy of Sciences (CAS) Suzhou and Suzhou University as high quality regional institutions that proactively engage with international institutions in professor exchange, TNE and research.

#### *Chinese Academy of Sciences Biotechnology in Suzhou (CAS)*

CAS Suzhou is a specialist education and research institution focusing on biomedical technology. The CBBC met with Wen Fei Dong, Executive Deputy Director, Yaoyao Cui, Director of Medical Ultrasound Department and Shouyan Wang, Director of Medical Electronics.

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T: +44 (0)20 7802 2000

CAS focuses on the development of research specifically for the commercialisation of technology and encourages professors to start their own spin-off companies as part of its research development. CAS acts as a platform for the biotechnology research industry to help the commercialisation of technology. It has software and engineering teams as well as access to manufacturing and electrical engineering facilities, which researchers can use to develop concepts from the initial feasibility study, design, clinical testing, tech transfer and through to manufacturing.

CAS has relationships with VC funds and government funding bodies and can assist in securing funds for projects that fall under the funding criteria. It also has relationships within the CFDA certification bodies and can help researchers gain the proper certification for new biotechnology products.

The CBBC discussed joint programme opportunities between CAS and Scottish universities. CAS stated that it is interested in discussing all areas of cooperation; however, its focus is strictly on biomedical engineering and predominantly on post-graduate Masters and PhD programmes.

CAS does have strategic relationships with domestic and international universities through creating joint Bachelor and Masters programmes and is open to exploring partnership models that benefit CAS, Scottish universities and the students themselves. CAS would be interested in exploring joint Masters and PhD programmes, professor and student exchanges, summer student exchanges and joint research programmes in the following thematic areas:

- Bio Materials
  - CAS is keen to strengthen its bio materials department and is look for a Principal Investigator lead professor for this department
  - It is interested in building relationships with Scottish universities with specific strengths in bio materials, to engage in academic faculty and student exchange within this discipline
- Medical Instruments
  - CAS is keen to explore collaboration in joint research in medical instruments, specifically in the development of optics, imaging systems and laboratory instruments for diagnostics
  - Its strategy focuses on research, with clear commercialisation potential using its facilities, research and testing teams and its network within the local cluster manufacturing supply chain
- Biological Engineering
  - CAS is interested in developing research collaboration for tumour diagnosis, biomarkers and testing equipment
  - It would use its laboratories and teams to take patented concepts and test them
  - It would use its relationships with medical institutions and the wider supply chain to facilitate commercialisation and bring products to market

### 7.2.3 East China: Taizhou

Taizhou is located on the north bank of the Yangtze River and in the last decade has become a well-connected city with a new bridge and railway that gives it easy access to the strong economic south of Jiangsu province. Traditionally, Taizhou was a key farming region in the province. Now, its main sectors include pharmaceuticals, mechanical and electrical manufacturing and IT.

#### Main clusters

##### China Medical City (CMC)

CMC is the only national medical high-tech development zone in China. It integrates R&D facilities, manufacturing, exhibition and trade, health care demonstration and education and has attracted major international and domestic enterprises since its opening in 2006. The particular fields of pharmaceuticals, bio-medical, bio-chemical and bio-tech, as well as stem-cell research are among the themes that current enterprises work in.

CMC has started construction of China's largest industry base in bio-pharmaceuticals, in accordance with the 13<sup>th</sup> Five Year Plan of Jiangsu Province, in which Taizhou is encouraged to set up a Big Health Industry Cluster during 2016-2020.

The innovation centre of Taizhou Vaccine Engineering Research Centre is also a key innovation platform that is promoted in the Five Year Plan. Currently, over 50 well known university and medical development institutions and over 600 international and domestic medicine enterprises are established within the district. It has already produced more than 400 medical innovations that are regarded as first class.<sup>54</sup>

#### Opportunities for International Collaboration

##### University Collaboration

###### *Nanjing University of Chinese Medicine Hanlin College*

Nanjing University of Chinese Medicine Hanlin College was founded in March 2002 and was approved as an independent college by the MOE in March 2005. The university is located in the National Medicine and High Technology Industries development zones. It is one of the comprehensive pilot institutes within China Medical City. It is committed to training students and teachers to international standards, nurture top talent, actively explore innovative research projects, improve teaching quality and make the most of the "school and city fusion" within the CMC.

The university is located within the CMC and its main research disciplines include; acupuncture, nursing, psychology, biopharm, pharmaceutical engineering, drug development and preparation, and medical resource development. 55

According to CMC's Mr Chen, in the past the university looked into establishing a joint programme with Huston Medical Centre but due to policy restrictions it was unable to proceed. The focus has now shifted to collaboration through specific research projects. Many of the researchers based in the industrial park are Chinese scholars returning from overseas study that have come back to work with the enterprises in

<sup>54</sup> <http://www.medmax.cn/ycqk/showclass.asp?classid=1>

<sup>55</sup> <http://www.hlxy.edu.cn/content.php?id=182>

the park. These researchers have often spent time in the US and other countries, and bring back techniques and projects they worked on abroad.

The university has established a 'technical post', where individuals provide equipment, device maintenance and training to enterprises within the park. This post has also collaborated internationally, for example sending some employees to the US to conduct research in US universities as post-doctoral students.

CMC is also interested in collaborating with international institutions on technology development and licensing patents for industrialisation, as well as technology transfer.

#### 7.2.4 East China: Zhejiang Province

Ningbo and Zhoushan are located in Zhejiang province and both cities have a particular focus on marine sciences, but also cover different subsectors within the field.



#### Ningbo

Ningbo is located in the middle part of the coastal line of the Chinese mainland. It is in the southern wing of the developed Yangtze River Delta, in the east of Zhejiang province and adjacent to Shanghai and Hangzhou.

Ningbo is an economic centre and an important development engine of the Greater Shanghai Economic Circle in China. It has been evaluated by the UN as one of the most promising cities in China. Ningbo covers a land area of 9,816 km<sup>2</sup> and has an urban resident population of 7.825 million. The prefecture-level city of Ningbo governs six districts and five county-level cities.



49 of the Fortune Global 500 companies have invested in a total of 110 projects in Ningbo, with total investment of USD 10.72 billion by the end of 2015. Over 140 countries and regions have invested in Ningbo, mainly from Germany, Singapore, USA, UK, Japan, Hong Kong and Taiwan.<sup>56</sup>

## **Zhoushan**

Zhoushan is located in the northeast of Zhejiang province, covering an area of 1,440 km<sup>2</sup> and with a total population of 1.14 million in 2014. Zhoushan has the biggest manufacturing, processing and sales base of sea products in China.

It incorporates 20% of China's islands and is the largest fishery in. Zhoushan is resource rich, including wind and tidal energy and submarine oil resources, which provide Zhoushan with the potential to develop marine engineering equipment, marine new energy and marine biopharmaceuticals industries.

## **Main Clusters**

### **Zhoushan Marine Industry**

This marine industry includes the Zhoushan Port Free Trade Zone and Zhoushan Economic Development Zone. Zhoushan Marine Industry Cluster Area is one of 15 provincial clusters in Zhejiang province. By integrating Zhoushan marine science city and other surrounding islands, the cluster is focusing on developing ocean clean energy, port logistics, coastal and marine tourism, modern fishery, aquatic product processing and marine biotechnology. The two industrial parks are included within this cluster. It aims to be a leading marine science R&D and industrialisation centre by 2020.

It would also like to develop the marine engineering equipment manufacturing industry, which includes deep-water exploration, ocean emergency rescue and deep sea remote supply technologies, by bringing in international advanced technologies.

The marine biopharm industrial park is within Zhoushan Economic Development Zone. The focus of the marine biopharm is research and development of marine healthcare products, marine functional foods and marine bio-enzyme products.

### **Ningbo Petro-Chemical Economic and Technology Development Zone**

This development zone has eight leading enterprises within the cluster. These can be seen in the table below.

*Table 14: Leading Enterprises within the Cluster*

Company name	Website
Total	<a href="http://www.total.com/en">http://www.total.com/en</a>
Akzo Nobel N.V	<a href="https://www.akzonobel.com/">https://www.akzonobel.com/</a>
SK	<a href="http://www.sk.com/?site=eng">http://www.sk.com/?site=eng</a>

<sup>56</sup> According to statistics provided by Ningbo MOFCOM

Lanxess	<a href="http://lanxess.com/en/corporate/home/">http://lanxess.com/en/corporate/home/</a>
Lyondellbasell	<a href="https://www.lyondellbasell.com/">https://www.lyondellbasell.com/</a>
LG	<a href="http://www.lgcorp.com/main/main.dev">http://www.lgcorp.com/main/main.dev</a>
Fund Energy	<a href="http://www.fundenergy.com.cn/">http://www.fundenergy.com.cn/</a>
Zhejiang Jiangshan Chemical	N/A

### **Ningbo International Marine Ecology Tech City**

Ningbo International Marine Ecology Tech City is located in Meishan District, Ningbo. It was established in January 2015, within the Ningbo Meishan Bonded Area. Its focus is on marine financial services, marine intelligent equipment and marine life sciences.

Ningbo Marine Research Institute and Meishan Scientific and Educational Park of Ningbo University are also a part of the Tech City. Ningbo Government and the State Oceanic Administration invested RMB 470 million in the Ningbo Marine Research Institute. It is expected to bring in at least 12 marine technology R&D teams within the next 5-8 years and to have 20 marine science-related technologies industrialised.

It is expected to cooperate with well-known research institutes, both internationally and domestically, to develop R&D in marine high-tech industries which include marine equipment manufacture, marine clean energy, medical device and marine bio-pharm. It would like to prioritise projects on marine bio-pharmaceuticals, marine functional foods and marine biological healthcare products.

### **Zhoushan China International Aquatic City**

Zhoushan China International Aquatic City is a large wholesale market for aquatic products in Zhoushan, with more than 4,000 traders from China and overseas.

### **Zhoushan Fishery**

Located in the east of Hangzhou Bay, Zhoushan Fishery is the largest fishing ground in China for fishermen from Zhejiang Province, Jiangsu Province, Fujian Province, Shanghai and Taiwan.

*Table 15: Key Universities within the Cluster*

University	Website
Ningbo University	<a href="http://www.nbu.edu.cn/">http://www.nbu.edu.cn/</a>
Zhejiang Ocean University	<a href="http://www.zjou.edu.cn/">http://www.zjou.edu.cn/</a>
Ocean College of Zhejiang University	<a href="http://oc.zju.edu.cn/">http://oc.zju.edu.cn/</a>
Marine Economy and Technology International Academy	N/A
Ningbo Institute of Technology, Zhejiang University	<a href="http://www.nit.zju.edu.cn/">http://www.nit.zju.edu.cn/</a>

## Key Thematic Areas

### Zhoushan

Aquaculture, developing ocean clean energy and marine biotechnology, which includes marine healthcare products, marine functional foods, and marine bio-enzyme products.

### Ningbo

Oil and Gas, specifically oil refining, ethylene production and engineering plastics. Marine ecology, specifically marine biopharma, marine functional food and marine healthcare.

### Zhoushan Aquaculture Research Institute

Zhoushan Aquaculture Research Institute has a R&D base in Putuo District, Zhoushan, which includes a laboratory area of 1,000m<sup>2</sup> and fry rearing water of 2,000 cubic metres.

The main work of the research institute is to bring in new cultivated varieties, protect fishery resources, monitor and restore fishery ecological environment. It also works to prevent and control aquatic biological diseases and provide marine and fishery technology training.

## Opportunities for International Collaboration

### University Collaboration

#### *Zhejiang Ocean University*

Zhejiang Ocean University has three areas of focus they would seek to internationalise through cooperation with overseas institutions; shipping and ocean engineering, marine science and marine culture.

The University currently works with an Italian university in marine bio-pharm. In total, it has cooperated with 41 international universities and research institutions from around the world.

It runs a joint marine-aquaculture engineering technology centre with a Russian institution and a fish threpsology joint laboratory with a Norwegian university. In addition to these centres it also runs a joint Masters programmes whereby professors from international universities take on lectures in Zhoushan, in partnership with Chinese tutors. After the four year programme, students receive diplomas from both universities, but all the tuition is undertaken in China.

A slightly different model is used in cooperation with the Norwegian university. Students that meet the conditions for IELTS examinations are permitted to spend the first academic year in Zhoushan and then complete the rest of their studies in Norway. Scottish institutions could consider both of these models as potentials for cooperation.

Zhejiang province has favourable scholarship programmes for visiting international students and also welcomes short-term exchanges in various disciplines, with language tuition included.

Ms Wang, from the International Office at Zhejiang Ocean University in Zhoushan, stated that there are opportunities for joint programmes; however, the Zhejiang Provincial government does not allow 2+2 programmes. As a result, as in the case of the Russian university, all tuition is conducted in China but students will receive a double diploma. The university also has various student and teacher exchange programmes with universities in Japan and Italy.

*Ningbo Institute of Technology, Zhejiang University*

Mrs Lin, Professor at Ningbo Institute of Technology, provided insight on joint programmes. The Institute has formed many joint programmes with universities in the US and New Zealand and has various student and teacher exchange programmes. In the UK, Ningbo Institute of Technology has had a joint 3+1 or 2+2 programme with the University of Plymouth since 2014.

Students who reach a certain academic and IELTS grade in the first three years can apply to study in the UK for their final year. Final year tuition will follow the University of Plymouth's standard tuition which is £12,250 per year, with a possible 10% discount. Ningbo Institute of Technology also has a joint programme with several international universities for short-term exchanges during the summer and winter vacations. These students may have the chance to apply for an exchange fund from the Ningbo Institute of Technology to cover part of their expenses.

Mrs Lin advises that Scottish universities come equipped with expertise in a specific area. Previously, Chinese universities would have to approach international institutions seeking relationships, but now the situation is reversed and quite competitive. Universities must have strengths in particular areas of need and in marine sciences in particular, in order to succeed. The school is open to cooperation, but would only consider a Scottish university once it can prove it has a unique strength.

Another challenge for joint programmes is that tuition fees are often higher than purely going abroad, due to the high costs entailed in requesting international professors to teach in China. Many students find it more cost effective to simply go abroad and thus it can be difficult to recruit Chinese students for these programmes. When forming a joint programme, the MOE has to approve the programme and any curriculum propositions. Since this procedure is long and difficult, they are not establishing these programmes as regularly as previously.

*Ocean College, Zhejiang University*

Ocean College was established in 2012, under an agreement signed by Zhejiang University and Zhoushan Government. It began enrolling students in 2013 and is expected to have 4,000 students in 2025. Currently, there are 71 academic teachers, 52% of which are recruited from overseas. The college offers four majors:

- Ocean engineering technology
- Port, waterway and coastal engineering
- Marine science
- Naval architecture and ocean engineering

Nine research institutes are set up within Ocean College. It has four joint programmes with international universities, on all of these majors, one of which is jointly set up with the University of Strathclyde in Scotland.

The College also looks at bringing in curriculum systems, textbooks and teachers from international universities. This enables students to benefit from good quality teachers from Zhejiang University and to

receive education from top international universities. In the future, it intends to bring in more teachers from abroad and promote pure-English teaching classes.

## 7.3 South China

### 7.3.1 South China: Guangzhou



Guangdong has the strongest economy in the south region, with a disposable income for the first half of 2016 (January-June) of RMB 19,777 while GDP was RMB 3,740 billion.

Guangzhou has the richest science and innovation resources in Guangdong province. 70% of scientists and 95% PhD students from Guangdong province work in Guangzhou. 80% of HEIs in Guangdong province are located in Guangzhou. Guangzhou has the highest number of research institutes and key laboratories in Guangdong province.<sup>57</sup>

2016 marks the beginning of various national and regional mid-term plans, as part of the 13<sup>th</sup> Five Year Plan. In line with the implementation of the Guangdong plan, the Guangdong government prioritises the following themes:<sup>58</sup>

- Advanced engineering
  - Manufacturing equipment
  - Ship and ocean engineering equipment
  - Railway transit
  - Aeronautical manufacturing
  - Satellite applications
- Modern Service Industry
  - Finance
  - Modern logistics
  - E-commerce
  - Business exhibitions and Trade Fairs

<sup>57</sup> <http://static.nfapp.southcn.com/content/201608/11/c118228.html>

<sup>58</sup> <http://www.gdjt.gov.cn/zhyw/34200.jhtml>

- Healthcare
- Modern medical services
- Strategic emerging industries
  - Internet of things
  - Big data
  - Cloud computing
  - Intelligent robotics
  - Electronics
  - Biopharma
- Competitive industries
  - New energy
  - Energy conservation and environmental protection
  - New energy automobile

Mr Dong Wang, Vice Mayor of Guangzhou, said in a government conference in August 2016 that by 2017, Guangzhou's fiscal funding for science activities will reach RMB 10.8 billion. By the end of 2016, it will have doubled the number of high tech companies to 500.<sup>59</sup>

As part of the plan, the Guangdong government accelerated its policy making in science and innovation. In January 2015, Guangdong issued *Guangdong Government's Opinions on Accelerating the Innovation of Science and Technology*.<sup>60</sup> This policy aims to build an eco-system to involve the government, research institutes and universities from home and abroad to work together. The Guangdong government also launched several funding options to support these endeavours:

- Article One: Build a system to provide capital reserve for enterprises' R&D activities
- Article Five: Build a system to provide fiscal subsidies for high-tech business incubators
- Article Seven: Give HEIs and research institutes autonomy in handling scientific and technological achievements

## Main Clusters

### Guangzhou Development District

Guangzhou Development District was established in 1984 and is located in the centre of the Pearl River Delta. It is one of the first national economic and technological development zones.<sup>61</sup> After years of resource integration and development, Guangzhou Development District now accommodates over 500 R&D institutes. It provides a cradle for scientific and technological companies and is now an incubator for 2,222 companies, with 837 graduated companies.<sup>62</sup> The overall aim of Guangzhou Development District is to promote and develop innovative business and it has already worked with countries including Singapore and Israel, member countries of the EU and North American companies, to build incubator platforms.

Based on CBBC research, the key thematic areas most relevant to this region are:

- Advanced Materials and Industrial Design
- Electric Vehicles

<sup>59</sup> <http://news.hexun.com/2016-08-26/185715689.html>

<sup>60</sup> [http://zwgk.gd.gov.cn/006939748/201502/t20150226\\_570220.html](http://zwgk.gd.gov.cn/006939748/201502/t20150226_570220.html)

<sup>61</sup> <http://www.getdd.gov.cn/2013/>

<sup>62</sup> <http://www.gdstc.gov.cn/HTML/kjdt/qdkjdt/14719406813875549440913827623150.html>

- Biopharma

Within Guangzhou Development District, the Guangzhou International Biology Island was established to focus on biological technology, in particular biopharmaceuticals. At the end of June 2015, the Biology Island established the “Sino-UK and Sino-Israel Life Science Technology Bridge” which hosts annual project match-making conferences, between the UK and Guangzhou.<sup>63</sup> It has also introduced 108 projects and hosts the Academy of Military Medical Sciences, South China Stem Cell Research Centre and Guangdong Medical Group Pharmaceutical Research Centre and Sales Centre.<sup>64</sup>

## **Opportunities for International Collaboration**

### **University Collaboration**

#### *Sun Yat Sen University*

Sun Yat Sen University in Guangzhou is open to international cooperation through joint programmes. Ms Ying Han, who works in the Foreign Affairs Office, stated that the preferred way of working with foreign universities is through student and teacher exchange. The university has specific funding for sending their professors abroad to foreign universities to further enhance their knowledge. They also welcome delegations of professors from international colleges and universities. Current programmes with Glasgow University and Birmingham University have an established “fast track” for further study and post-graduate education, which Sun Yat Sen University is also willing to expand.

For specific programmes, including 2+2, the agreements are left to the colleges involved to decide what the best options are regarding their fields of study. The key subjects that Sun Yat Sen University specialises in are big data and life sciences. The university has a supercomputing centre for big data and wants to make good use of this centre to generate more research. One of the ways in which they hope to do this is through collaboration with life sciences, to establish a precision medicine centre.

The university would be open to further collaboration with Scottish universities that have strength in big data and precision medicine. At the end of September 2016 they have a planned trip to Oxford and Warwick to look at their progress in precision medicine.

Sun Yat Sen University also has campuses in Zhuhai and Shenzhen which offer broader opportunities. The National Natural Science Foundation has specific funding for Sino-UK research projects which could be used for the collaboration.

## **Business Opportunities**

#### *Guangdong Board of Investment Promotion*

CBBC interviewed Ms Xiaochun Li, Section Chief of Guangdong Board of Investment Promotion, European and American Department, Department of Commerce. According to Ms Li, there are various models that Scottish universities can use to engage with China.

#### Model One: Bring a UK spin-out to China

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<sup>63</sup> <http://www.bioon.com/organization/guangzhou/585952.shtml>

<sup>64</sup> <http://www.21its.com/News/NewsInfo.aspx?id=34147>



One of the encouraged models is for UK spin-out companies to develop and market their business in China, allowing technology that has been developed in the UK to find a place in growing Chinese markets. This will provide opportunities to access funding and enter China's ecosystem of R&D, manufacturing and finance.

In 2014, Lancaster University signed a MoU with the Guangdong Department of Science and Technology (GDST).<sup>65</sup> In the MoU, GDST and Lancaster University launched the *Catalyst Plan*, which aims to promote the industrialisation of advanced technology. GDST will work with Lancaster University on joint industry project development and support match-making between UK scientific achievements and Chinese companies.

The focus is on high-end new electronic information, high-end equipment manufacturing, LED, new energy automobile, biology, energy saving and environmental protection, and new materials. The *Catalyst Plan* benefits small companies in the UK and China, and helps UK technology to incubate in Guangdong and benefit from the Chinese market.

#### Model Two: Joint Venture University

The Guangdong government has a strong focus on the development of industrial design. Coventry University and Guangdong University of Foreign Studies intend to open a joint university and it is reported that this university selection is due to Coventry's particular focus and strength in industrial design, particularly its leading automobile design programme.<sup>66</sup>

#### Model Three: Apply for Joint Funding

In CBBC's interview with Guangdong BIP, it mentioned applying for funding together can also be a way for Scottish universities to work with local universities and R&D companies to apply jointly for international projects.

For example, Guangdong Department of Science and Technology (GDST) signed a MoU with the Netherlands Organisation for Scientific Research (NWO) in December 2015. In the MoU, two organisations agreed to provide funding towards a joint research project on Advanced Materials Chemistry.<sup>67</sup> Under this MoU, on 7<sup>th</sup> April 2016, the Guangdong-Netherlands Advanced Materials Science and Technology Innovation Cooperation Conference was held in Guangzhou. NWO brought universities from the Netherlands to match-make with universities in Guangdong, to discuss jointly working together to apply for funded projects.<sup>68</sup>

In Guangzhou, there is a university cluster which contains two life-sciences oriented universities; Guangzhou University of Chinese Medicine and Guangdong Pharmaceutical University. Within this cluster there is also a Life Sciences Island, which accommodates R&D centres and incubators.

Scottish universities should take the above models as examples of possible methods of interaction with Chinese universities and institutions.

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<sup>65</sup> <http://www.antpedia.com/news/81/n-384581.html>

<sup>66</sup> <http://news.sina.com.cn/o/2016-03-11/doc-ixqhnv5738781.shtml>

<sup>67</sup> <http://www.gdstc.gov.cn/HTML/zwgk/tzqg/1454390363060-584839073718249104.html>

<sup>68</sup> <http://pubaux.gdstc.gov.cn/getNews?newsId=844860>

### 7.3.2 South China: Changsha

#### Hunan Province (Changsha)



Hunan province is located in south-central China, in the middle areas of the Yangtze River and south of the Dongting Lake. It has a population of 67.4 million and is comprised of 13 cities, with Changsha as its capital.

#### Main clusters

##### Changsha High Tech Zone

Changsha High Tech Zone is located near Changsha’s university cluster, which allows them to establish broader collaboration and cooperation with these institutions. The objectives of this cooperation are to develop research projects and findings for commercialisation and industrialisation, to more effectively integrate resources and provide an incubator for scientific achievements. Within the High Tech Zone, there is a Post-Doctoral Research Centre and an Academician Work Station, allowing for the best possible collaborative work and research.

*Table 16: Key Universities & Research Institutes in Changsha High Tech Zone*

University	Website
Central South University	<a href="http://www.csu.edu.cn/">http://www.csu.edu.cn/</a>
Hunan University	<a href="http://www.hnu.edu.cn/">http://www.hnu.edu.cn/</a>
Hunan Normal University	<a href="http://www.hunnu.edu.cn/">http://www.hunnu.edu.cn/</a>

## Key Thematic Areas

The cluster focuses on six key sectors:

- Advanced equipment manufacturing
- Electronic and internet technology application
- New materials
- New energy
- Biopharmaceuticals and healthcare
- Modern service industry

Mr Shuai, Director of the Investment Promotion Bureau at the High Tech Zone, expressed interest in collaboration with Scottish universities if the research areas were within these six sectors. He is very interested in introducing international research teams to the resources at their High Tech Zone incubator.

## Opportunities for International Collaboration

### University Collaboration

#### *Hunan University*

CBBC interviewed Carrie Hu, International Officer at the Study Abroad Department of Hunan University. Ms Hu gave insight on the methods of engagement with international universities that Hunan University prefers, and how Scottish universities can seek to establish partnerships.

Hunan University are keen to establish international partnerships in business and engineering. Hunan University expects its international partners to match it in national ranking tables, i.e. within the top 30 in the country, as it believes mutual interests will be better met. Current universities that it partners with include Swansea University, Hull University and Southbank University.

Hunan University selects successful graduates to send to an international partner institution, to complete a Master's degree programme almost entirely at the expense of the university. Generally, these opportunities are under the condition that upon completion of the programme abroad, the students will return to Hunan University to work there for eight years. In reality, some students do not return and instead pay a compensation fee to Hunan University, often subsidised by employers overseas who are keen to retain the talent.

Hunan University is also active in 2+2 programmes, with various international institutions. Students spend two years at Hunan and two years abroad and are awarded a diploma from the foreign institute.

When discussing the 2+2 programmes, Ms Hu emphasised the importance of Chinese students' experience abroad as an essential factor affecting how many students enrol in the future. In the age of social media, it is much easier to tell if international students are unhappy at their foreign host institution and that if foreign institutions make visible efforts to help Chinese students they will quickly build a good reputation.

#### *Central South University Hunan Xiangya School of Medicine*

Mr Xuejun Li, International Cooperation Department at Central South University Hunan Xiangya School of Medicine, explained that the university is open to seeking foreign university partnerships and collaborations. Hunan Xiangya Medical University is a renowned university in both Hunan and greater

China. It has seven affiliated hospitals and medical centres and is a pioneer in healthcare research. In general, university research is conducted and incubated within the university, as opposed to in an external high tech zone. Currently, the university works with institutions including Cornell, Yale, Emory and the University of Pittsburgh Medical Centre.

The main method of international cooperation is sending doctoral scholars from Changsha to partner institutions for training and welcoming visiting professors, researchers and scientists to Changsha to host lectures and workshops for researchers and doctoral students. Mr Li thinks the same model could work effectively with Scottish institutions, but he also looks forward to a deeper relationship of joint research programmes and 2+2 opportunities.

International cooperation is encouraged through the Belt and Road government initiative and Changsha High Tech Zone is happy to support Scottish universities that are reaching out for collaboration, as this falls in line with Chinese national strategy. Specific models of collaboration including funding, establishing a joint institute, TNE and joint programmes are all options that are best discussed on a case-by-case basis.

### 7.3.3 South China: Fujian Province



Fujian province is located on the southeast coast of China.

#### Key thematic areas

##### Aquaculture

Aquaculture is Fujian's strategic development focus and the sector for targeted growth. Businesses and enterprises in Fujian are eager to introduce technology, particularly in relation to salmon farming, where they see immediate and potentially successful cooperation.

Ms Lihong Cai, Director at Fujian China Council for the Promotion of International Trade (CCPIT), said there is a lot of interest in utilising Scottish strength in on-land salmon farming, which is more sustainable

with minimal environmental impact and helps reduce disease and bacteria from sea lice and chemicals. Collaboration for the development of this technology is a key strategic area where Scotland could bring valuable expertise to the Chinese market.

In addition, there is a growing desire for the development of technology for seaweed farming. Ms Cai referenced developments in the Netherlands using horticultural technology to help the growth of seaweed and increase the area in which seaweed can be produced. The current technology for seaweed farming in Fujian is underdeveloped and businesses are keen to improve it.

Three areas of Fujian have particular interest in this type of technology:

- Ningde
- Zhangzhou
- Fuzhou

Xiamen University, Fuzhou University and Jimei University are very strong in ocean studies and aquaculture. Xiamen University has a College of Ocean and Earth Sciences, Fuzhou University has the College of Oceanography, and Jimei University has the Fisheries College. CCPIT would welcome cooperation between these universities and Scottish institutions regarding previously mentioned aquaculture fields of interest.

*Table 17: Key Universities & Research Institutes in Fuzhou and Xiamen*

University	Website
Xiamen University	<a href="http://www.xmu.edu.cn/">http://www.xmu.edu.cn/</a>
Fuzhou University	<a href="http://www.fzu.edu.cn/">http://www.fzu.edu.cn/</a>
Jimei University	<a href="http://www.jmu.edu.cn/">http://www.jmu.edu.cn/</a>

### **Healthcare**

Regarding healthcare research in Fujian, the subsector of elderly care and dementia are particularly prominent. Fujian province is especially interested in developing technology such as monitors or wearable devices for people suffering from dementia.

In Fuzhou, there is a high tech science park that specialises in dementia research. Ms Cai explained that there would be various opportunities for Scottish universities to come to the science park to conduct technology demonstrations and the government would provide space and offices should Scottish universities be interested in developing R&D centres for elderly care and dementia research in the park.

### **Big Data**

Fujian province is at the core of the “Ocean Silk Road” that largely handles the trade of seafood along the entirety of the East China and East Asia coastline. Due to its status as a hub of international seafood trade and its strategic importance to the Belt & Road initiative, it requires strong e-commerce platforms. In addition, it is developing a global trading centre for beef which furthers the need for e-commerce to facilitate trading.

Scottish universities with strength in e-commerce aspects of big data would be welcome to work with these trading sectors in the improvement of technology and online system processing.



Located at an intersection of the Yangtze River, Wuhan has historically been the gateway to China's nine central provinces and is the hub for railway, road and water intersections. It is only 4 to 5 hours from Beijing, Shanghai, Guangzhou and Hong Kong.

Wuhan has nearly 1 million students, of which 10% are post-graduates, across 80 universities including 7 top Chinese universities. Due to a well-educated and skilled local workforce, Wuhan is home to China's leading production base for fibre optics and lasers.

## **Main Clusters**

### **City Cluster along the Middle Reaches of Yangtze River**

In April 2015, the State Council approved the *Development Plan for City Cluster* along the Middle Reaches of Yangtze River. According to the plan, "the city cluster will promote the coordinated development between urban and rural areas, facilitate the connectivity of infrastructure, promote coordinated development of industries, co-build ecological civilisation, share public services and deepen reform and opening-up". In terms of the coordinated development of industries, the plan particularly emphasised that the city cluster should build competitive industry clusters, strengthen modern agriculture bases, promote industrial transfer among different areas and speed up industrial upgrades.

The total coverage of this city cluster is 317,000 square kilometres, comprising of 3 provinces and 31 cities.<sup>71</sup> Higher education institutions, local policy-makers, R&D institutes and think tanks are working together to support the economic development of the region.

### **Wuhan East Lake High-tech Development Zone**

Wuhan East Lake High-tech Development Zone (WELHDZ) was founded in 1988. In 2001, it was approved by the former State Planning Commission and the Ministry of Science as the optoelectronic industry base for the country; the "Optics Valley of China".

WELHDZ is ranked 3<sup>rd</sup> in China's high-tech zones and generated a revenue of RMB 85 billion in 2014, a year-on-year increase of 31%. Optoelectronic and optical communications generated RMB 36 billion of the total in 2014, a year-on-year increase of 37% and accounting for 43% of the total. Approximately 3,043 hi-tech companies are located in the zone, employing 449,644 people.<sup>72</sup> The zone has core strength in optoelectronic information and has strategic development plans for the bio-industry, environmental protection and energy saving industry as well as advanced equipment manufacturing.

Fields with strong competitive advantages include optical communications, laser technology, consumer electronics, integrated circuits and geo-space information.

To date WELHDZ has received more than 50 policy support efforts from the central and municipal government in regards to management, finance and the commercialisation of research findings.

The most influential policy, *Opinions on the Innovation Mechanism of Commercialization of Research Findings of Wuhan East Lake State Innovation Demonstration Zone*, plays a significant role in inspiring higher education teachers to start their own business and encouraging them to commercialise the research findings. The policy stipulates that the income distribution rate for the research team can be up to 80%, a sharp increase that also impacts incentive.

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<sup>71</sup> [http://news.xinhuanet.com/local/2015-04/16/c\\_1114995338.htm](http://news.xinhuanet.com/local/2015-04/16/c_1114995338.htm)

<sup>72</sup> <http://www.dhtj.net/newsDetail.shtml?newskindid=20100730104946109v7YzAqBJRAOqK&newsinfoid=20160701095647103eZxMPKfA7zLs1>

## Key thematic Areas

### Sensors and Imaging

Dating back to 2001, China has had an established optoelectronic industry base in Wuhan city, Hubei province. It is the first and only national high-tech development zone specialising in optoelectronics and optical communication.

In 2009, the State Council approved the establishment of the second *National Innovation Demonstration Zone* in Wuhan which catalysed the cooperation of industry, academia including R&D.

### Optical communications

China's first optical fibre and optical transmission system was established here, and it yielded the largest production volume of optical fibre and cables. The annual output of optical fibre is 70 million kilometres.

*Table 18: Leading Companies in Optical Communications*

Company	Website
FiberHome Technologies Group	<a href="http://www.fiberhomegroup.com/en/About/57.html">http://www.fiberhomegroup.com/en/About/57.html</a>
Yangtze Optical Fibre and Cable Joint Stock Limited Company	<a href="http://en.yofc.com/index.php/index-show-tid-8.html">http://en.yofc.com/index.php/index-show-tid-8.html</a>
Wuhan Wutos	<a href="http://www.wutos.com/About/4.aspx#">http://www.wutos.com/About/4.aspx#</a>

### Laser Technology

The WELHDZ is the biggest industrial base for lasers in China, and includes more than 200 companies with a domestic market share consistently over 50%.

*Table 19: Leading Companies in Laser Technology*

Company	Website
Huagong Tech	<a href="http://www.hgtech.com/About/Corporate-Information.html">http://www.hgtech.com/About/Corporate-Information.html</a>
Wuhan Raycus Fiber Laser Technologies (Raycus)	<a href="http://www.raycuslaser.com/en/About/Default.aspx">http://www.raycuslaser.com/en/About/Default.aspx</a>
Chutian Laser Group	<a href="http://www.chutianlaser.com/">http://www.chutianlaser.com/</a>

### Consumer Electronics

The production capacity for desktop computers in Wuhan Foxconn Science and Technology Park is the largest in the world, and accounts for over 50% of capacity worldwide. Lenovo's MIDH operations in Wuhan are soon expected to produce 100 million smartphones and computers. The TFT-LCD and CF G4.5 production projects by Wuhan Tianma Micro-Electronics have developed into the largest individual investment manufacturing projects for the new tablet/PC display sector in Hubei.



Table 20: Leading Companies in Consumer Electronics

Company	Website
Wuhan Foxconn Science and Technology	<a href="http://www.foxconn.com.cn/">http://www.foxconn.com.cn/</a>
Lenovo	<a href="http://www.lenovo.com.cn/">http://www.lenovo.com.cn/</a>
Tianma Micro-Electronics	<a href="http://en.tianma.com/">http://en.tianma.com/</a>

### **Integrated Circuits**

With the establishment of Wuhan Xinxin Semiconductor Manufacturing and the completion of the 12'' Chip project, the semiconductor upstream and downstream industries have developed and aggregated. Currently, there are more than 20 IC design companies in the WELHDZ. Notable companies include Synopsys and Wuhan Guide Infrared.

Table 21: Leading Companies in Integrated Circuits

Company	Website
Synopsys	<a href="http://www.synopsys.com/home.aspx">http://www.synopsys.com/home.aspx</a>
Wuhan Guide Infrared	<a href="http://www.wuhan-guide.com/Plus/m_default/Cms/default.php">http://www.wuhan-guide.com/Plus/m_default/Cms/default.php</a>

### **Opportunities for International Collaboration**

#### **University Collaboration**

Wuhan is particularly well known for its higher education. The following describes top Wuhan universities, their key research focus areas and collaboration practices.

##### *Wuhan University*

Founded in 1893, Wuhan University is a comprehensive and key national university directly under the administration of the MOE. It is also one of the "211 Project" and "985 Project" universities, with full support in construction and development from China's central and local government.

Wuhan University has five national key disciplines; theoretical economics, biology, hydraulic engineering, surveying and mapping, and library, information and document management. It also has five key state laboratories; virology, water resources and hydropower engineering science, hybrid rice, software engineering and information engineering in surveying, mapping and remote sensing.<sup>73</sup>

Wuhan University has signed cooperation agreements with more than 400 universities and research institutions in over 45 countries and regions for in-depth cooperation in various fields, including University of Chicago, Duke University, University of Cambridge, London School of Economics and Political Science (LSE), National University of Singapore, Erasmus University Rotterdam (EUR) and Université Paris Diderot-Paris.

<sup>73</sup> <http://www.whu.edu.cn/xxgk/xxjj.htm>

Wuhan University promotes its Top Master Programmes to encourage transnational education. In 2015, Wuhan University collaborated with LSE to enrol five students to take further study in UK.

Cooperating with prestigious universities abroad, Wuhan University has launched joint training programmes in the fields of physics, chemistry, medicine, computer science, remote sensing, law and economics, to mentor talents with international experience, perspective and competitiveness.

#### *Huazhong University of Science and Technology (HUST)*

HUST is a comprehensive and multi-disciplinary research university directly under the administration of MOE. It has seven national key first-level disciplines and 15 national key sub-disciplines. The University is ranked first in China in three disciplines: mechanical engineering; optical engineering; and public health and preventive medicine.

HUST has established partnerships with more than 100 renowned universities and research institutions worldwide. In the UK, HUST has cooperation programs with seven universities; including University of Birmingham, University of Glasgow, Loughborough University, Queen Mary University of London, University of Aberdeen, University of the West of England and Cranfield University.

#### *Wuhan University of Technology (WUT)*

WUT is one of the leading Chinese universities under the direct administration of the Ministry of Education and one of the universities constructed as priority by the “State 211 Project” for Chinese higher education institutions.

WUT has 27 innovative research centres with international leading levels including two State Key Laboratories, one State Engineering Laboratory, one National Engineering Research Centre and ministerial or provincial level laboratories in the areas of new materials, new energy, transportation and logistics, mechatronics and automobile, information technology, resources and environmental technology.

In 2010, WUT established the Joint Laboratory of Advanced Optoelectronic Materials and Devices with the University of Strathclyde.

Ms Wan, Director of Overseas Study at the Centre of International Education and Exchange in Wuhan University of Technology, explained that its TNE programmes are divided into two categories.

#### Chinese-Foreign Joint Programme Approved by MOE

In 2010, Wuhan University of Technology launched a joint programme with the University of Wales. The approved programme allows WUT to recruit 100 students each year from 2010 to 2017. Students can earn a diploma from WUT and a Bachelor Degree of Arts in Design from the University of Wales.

WUT also has an approved joint programme with the University of Wales in automotive engineering. From 2013 to 2017, WUT can recruit 150 students each year. Students will be awarded a Bachelor of Engineering Degree from WUT, Bachelor of Engineering in Automotive Engineering and Bachelor of Engineering in Motorsport Engineering from the University of Wales.

#### International Exchange Program

WUT has established international exchange programmes with several foreign universities. For example, the University of Dundee and the University of Strathclyde already have established international exchange programmes with WUT. International exchange students have the opportunity to study at the

University of Dundee, for one or two years, and are then required to return to WUT after graduation in order to gain credit acknowledgement.

WUT is open to discuss further collaboration opportunities with Scottish universities on possible joint programmes and student exchange or study abroad.

#### *Research Institutes*

The National Engineering Research Centre – Optical Fibre Communications Technology (NERC-OFCT) was built on the basis of the research strength of Wuhan Institute of Post and Telecommunications. NERC-OFCT put a lot of effort into transforming research findings into key technologies that can be produced large scale. The centre is managed by FiberHome Technologies.

NERC-LP was built based on the research strength of Huazhong University of Science and Technology. The centre mainly involves research and development, commercialisation of laser components, laser processing techniques and equipment.

Wuhan National Laboratory for Optoelectronics (WNLO) was co-founded by the MOE, Hubei Provincial Government and Wuhan Municipal Government. It is one of the initial five national laboratories authorised in November 2003, by the Ministry of Science and Technology. The laboratory is managed by Huazhong University of Science and Technology in collaboration with Wuhan Research Institute of Posts and Telecommunications.

It is structured with six divisions of research:

- Biomedical photonics
- Information storage and optical display
- Laser and Tera-hertz technology
- Optoelectronic devices and integration
- Optoelectronic detection and radiation
- Photonics for Energy

The Optical Fibre Sensing National Engineering Laboratory was founded in November 2011. It is approved by NDRC with the aim of carrying out optical fibre sensor research and to improve the level of industry information in China. It also does research on key components of optical fibre sensor, sensing devices and system simulation and simulation verification. The laboratory is managed by Wuhan University of Technology.

#### **Business Collaboration**

According to Mr Zhang Xiao, Director of Corporate Services at WELHDZ, optoelectronics and optical communications are traditional and core industries occupying the largest proportion of GDP in the zone. In line with further technology development and national strategy, bio-technology, advanced engineering and modern service industries are also given strategic focus.

In the bio-technology industry, WELHDZ has attracted several Fortune 500 companies' R&D centres including: BAYER, Fresenius KABI, Thermo Fisher Scientific, Pfizer and Syngenta. A Chinese company in the bio-technology industry, Humanwell Healthcare Group, has seen rapid growth and was the first listed company in Hubei Province. Another Chinese genetic technology company, BGI, established the Wuhan BGI in WELHDZ, with the aim of commercialising cutting edge research findings for the human health and agricultural breeding.

In the traditional optoelectronics and optical communications industry, Mr Zhang said there are many successful projects and gave two as an example:

- Laser Processing
  - Leveraging the research findings of the National Engineering Research Centre in laser processing, Huazhong University of Science and Technology and a university from Moscow signed an agreement to commercialise Russia's solid laser cutting techniques in China
  - Wuhan Laser Engineering, a laser company with extensive experience in laser equipment manufacturing in WELHDZ was commissioned to establish a joint venture to satisfy the need for wide cutting equipment in the global market
  - During the launch of this project, WELHDZ also provided financial support.
  
- Light Links the Things
  - In 2015, WELHDZ released a "grand plan" called *Light Links the Things*
  - Huawei Wuhan Research Centre, located in WELHDZ, is the flagship company in this area
  - It developed a special optical fibre sensing with the Irish Photonic Integration Centre (IPIC)

Since 2002, the Optics Valley of China has built a platform to showcase its cutting-edge technologies and to seize market opportunities through international exchange. It will hold the 13<sup>th</sup> International Optoelectronic Exposition and Forum (OVC Expo) in Wuhan from November 3<sup>rd</sup> to 5<sup>th</sup> 2016. The Expo will present optoelectronic technology in the areas of optical communications, mobile communications, fibre and cable, big data application, laser application, 3D printing and smart cities.

The Expo is organised by MIIT, MST, State Intellectual Office of China, The Chinese Academy of Sciences, China Council for the Promotion of International Trade and Peoples' Government of Hubei Province. Around 480 optoelectronic companies will participate, with an expected 27,000 visitors.

According to Mr Zhang, WELHDZ has cooperated with the United States Patent and Trademark Office, the Irish Photonic Integration Centre, a professional research institute from Russia and others in past Expos. No research institute or company from the UK has attended the Expo up to now. WELHDZ hopes to cooperate with universities, research institutes and companies from Scotland and would like to invite them to participate in the Expo 2016 and hold an event or forum for collaboration with Chinese stakeholders. Regarding the booth and forum expenses, they would be willing to give support to Scottish institutions hoping to attend.

Mr Zhang also said WELHDZ would like to bring in talent and advanced technology in the particular subsectors of:

- Chip design for the integrated circuit industry
- Chips applied in precision instruments and lasers
- Genetic sequencing technology
- Cerebral angiography in the life sciences industry

If cooperation in these areas were successful with Scottish universities, the partnership would be especially beneficial for the development of optoelectronics in China.

#### 7.4.2 Central and West China: Shaanxi Province - Physics & Life Sciences



Shaanxi Province is located in central China and is a key transfer station for inland transportation to Central Asia and Europe. Shaanxi covers an area of 205,800 square kilometres and has a population of 37.50 million.

Shaanxi is an important base for key scientific research and industry in the fields of national defence technology, modern agriculture and hi-tech studies. It has 1,076 research institutes and 1.47 million professionals of different disciplines, including 52 members of the Chinese Academy of Science and Chinese Academy of Engineering.

The index of Shaanxi's scientific and technological comprehensive progress in 2015 was 60.73%, ranking it 7<sup>th</sup> nationwide and 2<sup>nd</sup> for innovation outputs. The provincial capital city of Xi'an is the third largest educational hub in China, with only Beijing and Shanghai surpassing it. In January 2010, Xi'an was selected as one of the first national group of innovative pilot cities.

#### **Main Clusters**

##### **Xi'an Institute of Optics and Precision mechanics of CAS (XIOPM)**

Based in Xi'an Hi-tech Industrial Development Zone, XIOPM has transferred and transformed more than 30 hi-tech projects, incubated over 50 hi-tech enterprises, absorbed over 700 million social investments and formed an optoelectronic integrated circuit chip industrial cluster, high-end laser equipment and manufacturing industrial cluster as well as a medical health industrial cluster.

The key research fields of XIOPM cover basic optics, space optics and photoelectric engineering. Its main research directions include transient optics, photonics theory and technology, space optics remote sensing techniques, interference spectrum imaging theory and technology and photoelectric information technology.

E: [research@cbbc.org](mailto:research@cbbc.org)

T: +44 (0)20 7802 2000

The Institute has one national key laboratory and two CAS key laboratories State Key Laboratory of Transient Optics and Photonics, CAS Key Laboratory of Ultrafast Diagnosis Technology and CAS Key Laboratory of Spectral Imaging Technology.

In recent years, XIOPM aimed to build a platform for better entrepreneurship through learning from world leading technology. It developed the “Talent, Technology, Service, and Capital” model of commercialising research findings and established the first Angel Funding and incubation centre in northwest China. Together with Xi’an Hi-tech Industries Development Zone, XIOPM established the Incubation and Collaborative Innovation of Optoelectronic Engineering Demonstration Base in 2013, with the aim of bringing global talent in the field of optoelectronic and optical communications and to incubate high-tech enterprises.

In 2015, President Xi Jinping visited XIOPM and supported the achievements in research commercialisation. The provincial governor of Shaanxi stated in the Government Work Report, that it should duplicate the innovation mechanism of XIOPM to stimulate the passion for entrepreneurship.

*Table 22: Key Universities & Research Institutes in the Cluster*

Organizations	Website
Xidian University	<a href="http://www.xidian.edu.cn/">http://www.xidian.edu.cn/</a>
Xi’an University of Posts & Telecommunications	<a href="http://www.xiyou.edu.cn/">http://www.xiyou.edu.cn/</a>
Institute of Photonic & Photon-Technology of Northwest University	<a href="http://ippt.nwu.edu.cn/">http://ippt.nwu.edu.cn/</a>
Xi’an Jiaotong University	<a href="http://www.xjtu.edu.cn/">http://www.xjtu.edu.cn/</a>
Shaanxi Institute of Optoelectronic Integrated Circuit Led Technology	<a href="http://www.chinaoeic.com/cn/index.html">http://www.chinaoeic.com/cn/index.html</a>

*Table 23: Key Companies in Sensors and Photonics in the Cluster*

Organizations	Website
Xi’an Sino Zhijing Electric Power Technology	<a href="http://www.sinozhijing.com/contents/3/136.html">http://www.sinozhijing.com/contents/3/136.html</a>
Xi’an Crystal Pixel Optoelectronics Technology	<a href="http://www.christalpixel.com/womene/womene.htm">http://www.christalpixel.com/womene/womene.htm</a>

Xi'an Heqi Opto-Electronic Technology (Optosensor)	<a href="http://www.optsensor.net/who.php">http://www.optsensor.net/who.php</a>
QXP Technologies Inc.	<a href="http://www.qxptech.com/en/html/about/introduction/">http://www.qxptech.com/en/html/about/introduction/</a>
Xi'an Zhixiang Optoelectronics Technology	<a href="http://www.chishine3d.com/en/list.php?pid=1">http://www.chishine3d.com/en/list.php?pid=1</a>

### **Yangling Agricultural Hi-tech Industrial Demonstrative Zone**

The Yangling Agriculture Hi-Tech Industrial Zone was approved as a national-level hi-tech development zone by the State Council in 1997. It is only 82 kilometres from Xi'an to the east and 70 kilometres from Xi'an Xianyang International Airport.

The Yangling is the only Agricultural Hi-tech Industries Demonstration Zone at a state level, giving it access to special joint ministry-province administrative systems. The leading industries of Yangling are modern agriculture, green food, biotechnology, and energy-saving and environment-friendly industries. At present, there are more than 1,000 registered enterprises, 59 identified as hi-tech enterprises and 22 companies limited by shares.<sup>74</sup>

Yangling demonstration zone has introduced and promoted more than 1,700 quality breeds from both home and abroad, by focusing on arid and semi-arid modern agriculture. Additionally, it has popularised 200 million mu of crop breeds and more than 1,000 practical agricultural technologies from which more than 50 million rural residents have benefited. At present, the zone covers these eight industries:

- Quality breeds of grain and oil
- Vegetables
- Nursery stock
- Fine breeding pig rearing
- Fine beef cattle rearing
- Flowers and plants
- Edible fungi
- Economical forestry and orchard

It has more than 1,400 new and quality breeds of 17 varieties; 10,000 mu of grain breed rearing bases and has yielded 5 million km fine wheat seeds. The vegetable production base has set up more than 4,800 sunlight greenhouses and more than 4,300 mu of medium vegetable shelters; fruit trees and nursery stock bases cover more than 7,000 mu and enables 1,000 mu of walnut seed rearing bases in Wugong County.

Projects to be completed include livestock cultivation projects such as Kingbull husbandry, Aoyuan husbandry and ten thousand Qinchuan dairy and beef cattle, as well as the production of demonstrative bases for quality edible fungi, flowers and plants.

*Table 24: Educational Institutions Located in Yangling Agricultural Hi-tech Industrial Demonstrative Zone*

<sup>74</sup> <http://www.yangling.gov.cn/ylzx/bdyw/13100.htm>; <http://xian.qq.com/a/20141110/046115.htm>

University	Website
Northwest Agriculture & Forestry University	<a href="http://www.nwsuaf.edu.cn/">http://www.nwsuaf.edu.cn/</a>
Yangling Vocational & Technical College	<a href="http://www.ylvtc.cn/">http://www.ylvtc.cn/</a>
Shaanxi Medical College	<a href="http://www.xayz.com.cn/">http://www.xayz.com.cn/</a>
Yangling Middle Vocational School	<a href="http://www.ylcollege.com.cn/">http://www.ylcollege.com.cn/</a>
Yangling Vocational Education Centre	<a href="http://www.ylvec.com/">http://www.ylvec.com/</a>

Modern agriculture has close connections with biotechnology and information technology. The Northwest Agriculture and Forestry University, typically referred to as a traditional agriculture university in China, has strong research capabilities in animal sciences and animal medicines. It has a key laboratory on livestock reproductive endocrinology and embryonic stem cell research, which was approved in 1980 by the Ministry of Agriculture of China. The laboratory focuses on three key areas; livestock embryo, animal cloning and transgenesis, stem cells and tissue engineering. Since the 1990s, the laboratory has achieved many great results in each of the three areas.<sup>75</sup>

The Yangling local government and Digital China have jointly founded the "Yangling Agricultural Cloud" based on the "Internet + agriculture" strategy. It is built using the technology of agricultural big data that covers farmland right registration data, farmland trading records, agricultural finance data, agricultural technique data and a vast amount of data on agricultural production processes.

### Key Thematic Areas

Based on the innovation development encouraged by the State Council, Shaanxi province has paid special attention in recent years to the key thematic areas detailed below, which Scotland also has comparable strength in.

#### **Physics (sensors and photonics)**

Shaanxi is one of just three key sensor production bases in China, focusing on voltage sensitivity, thermal sensitivity and automobile electronics.<sup>76</sup>

According to the Shaanxi Province 12<sup>th</sup> Five Year Plan on the Internet of Things industry (IOT), released by the Shaanxi Provincial Government in 2016, Shaanxi has over 70 sensor R&D and production organisations in the sensors field that have significant influence in areas of smoke, image, gravity and Micro-Electro-Mechanical Systems (MEMs) pressure sensors. Shaanxi will establish a sensor engineering research centre, supported by Xi'an Datang Telecom, Northwestern Polytechnic University and other related organisations.<sup>77</sup>

<sup>75</sup> <http://www.nwsuaf.edu.cn/kxyj/kyjd/sbjyszdsys/2515.htm>

<sup>76</sup> <http://sensor.ofweek.com/2015-12/ART-81012-8420-29041130.html>

<sup>77</sup> <http://www.shaanxi.gov.cn/0/1/65/364/857/1239/238.htm>



Since the "Broadband in China" and "Made in China 2025" initiatives were laid out in early 2016, the Science and Technology Department of Shaanxi Provincial Government has contributed RMB 20 million, together with Shaanxi Science and Technology Holding Group and Xi'an Institute of Optics and Precision Mechanics of CAS (XIOPM), to co-establish the Shaanxi Institute of Advanced Optoelectronic Integrated Circuit Technologies in order to promote the optoelectronic integrated circuit industry.<sup>78</sup>

### **Life Science (plant, animal and veterinary science)**

Shaanxi province has a good base for life science development. Currently, there are eight HEI's with life science disciplines and four research institutes for biological science. Among these institutes, the Fourth Military Medical University, Northwest University, Northwest Agriculture and Forester University, Xi'an Jiaotong University and Shaanxi Normal University are the national life science and technology talent cultivation bases, with 13 national key laboratories and 14 provincial key laboratories.<sup>79</sup>

## **Opportunities for International Collaboration**

### **University Collaboration**

#### *Northwest Agriculture and Forestry University (NWAUFU)*

NWAUFU is a key national comprehensive university, directly under the administration of the MOE. As one of the leading universities in China, NWAUFU is supported by the MOE's "Project 985" and "Project 211". The University is located in the National Agriculture High-tech Industrial Demonstration zone in Yangling, Shaanxi province.

NWAUFU has 26 colleges and institutes including agronomy, horticulture, veterinary medicine, water resources and architectural engineering, plant protection, animal science and technology, forestry, natural resources and environment, mechanical and electronic engineering. It has an institute of soil and water conservation and a state key laboratory of crop stress biology for arid areas.

Mr Qiao Wenjun, Vice Director of International Cooperation Department at NWAUFU, said that NWAUFU has established cooperation for joint training with institutes across the world including the UK, Spain, France, the US, Australia, Japan, Denmark, Belgium, Germany and Canada.

In the UK, Bangor University and the University of Exeter have good intercollegiate exchange programmes with NWAUFU and the university is open to establishing more opportunities of cooperation in research programmes and training programmes particularly with Scottish universities.

### **Business Collaboration**

#### *Xi'an Institute of Optics and Precision Mechanics of CAS (XIOPM)*

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<sup>78</sup> <http://www.sxdaily.com.cn/n/2016/0102/c266-5781477.html>

<sup>79</sup> <http://www.shaanxi.gov.cn/0/1/65/364/857/1239/242.htm>

Mr Geng, Project Director of Xi'an Institute of Optics and Precision Mechanics of CAS (XIOPM), explained its methods of international cooperation and provided some suggestions for potential cooperation with Scotland.

XIOPM has established extensive international exchange programmes and cooperation with many countries including the US, UK, Canada, Italy, Switzerland, Japan, Australia and Germany. In 2014, it concluded an agreement to jointly train graduates with the University of Rochester in the US. The Institute has also cooperated with Italy to establish the Joint Laboratory for Ultra-fast Photonic Network and Communication.

Working with the University of South Wales, it established a China-UK joint research centre for micro-nano photonics, and established respective joint laboratories with Xi'an Jiaotong University and Northwest Polytechnic University.

Potential areas of international cooperation include optical engineering, optoelectronic integrated circuit, optical remote sensing, biomedical sensors and measurement, deep sea detecting optical imaging and solar energy.

#### *Yangling Agricultural Hi-tech Industrial Demonstrative Zone*

In 2008, the China-UK Sustainable Agriculture Innovation Network (SAIN) was established, with its secretariat based in NWAUFU at the Industrial Development Zone. SAIN provides a coherent framework for the development and implementation of China-UK collaboration on environmentally sustainable agriculture and supports cooperation in sustainable agriculture and food security, providing a flexible and largely self-sustaining platform for long-term collaboration.

There is no limit on disciplines for the cooperation, and could include life science, veterinary medicine, plant protection, animal science and other disciplines which are comparatively strong in Scotland.

In November 2016, NWAUFU will run an event in Yangling focusing on precision agriculture and big data. According to Mr Li, there will be a UK delegation of 15 UK universities attending the event and they would welcome Scottish universities to attend.

Mr Liu Xiaojun, Director of International Cooperation at Shaanxi Provincial Department of Science and Technology (SPDST), explained to CBBC that according to the Overall Development Goals of Shaanxi Province during the 13<sup>th</sup> Five Year Plan, Shaanxi will form an innovation-driven development system that features Shaanxi's strengths and advantages.

Furthermore, Shaanxi will strengthen its innovative ability and increase investment in research and development. The major research areas are; energy and chemical industry, equipment manufacturing, electronic information, biomedicine, new materials, new energy, modern agriculture, modern services, energy saving, environmental protection, 3D print, robotics, big data and cloud computing, semiconductors and photo electronics.

According to Mr Liu, Shaanxi comprehensively developed around 200 disciplines, among which physics, new energy, big data and life science could be potential areas to cooperate with Scotland.

In September 2016, the Shaanxi International Cooperation Base will be set up in order to promote the internationalisation of high-tech enterprises, scientific research institutions and high-tech industrial park. The base plans to establish long-term and stable cooperation mechanisms with foreign countries via R&D cooperation, talents co-cultivation, exchanges and visits, and technology transfers.

### 7.4.3 Central and West China: Sichuan Province - Life Sciences & Creative Industries



West China plays an important role in China's higher education sector. 25 of the 134 national key universities are located in west China, 19% of all Chinese universities. There are nine in Shaanxi, seven in Hubei, six in Sichuan and three in Chongqing.<sup>80</sup> The university clusters in southwest and northwest China also have close interaction with local industry.

#### **Policies and regulations from local government to support the region**

In 2016, the Chinese government initiated various 13<sup>th</sup> Five Year Plans at a national level. In 2011, the Chengdu-Chongqing economic zone was approved by the central government and is the "fourth pole" following Bohai Bay, Yangtze River and Pearl River Delta regions.

The economic zone comprises 15 cities and 31 districts and counties in Chongqing municipality and in Sichuan province, covering an area of over 200,000 square kilometres. It lists eight sectors including equipment manufacturing, auto accessories, electric information and aviation, as key industries for its future development.

In 2016, a Chengdu-Chongqing city cluster was also approved by the central government as a national-level cluster. The three major sectors the cluster will focus on are; equipment machinery, pharmaceuticals and life sciences, and agriculture. The government is also interested in developing new sectors including logistics, tourism and the creative sector.<sup>81</sup>

To follow on from the above strategy, the Chongqing and Chengdu governments are planning to issue the Three Year Action Plan for Emerging Industries in the region, as a revitalisation strategy for the southwest industrial base.

#### **Main Clusters**

<sup>80</sup> [http://www.360doc.com/content/16/0619/17/6324201\\_569054895.shtml](http://www.360doc.com/content/16/0619/17/6324201_569054895.shtml)

<sup>81</sup> [http://www.cq.xinhuanet.com/2016-03/31/c\\_1118495424.htm](http://www.cq.xinhuanet.com/2016-03/31/c_1118495424.htm)

### Chengdu High tech Zone

Chengdu High-Tech Zone is home to 773 life sciences companies, with a pharmaceutical cluster of over 300 companies and a medical technology cluster of around 200 companies.<sup>82</sup> The total number of employees in the zone is 27,000.

Taking the drug development industry as an example of specific subsectors within pharmaceuticals, there are already companies set up that deal specifically with drug discovery, drug development, clinical trials and final manufacturing.

*Table 25: Life Sciences Companies Located in the High-Tech Zone*

Company	Website
Diao Group Chengdu Pharmaceutical	<a href="http://www.diaocdy.com/">http://www.diaocdy.com/</a>
Chengdu Rongsheng Pharmaceuticals	<a href="http://www.ronsen.com/eng/">http://www.ronsen.com/eng/</a>
Chengdu Xiandao Drug Discovery and Development	<a href="http://www.bio1000.cn/com/pcc49581629/">http://www.bio1000.cn/com/pcc49581629/</a>
Alltechmed	<a href="http://www.alltechms.com/">http://www.alltechms.com/</a>
icareTech Healthcare	<a href="http://en.icaretek.com/">http://en.icaretek.com/</a>
Clover Biopharmaceuticals	<a href="http://www.cloverbiopharma.com/">http://www.cloverbiopharma.com/</a>
Chengdu Mollcan Biopharma	<a href="http://www.molcancd.com/">http://www.molcancd.com/</a>
Baiyu Group	<a href="http://www.baiyujituan.com/index.php?go=default">http://www.baiyujituan.com/index.php?go=default</a>
Chempartner	<a href="http://www.chempartner.com/">http://www.chempartner.com/</a>
Baili Phar	<a href="http://www.baili-pharm.com/">http://www.baili-pharm.com/</a>
BetterLife Medica	<a href="http://www.goblm.com/Index.aspx#">http://www.goblm.com/Index.aspx#</a> <a href="http://www.tianyancha.com/company/2350379329">http://www.tianyancha.com/company/2350379329</a>
SentinAll Bio Technologies	<a href="http://www.sentin-all.com/">http://www.sentin-all.com/</a>
Brilliant Pharmaceutical Group	<a href="http://www.btyy.com/">http://www.btyy.com/</a>
Revotek	<a href="http://www.revotek.com.cn/">http://www.revotek.com.cn/</a>
Genekey Biotech (Chengdu)	<a href="http://www.genekeybio.com/">http://www.genekeybio.com/</a>
Chengdu Origissay Diagnostics	<a href="http://www.origissay.com/">http://www.origissay.com/</a>

According to a public speech from the senior management team at the high tech zone in May 2016, it plans to focus on the following subsectors for life sciences:

- Biopharmaceuticals, including new vaccine discovery

<sup>82</sup> <http://www.biotech.org.cn/information/134275>

- Medical device development, including imaging equipment
- Diagnosis equipment
- Long-distance diagnosis
- Digital health<sup>83</sup>

### **Creative cluster at Tianfu Software Park (Chengdu High-tech Zone)**

Over 600 gaming and animation companies are now operating in the Chengdu high tech zone. Chengdu has the most potential for gaming and animation R&D in China, supported by the fact that among the Top 10 global gaming companies, five are in China, three of which are in Chengdu; Digital Sky, Dreamwork and Tap4fun.

### **Chengdu Animation & Network Culture Association**

The Chengdu Animation & Network Culture Association was established by the Chengdu Municipal Culture Bureau in 2012, acting as the functional organisation of the government. It hosts animation exhibitions in southwest China and creates incubation platforms for the gaming and animation industries.

According to the 13<sup>th</sup> Five Year Plan for Sichuan province, the industries for development include news, publishing, broadcasting and film, with plans to build a group of industry parks for the creative sector.

Sichuan aims to have two to three industrial groups which generate over RMB 10 billion per year and a further five to eight enterprises with revenue over RMB 5 billion. An estimated three to five companies will be publically listed.

*Table 26: Key Universities & Research Institutes in Creative Sector*

University	Website
Sichuan University of Media and Communications	<a href="http://www.scmc.edu.cn/">http://www.scmc.edu.cn/</a>
Sichuan Film and Television University	<a href="http://www.scftvc.com/">http://www.scftvc.com/</a>
Sichuan Vocational College of Culture and Communication	<a href="http://www.svccc.net/">http://www.svccc.net/</a>
Chengdu Art Vocational College	<a href="http://www.cdartpro.cn/">http://www.cdartpro.cn/</a>
Jincheng College of Sichuan University	<a href="http://www.scujcc.com.cn/">http://www.scujcc.com.cn/</a>

### **Policies and regulations from local government to support the cluster**

The Chengdu Five Year Plan sets the target of coordinating core creative cities to develop sufficient talent, including recruiting talent from abroad. Additionally, the government wants to incubate a group of leading enterprises whose annual turnover is over RMB 100 million and establish internationally recognised brands, as well as popular clusters for creative industries.

<sup>83</sup> <http://www.biotech.org.cn/information/134275>

The combination of creative sectors and technology is the new trend for Chengdu, creating a growing focus on cultivating gaming and animation, application development, new media and 3D/environmental friendly printing.

The Sichuan government also plans to use the base of the National Centre for Developing Animation, Cartoon & Game Industry Sichuan (<http://www.ncacg.org/>) to establish platforms for animation materials, works, technologies and digital channels. CANCA is also considering getting involved with these projects.

According to the 2015 Internet Plus White Paper, the opportunities for the southwest market will be through the blue ocean market such as MOBA, 3D Action and sandboxing, instead of cosplay and cards.

## **Key Thematic Areas**

### **Life Sciences**

Chengdu is home to nearly 400 biomedical enterprises that cover various aspects of the industry, including modern applications for Traditional Chinese Medicine (TCM), synthetic drug production and pharmaceutical research. Blood-based products and major transfusion products manufactured in Chengdu account for one-third of the nation's market share, and the gross annual output of the pharmaceutical and manufacturing industries rank first in West China.

According to research from the consulate of the Netherlands in 2013, Chengdu is regarded as a unique metropolitan area for employment in the bioscience field. There are ten universities in Chengdu that offer majors in pharmaceutical sciences and 13 offer majors in chemistry. A further 12 vocational and technical colleges offer secondary technical training in pharmaceuticals and nearly 10,000 professionals in various fields are trained each year. Chengdu has the world's largest clinical education training centre which is certified by the American College of Surgeons in Asia, according to the same research.

### **Gaming and Animation**

Chengdu is the 4<sup>th</sup> largest market for mobile games and the gaming and animation industry base here is well known for its R&D capability. Several top ranking Chinese companies have already expanded into markets in America, France and Southeast Asia.

## **Opportunities for International Collaboration**

### **University Collaboration**

#### *Sichuan University<sup>84</sup>*

Located in Chengdu, Sichuan University is a key comprehensive university under the direct supervision of the Ministry of Education with disciplines covering the humanities, science, engineering, medicine, economics, management, law, history, philosophy, agriculture and education.

Sichuan University has strengths in life sciences research, with 13 national key laboratories and engineering centres, 11 key laboratories and 6 engineering research centres. It has established international relationships with colleges, universities and research institutes from 32 countries and regions.

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<sup>84</sup> <http://www.scu.edu.cn/en/>

*West China Centre of Medical Sciences, Sichuan University*<sup>85</sup>

Located in Chengdu, the West China Centre of Medical Sciences is one of the eight key medical universities under the Ministry of Education. As a leading medical school, it consists of five key disciplines; basic and forensic medicine, medicine, stomatology, public health and pharmacy. With nine well-equipped, cutting-edge research laboratories and centres, it maintains cooperation with 150 universities from 43 countries and regions including the US, UK, Canada, the Netherlands and Japan.

The West China Centre of Medical Sciences has four affiliated hospitals, among which the West China Hospital is the largest and one of the best in China, with 36 clinical departments, 15 medical technology departments and 25 open laboratories, receiving thousands of patients each year and conducting numerous operations.

*Sichuan Film and Television University (SFU)*<sup>86</sup>

Located in Chengdu, SFU is the second largest film academy in China, with 27 majors covering various related subjects in total. It has strength in broadcasting, music, acting, and arts and has nine on-campus training facilities, which have already produced many famous presenters, actors and directors. The university works in cooperation with Chinese broadcasting corporations including CCTV, Hunan TV and China Educational Television.

SFU runs exchange programmes with foreign universities, such as USC School of Cinematic Arts and University of the Arts London. Moreover, it is interested in establishing a TNE acting programme with Scottish universities.

Mr Li, Office Manager at SFU, told CBBC that the University has already worked with a number of overseas universities, including some from the UK. It prefers to establish TNE programmes by subject or sector. So far, the majority of programmes are in the film sector, for example with USC on film development. It has yet to establish any partnerships with regard to an acting programme and Mr Li noted that since Scotland has strength in acting and stage performance there are opportunities in this space.

Mr Li also mentioned that SFU is in the process of building a creative park for film and it was announced in April 2016 that SFU will invest RMB 0.4 billion to develop the park. The creative park will be a film hub for SFU and is listed as part of the 13<sup>th</sup> Five Year Plan for Sichuan Province Creative Industries.

Mr Li mentioned that SFU sends students to the US for internships who often come back with small projects and shows. He said that a TNE programme with Scottish universities, which would also allow Chinese students to return with projects to Chengdu for commercialisation, would be welcomed. In addition, the university often hosts guest professors from international universities on topics relating to the creative arts and would be open to the same kind of cooperation with Scotland. Scottish institutions would be welcome to send a delegation to Chengdu to further discuss potential opportunities for cooperation.

## **Business Opportunities**

### *Life Sciences*

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<sup>85</sup> <http://eng.cd120.com/a/aboutus/>

<sup>86</sup> <http://www.scftvc.com/>

CBBC interviewed Mr Wei Shao, Operations Manager at Chengdu High-Tech Zone, who outlined business models of partnership companies. The Chengdu High-Tech Zone welcomes companies that are registered in Chengdu in the sectors of big data, healthcare, life sciences, gaming and software development.

An increasing number of successful companies are establishing in Chengdu, given the leading university and talent strength in the region. The Chengdu government has placed emphasis on the development of the healthcare industry, particularly how to use big data and IT to advance healthcare practices and development.

In January 2016, a company called Diying Jia was set up in the high-tech zone specialising in robotic diagnostics for patient records. Robots support doctors in the diagnosis of cancer through learning and sorting medical record pictures. It then has the ability to judge in seven seconds whether the medical picture has cancerous elements. The founder of the company is a Chinese scientist who returned from studying in the US.

#### *Pharmaceutical*

One Chinese Pharmaceutical company, headquartered in Chengdu, is looking for new innovative drugs for oncology, cardiovascular and psychological at Phase II or Phase III clinical trials and is keen to continue its development in China for commercialisation in the Chinese market. This company focuses on manufacturing, R&D and exporting for biopharmaceutical, synthetic pharmaceutical and active pharmaceutical ingredients (APIs) in western China.

#### *Medical devices*

A large medical device company based in Chengdu is looking to act as distributor for UK infection control companies. It specialises in medical device manufacturing and sales and is looking for UK medical device companies with relevant infection control products and a desire to sell in the Chinese market. Ideally, the products should have certain IP and be the most current technology.

#### *IVD*

A China medical devices distributor is seeking UK in-vitro diagnostic medical device products and technology. The company is also willing to invest in a UK company if necessary. The Chinese company was founded in 1998, and is registered in the Chengdu High-Tech Industrial Development Zone. It is mainly engaged in medical equipment, medical polymer materials, biotechnology and information technology and other products research and development, production, sales and service.

#### *FDI*

A China based listed Life Sciences group whose headquarters are in Chengdu High-Tech Zone is seeking to invest through M&A to a life sciences company in the UK market. The ideal targets should already have revenue in 2015 and ideally the project would be commercialised in China. The particular fields could be in 3D printing, IVD or healthcare groups. The company has strong financial advantages and is looking for targets in the UK market.

#### Models of cooperation:

- The conceptual idea can be established outside China, but the actual project should go through the commercialisation process in the high tech zone. There is also government support for high-tech projects within the zone, with the government offering RMB 0.5 billion to support new projects.



- There are also opportunities for returning Chinese scientists and researchers, with experience working in Scotland, to establish a company in the high tech zone. Ideally, the technology or programme will be brought to the zone in its later stages of development. The Chengdu government also has policies supporting this kind of set up with additional funding support available.
- China-based companies are also interested in investing in Scottish universities that have new technologies, which can potentially be commercialised in China. The ideal model would see the Chinese company investing in the Scottish company to hold the share; the Scottish company carrying out the research in Scotland and finally seeing the technical products manufactured either in China or Scotland. The Chinese company would then have the distribution rights in China or Asia; or in some cases they might seek to have distribution rights for the product globally.

### *Creative sectors*

Mr Shao also highlighted the booming gaming industry in Chengdu. Several gaming companies have set up bases in the high tech zone and the region has strong resources in gaming and software development. CBBC also interviewed Mr Zhu (Vice Secretary), Mr Xu (Cooperation Manager), and Mr Chen (Projects Manager) at Chengdu Animation & Network Culture Association, Chengdu City to further understand the various subsectors in the creative industries

The representatives from the animation association said that Chengdu is one of the top four gaming centres in China and has opportunities for Scottish gaming companies to sell their mature games IP to Chinese gaming companies in Chengdu. They also noted there is potential for TNE programmes in animation development with some of the higher education institutions in Chengdu.

### Models of cooperation:

- A Chinese company can purchase advanced technology or global IP from Scotland for its gaming products and then the Chinese company will distribute the game globally.
- Universities in Scotland can work together with Chinese companies to jointly develop new technology in digital fields including 3D and human-computer interaction gaming.
- CANCA showed some interest in knowing more about the frontier technologies in Scotland as well as attractive IP opportunities. Scotland could benefit from promoting their advanced technologies and strong points in gaming and animation.
- CANCA is willing to host gaming and animation delegations between Chengdu and Scotland and recommend approaching Digital Sky, Tap4fun, Skymoons and Dreamwork in the gaming industry, and Tinman Arts and Hengfeng Animation in the animation industry.

## 8. APPENDICES

### 8.1 Appendix 1 - List of TNE and research areas for China universities part of the 985 project



Microsoft Excel  
Worksheet

## 8.2 Appendix 2 - China's innovation Driven Development Strategy - Sector Specific Priorities

1. **The next generation IT network technologies** - ensure successful transformation of the economy and safeguard national cyber security.
  - Research for technologies such as quasi-human intelligence, virtual reality, microelectronics and optoelectronics
  - R&D and deployments of broadband mobile network, cloud computing, Internet of Things, big data, hi-performance computing and smart mobile terminals.
  - Breakthroughs and deployment of home-grown software and hardware products (e.g. Integrated circuits and industrial control) as well as internet security solutions.
  
2. **Green, intelligent manufacturing technologies** - move manufacturing up the value chain.
  - Restructure the manufacturing technology system to transform this sector into a strong industry.
  - Accelerate in-depth use of new technologies such as cloud computing and big data so that the industry can be more automated, intelligent and service-oriented.
  - Reform the traditional manufacturing industries to be green and intensified.
  - Strengthen the fundamental technology capabilities and trial platforms to enhance the key generic technologies such as the basic materials, components and software.
  - To develop high-end equipment and products including large aircraft, aero generators, nuclear power, high-speed rail, marine engineering equipment and ultra-high voltage electricity transmission systems.
  
3. **Eco-friendly, safe and effective agricultural technologies** - ensure food security and safety, embracing a modern agriculture that produces high output and safe products with low input<sup>87</sup> and environment-friendly approach.
  - Strengthen R&D on animal and plant breeding and high-end equipment.
  - Roll out technologies to increase yield and retrofit the low and medium yield fields.
  - Step up R&D on technologies for water saving<sup>88</sup>, circular production, organic farming and bio-fertilizers as well as for large standardized modern livestock farms.
  - Introduce cost-effective technologies and models to reduce agricultural pollution.
  - Set up new food safety systems to cover the full life cycle of the food productions.
  - Drive agriculture to evolve towards a value-added and brand-oriented industry that integrates with the second and third industries.
  
4. **Secure, clean and efficient energy technologies** - revolutionize energy productions and consumption to move towards clean and low carbon energy with the priority on optimal energy mix and improved efficiency.
  - Exploration and mining technologies for oil, gas and mineral resources and demonstration projects for shale gas.
  - Accelerate development, equipment manufacturing and large scale use of new energies including nuclear energy, solar energy, wind energy and biomass with breakthroughs in optimizing demand and supply, energy storage and grid connections.
  - Roll out energy-saving technologies and products, retrofitting high energy-consuming industries such as iron and steel, petrochemical, construction materials and non-ferrous metals.

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<sup>87</sup>China's arable land accounts for 7% of the world's total, however, the country consumes about 35% of world's fertilizer and pesticide.

<sup>88</sup> China's agriculture accounts for about 2/3 of fresh water consumption

- Drive R&D and application of new-energy vehicles and smart grids
5. **Environmental protection technologies** – enable efficient use of resources and build a resource-saving and eco-friendly society.
    - Develop technologies and industries for pollution treatment and resources recycling with a holistic approach.
    - Build early warning and analysis systems for heavy air pollution events and a modern integrated water utilization system.
    - Step up waste management and recycling, environment monitoring and emergency response systems, and increase environmental capacity.
  6. **Advanced marine and space technologies** - cultivate marine and space economies. Implement the National Marine Strategy.
    - Technologies for efficient and sustainable use of marine resources.
    - Marine engineering equipment for multi-dimension synchronized observation systems.
    - Enhance technologies for space exploration and improve space infrastructure while boosting R&D and the industrial chain of satellite technologies including remote sensing, communications, navigation and GPS services.
  7. **Smart city and digital technologies** - drive people-oriented urbanization.
    - Modern city development and public services to be supported by new technologies and governance innovations.
    - Roll out information technologies for social security.
    - City infrastructure such as transport, electricity, telecom and underground pipelines will comply with standards and be more digitalized and ‘smart-ized’.
    - Key technologies for green buildings, smart cities and eco-cities.
    - Key solutions and breakthroughs for emergency response.
  8. **Safe and effective health-care technologies** - address challenges from major diseases and the aging population.
    - Integrating technologies in the areas such as life science, western /traditional Chinese medicine and bio-engineering.
    - Develop innovative medicine, new vaccines, advanced medical equipment and biotherapies.
    - Promote R&D on big data, precision medicine, inheritable genes and predisposing genes for chronic diseases.
    - Improve diagnosis and treatment for major health challenges such as cardiovascular diseases, malignant tumours, respiratory problems and diabetes.
    - Scale up digitalized, remote, personalized medicine and internet services for disease prevention, treatment, recovery, healthy life style and elderly care. Establish an integrated health-care model.
  9. **Technologies for modern services** - support business innovations and drive advancement of economic formation.
    - Build the infrastructure for modern services and expand emerging services in digital consumption, e-commerce, modern logistics, internet finance and remote learning.
    - Accelerate integration of industrial design, new cultural concepts and relevant sectors to boost innovative design capability for key industries.

10. **Disruptive technologies** - revolutionize businesses while nurturing new industries and creating new jobs.

- Deploy cutting edge R&D for emerging industries.
- Develop technologies such as mobile Internet, quantum IT, space, advanced manufacturing, AI robots, driver-less automobiles, new energy (hydrogen, fuel battery, etc.) and new materials (nano & graphene).

*Source: policy section - British Embassy - Beijing*

### 8.3 Appendix 3 - Aspects of commercialisation of research in China

The appendix gives details on

- Current Research Commercialisation Status in China
- Favourable Policies on Research Commercialisation from Government
- Different Models of Research Commercialisation
- Challenges and Risks with Research Commercialisation in China - The legal and IP environment

#### Current Research Commercialisation Status in China

National Achievements of Science and Technology (NAST)<sup>89</sup> is an official platform for technology publication and presentation, established by MoST and managed by the National Office of Science and Technology Awards (NOSTA). In 2014, more than 700,000 organisations were registered on the platform, of which more than 120,000 were research centres including universities and colleges, independent research institutes and enterprises in China.

According to NAST analysis, the following sectors have the most transferable technologies:

- Biomedical and medical devices
- Modern agriculture
- Electronic information
- New material
- Advanced engineering
- Environmental protection
- New energy and energy conservation
- Earth, space and ocean
- Aviation and aerospace
- Nuclear applied technology

The top 10 institutions with the most technology transfers are:

- Shanghai Jiaotong University
- Tongji University
- Tsinghua University
- Shandong University
- Henan University of Science and Technology
- Tianjin University
- Zhengzhou University
- East China University of Science and Technology
- The Tianjin Institute of Pharmaceutical Research (TIPR)
- Xi'an Jiaotong University

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<sup>89</sup>NAST website: <http://www.tech110.net/portal.php>

In 2014, R&D funding invested in China was over RMB 1.3 trillion, according to the National Bureau of Statistics.<sup>90</sup> However, the technology transfer conversion rate in 2013 was only 10%, compared with 40% in developed countries.

The number of new patents is high in China but patent quality is severely lacking. The central government rank provinces by the number of patents, encouraging regional governments to launch beneficial policies on patent application, but this makes them less focused on the quality. The government covers the majority of the cost for the first three years, including application fees and maintenance costs, while inventors can also receive financial incentives. The objective of applying for patents in China is often not for improving technical strength and innovation; but rather to receive preferential policy from central or local government. Criteria for patent approval include; novelty, creativity and practicability, rather than scientific prowess and precision.

In 2015, there were more than 1.1 million patent applications in China, surpassing other countries for the last five years. 60.2% of the applications were from enterprises, around 58,000 organisations. In 2015, the State Intellectual Property Office (SIPO) authorised 359,000 patents, of which 263,000 were from Chinese organisations.

Whilst the number of patent applications in China is increasing steadily; SIPO recognises that there is still a gap in the following seven sectors in comparison with developed countries: optics, engine, transportation, semiconductor, basic communications program, audio-visual technology and medical technology.

#### **Favourable Policies on Research Commercialisation from Government**

The *Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements* was passed in 1996 and implemented from 1<sup>st</sup> October 1996. It was revised in 2015 when the government realised that the previous Law was insufficient in terms of fulfilling current technology transfer demands and the research commercialisation rate in China is low when compared with developed countries.

The main objective of the revision is to accelerate technology transfer from universities and scientific research institutions. The most significant revision is increasing remuneration to the researchers from a minimum of 20% to a minimum of 50% of the total net earnings from transfers and commercialisation. In addition, Chinese universities and R&D institutions will have autonomy in transferring IP from scientific research, will own and manage the revenue of technology transfers and will have full rights of ownership. Prior to this revision, technology transfers were considered assets of the government.

To further facilitate research commercialisation, the government issued *Provisions of the Implementation of the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements*<sup>91</sup> in March 2016 and the *Action Plan to Promote the Transformation of Scientific and Technological Achievements* ('Action Plan') in April 2016.

The March 2016 regulation is one of various policies issued by the State Council that aims to encourage and instruct scientists on how to commercialise their findings. The policy outlines measures for scientists, inventors and academics on how best to commercialise their work and encourages them to transfer or license their research as trade-ins. The policy also states that success in technology transfers and product outcomes will be included in the performance evaluations of universities and research institutions.

<sup>90</sup> [http://www.stats.gov.cn/tjsj/tjgb/rdpcgb/gkjiftrtjgb/201511/t20151123\\_1279545.html](http://www.stats.gov.cn/tjsj/tjgb/rdpcgb/gkjiftrtjgb/201511/t20151123_1279545.html)

<sup>91</sup> [http://www.most.gov.cn/tztg/201603/t20160303\\_124393.htm](http://www.most.gov.cn/tztg/201603/t20160303_124393.htm)

The Action Plan sets up the basic principles, main objectives and main tasks for universities, academics and enterprises, during the period of the 13<sup>th</sup> Five Year Plan, in order to improve the performance of research commercialisation in China. The main objectives are:

- Set up 100 national technology transfer organisations and 10 demonstration technology transfer areas
- Develop crowd innovation spaces in key sectors
- Build technology transfer talent training bases and train 10,000 professional technology transfer specialists
- Sign technology transaction contracts with the aim of reaching a volume of RMB 2 trillion

The main tasks are to:

- Promote an online technology registration system and launch national technology databases and platforms
- Develop advanced technologies with a focus on key sectors including; information networks, green manufacturing, modern agriculture, modern energy, efficient utilisation of resources and eco-environmental protection, ocean and space, smart city, digital society and population health
- Help link universities and scientific research institutions with enterprises and industries by developing effective technology transfer mechanisms
- Support enterprises to set up joint R&D institutions or technology transfer organisations with universities and scientific research institutions
- Develop multiform Industrial Technology Innovation Alliance with a focus on Made in China 2025 and Internet Plus
- Build industrialisation bases of research findings with a focus on emerging industries, such as energy conservation and environment protection, new generation information technology, biotechnology, high-end equipment manufacturing, new energy, new material, and new energy automobile
- Establish a national technology exchange online platform
- Strengthen regional resource sharing between key regions based upon Belt and Road, Beijing Tianjin Hebei Coordinated Development Plan and Yangtze River Economic Belt strategy and improve technology transfer across regions
- Encourage domestic organisations to work in partnership with well-known international technology transfer organisations to bring in advanced scientific technology from other countries and to train professional technology transfer talent through cooperation
- Encourage regional governments to launch specific funds for start-up business investment, technology transfer and IP management and to attract other social capital
- Hold innovation contests, such as China Innovation & Entrepreneurship Competition

## **Different Models of Research Commercialisation**

### **The National University Science Park / Incubation Centre**

By the end of 2014, there were 115 of centres recognised by MoE and MoST.<sup>92</sup> The National University Science Park (NUSP) is a high-tech cluster based around research universities or universities. Taking advantage of talent, technology, laboratory facilities and information from the universities; the NUSP can provide a supporting platform for innovation, incubation and technology transfer in universities, by

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<sup>92</sup> [http://www.most.gov.cn/tztg/201507/t20150703\\_120548.htm](http://www.most.gov.cn/tztg/201507/t20150703_120548.htm)



introducing policy guidance from the government and bringing in diversified investment channels. In this way, the NUSP links research and development with industrialisation.

There are three methods of technology transfer in the NUSP. Firstly, technologies can be applied directly to enterprises in the NUSP. Most of the companies in the NUSP have a strong demand for technology and putting relatively mature technology directly into use in these companies reduces their R&D costs. Researchers can engage directly with the company, which in turn can improve industrialisation rates.

Secondly is the transfer of technology via research and development institutions in the NUSP. Many companies have set up R&D institutions in the NUSP in order to get technology and talent support from universities that allows the NUSP to introduce new technologies based upon actual demands from the universities. With cooperation and guidance from scientific research personnel in higher education, the R&D institutions of these companies can undertake secondary development and industrialisation development, which will facilitate final technology transformation and industrialisation.

Thirdly is to establish high tech enterprises using the core new technology. NUSP can invest and establish a start-up. Once the technology is mature, the company will have higher market value. NUSP can then sell the company together with the technology to achieve the technology transfer and receive economic returns from the IP and the up-front investment.

South East University Science Park (SEUSP) is one of the first 15 pilot NUSPs in China. It is located in Nanjing, Jiangsu Province in the Eastern part of China. It 2006, it established a Student Innovation Centre and since then has incubated 154 student start-ups. It currently has 55 enterprises, with 700 student entrepreneurs and 3,000 student employees. The centre brings in professional personnel to help student entrepreneurs deal with company registration and tax issues. They provide rental-free venues for two years and help enterprises apply for national and provincial funds. They also signed contracts with venture capitals and municipal governments to invest money to support student innovation and research commercialisation. They are currently focusing on electronic information, energy and environment, equipment manufacturing, biomedicine, chemical materials and civil engineering.

### **University-owned Enterprises**

University-owned enterprises are established by the university who also employ their own management executives and staff. Relying on technologies developed by universities and research personnel, university-owned enterprises focus on research development and technology transfers. Peking University, for example, owns 36 university enterprises including; Founder Group, Beida Jade Bird Group, Sinobioway Medicine and PKU Resources.

By the end of 2013, total assets of 75 MOE-administrated Chinese university/college-owned enterprises were RMB 316 billion. The five universities with the most assets are; Peking University, Tsinghua University, North-eastern University, Tongji University and China University of Petroleum. Total assets of these five universities account for 80% of the total assets of the 75 universities. In 2013, the top five provinces with the highest net profit in university-owned enterprises were; Beijing, Shanghai, Liaoning, Guangdong and Shandong.<sup>93</sup>

In 2014, total assets of the university-owned enterprises of Peking University were over RMB 180 billion, a 50% increase from 2013. It is estimated that the total assets of Chinese university-owned enterprises may exceed RMB 1 trillion in the next few years.<sup>94</sup>

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<sup>93</sup> <http://www.moe.edu.cn/ewebeditor/uploadfile/2014/12/31/20141231165824709.pdf>

<sup>94</sup> <http://learning.sohu.com/20150513/n412938893.shtml>

By the end of 2013, the number of patents owned by university-owned enterprises was 3,206, of which 1,985 products received national and provincial awards.<sup>95</sup>

The ownership and management model is, however, not clear and the enterprises and universities are not separate. This can give rise to a number of difficulties and in recent years there have been cases of corruption. In 2014, 39 people in a higher education management team were investigated. Critics feel that management teams in universities are too involved in the operation of the enterprises.

Enterprise staff need to spend sufficient time handling relationships with universities and sometimes they are required to undertake actions that conflict with their original intentions. Due to this, the government issued guidelines on best practice conduct for these organisations and decided the best course of action was to start separating universities and R&D institutions from their subsidiaries and to cease applications of new university-owned enterprises.

### **Joint Venture and Licensing**

In July 2016, a follow-up meeting was held after the one year implementation of the *Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements*, in which the progress and problems in technology transfer were discussed by MoST, MOE, NDRC (National Development and Reform Commission) and three other relevant departments.

One example of successful technology transfer that was discussed during the meeting, was the innovative technology developed in the aerospace and aviation sector by Professor Li Renfu and his team from Huazhong University of Science and Technology (HUST). In November 2015, the development was capitalised as share in a newly established company, Huawu Aerospace Technology. The technology was capitalised as RMB 27.5 million, with Professor Li owning 15.45% of stock shares and HUST owning 9.55% of shares.<sup>96</sup> Both technologies are listed in Wuhan Optics Valley United Property Rights Exchange, a provincial technology exchange centre in Wuhan.

Professor Li acknowledged that aerospace and aviation is included within the high-end equipment manufacturing sector, one of the seven national strategic emerging industries, and noted continued government investment in this industry.<sup>97</sup> In June 2016, the new company was established in Wuhan Future City and some innovative and prospective projects, in relation to Unmanned Aerial Vehicle (UAV) are already in progress.

This case is not in isolation. In 2013, Professor Luo Qingming from HUST transferred his research team's patent, Micro-Optical Sectioning Tomography, to OE Biotechnology for a price of RMB 10 million, with 70% revenue going to the R&D team and 30% to the university.

In 2016, Professor An Bowen from Shanghai Maritime University (SMU) established Shanghai Anxin Information Technology Limited using his patent fibre-optic sensing detection system as intangible assets and partnering with an enterprise. The partnering enterprise owns a 70% share while SMU owns 7.5% and Professor An's team owns 22.5%.

These cases all occurred after the implementation of the new technology transfer policy, encouraging the new income distribution method and allowing universities to handle technologies themselves. The key point of the revision in 2015 was to award the person or team contributing to the development of the new technology at a minimum of 50% and the above cases show the successful effect of the revisions.

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<sup>95</sup> <http://www.moe.edu.cn/ewebeditor/uploadfile/2014/12/31/20141231165824709.pdf>

<sup>96</sup> [http://finance.ifeng.com/a/20151118/14076966\\_0.shtml](http://finance.ifeng.com/a/20151118/14076966_0.shtml)

<sup>97</sup> <http://www.changjiangtimes.com/2016/06/537843.html>

However, researchers do bear the burden of income tax on their stock awards. Despite being permitted to pay in instalments over five years, it can be difficult for them. At the meeting, one professor said they are expecting further revisions in technology transfer policies in terms of tax payments, which will provide even more incentives for researchers to commercialise their technology.

### **Technology Transfer Centre Setup**

The USA is one of the most successful countries in research commercialisation and technology transfer in terms of conversion rate and revenue generation. The UK, Germany and Japan have also made significant progress and performed well in this area.

Most Chinese universities do not set up their own technology transfer offices; rather it is handled by staff in the Science & Technology Department or Industrial Development Office, for whom technology transfer and research commercialisation is part of their job responsibilities. These individuals are not always professionally trained in this area and can lack capabilities including market promotion, market planning, negotiation and business development, which in turn affects technology transfer between enterprises and universities.

In the 1980s, China set up the first batch of technology transfer centres. By 2001, China had recognised six university technology transfer organisations as National Technology Transfer Centres.

Some Chinese universities are adopting the international model of technology transfer offices, to allow academic staff to be more adept and better understand how to apply for technology transfer.

Vice-Minister of MOE stated that 20 technology transfer centres have been established in 25 MOE-administrated universities. A basic technology transfer team with 5-10 people was set up through talent recruitment and training. For example, China University of Geosciences relies on the technology transfer service platform of the Central National Technology Transfer Centre and brings in all types of intellectual property management and technology transfer professionals from the international market.<sup>98</sup>

Technology is however intangible, which adds to the complexity of involving technology agents and third-party service providers. Although many universities have set up technology transfer offices, their major responsibility is administration. Professionals should be equipped with knowledge of the technology, market, finance and legal issues. The lack of professionals for technology transfer severely restricts the development of technology industrialisation in China.

When CBC interviewed the Technology Transfer Office in Zhejiang Science and Technology Department, they stated that they would welcome an international technology transfer office to set up branches in Zhejiang province and would offer very favourable terms.

### **University Professor Start-ups**

Traditionally, teachers are not allowed to be engaged in business, which includes establishing a start-up and this is especially true for teachers in management positions. Previously, university teachers would be required to resign from their teaching position before they could start their own businesses. This prevented many teachers from starting up a new business because of the insecurity of not having a job to return to should their business not succeed.

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<sup>98</sup> <http://www.antpedia.com/news/55/n-1342355.html>

New policies have been developed in a number of provinces, to encourage university teachers and scientific researchers to start up new businesses. The universities will keep their position open for 3-5 years and researchers can retain all earnings from the start-up and at least 50% earnings of the transfers will be rewarded to the researchers.

Some of the areas of policy implementation are still unclear. Policies on salary level, professional title appraisal and departure procedures after success do not yet exist. There are also conflicts of interest between universities and teachers. Previously, universities could share in some of the research earnings, but now all earnings will go to researchers themselves once they start up their own business, which has an impact on university earnings. Technology transfer earnings from commercialisation are split between universities and researchers; however, there is room for further complexities here as the percentage division is decided by the researchers themselves.

Not all stakeholders have embraced this new policy. The Deputy Dean of the School of Civil Engineering of Southeast University said that nearly 20 out of 120 teachers have been involved in start-up businesses, which has had significant impact on day-to-day teaching and research proficiency of the school.<sup>99</sup> While the policy is in place, there is still room for revision and clarification on some of the details.

### **Venture Capital**

Technology research and development requires financial support and to commercialise findings requires further financial support. The proportion of money spent in preliminary research, development and pilot testing, and industrialisation is roughly 1:10:100. However, it might be difficult for an individual project to locate specific venture capital, as projects under research and development are more risky in terms of ROI.

The government now encourages venture capital organisations to work in-depth with incubators, so that inventors with new technologies have a channel through which to win venture capital. The government is also setting up encouraging mechanisms to Private Equity (PE), Venture Capital (VC) and angel capital, so that it can attract more funds and top level talent.

Currently, many investors in China establish incubators. Companies which start up in the incubator have a better chance at receiving starting capital. For example, Innovation Works was established by Mr Kai-Fu Lee, ex-President of Google China, and Inno Valley was established by Mr Zhu Bo, ex-CMO of Huawei, with both incubators focusing on the information industry.

During CBBC's interview with Jiangsu Industrial Technology Institute, they mentioned that as a technology transfer platform, they plan to set up a research and development fund, Fund of Funds (FOF), and angel capital and will try to lead venture capitals to invest in technology industrialisation.

### **Joint Research with Enterprises**

Technology and innovation are at the core of competition between enterprises. Business can only develop and garner more market share with the improvement of their technology. With rapid economic development, technologies update very quickly and any given product might incorporate various technologies and services. A good way for enterprises to quickly adapt to technology development and market change is to collaborate with a research partner that helps them to stay ahead of the game in new developments.

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<sup>99</sup> [http://jckb.xinhuanet.com/2016-01/13/c\\_135003308.htm](http://jckb.xinhuanet.com/2016-01/13/c_135003308.htm)

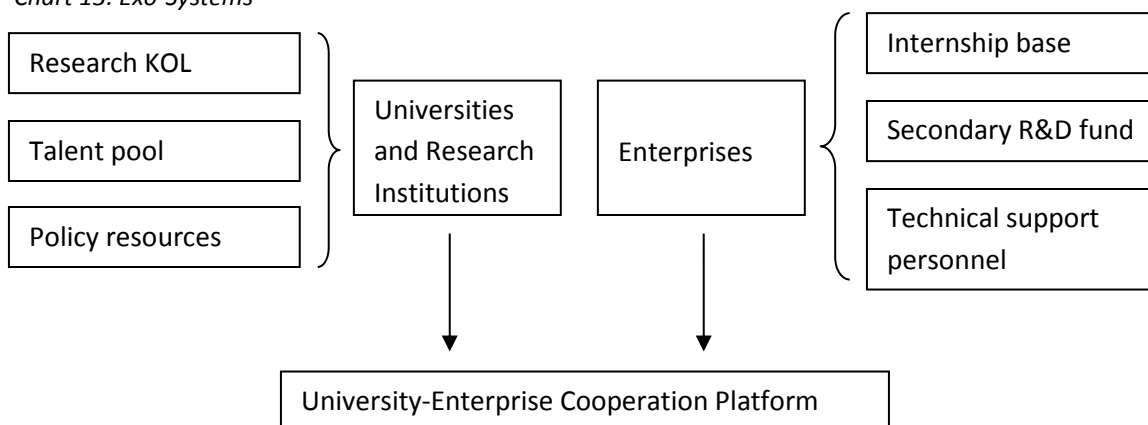
Universities have high tech research talent and technologies; however, the majority of the technology is not commercially exploited. University research objectives typically revolve around the publication of theses and articles for academic evaluation. However, finding a way to commercialise and industrialise research is a cost effective way to gaining back time and funds spent on initial development for research purposes. Universities can apply for government funding for research development; however, the funds do not cover technology commercialisation. By cooperating with enterprises, universities and research institutions can receive financial rewards with which they can develop more technologies. By combining university R&D and manufacturing, companies can commission research with the universities and will be able to select the projects that have the greatest chance of commercial success.

Most of the research projects in universities are following government policies, while only a few of them stem from actual demand from enterprises and the market. Researchers often focus on advanced technologies which are not always practical for enterprises; or research projects based on their own interest and expertise which again does not always cater to demands from enterprise or technology industrialisation prospects. The result is that technologies developed are not mature enough and cannot be manufactured on a large scale. Although the number of technologies is high, they are not systematic. These findings are not able to solve technical problems during the manufacturing process.

Enterprises are encouraged to bring in technologies from higher education and research institutions by the government. It is reported that Guangzhou Municipal government passed *Measures for the Implementation of the Transformation of Scientific and Technological Achievements* at the end of 2015. It regulated that for enterprises that have brought in technologies from higher education or research institutions from China and abroad and get the technologies industrialised, the government will subsidise the enterprises 5% of the actual amount of the technology contract with a maximum of RMB 5 million per year.<sup>100</sup> Many other municipal governments also issued policies on financial subsidies using different models.

Enterprises cooperate with universities on joint research in four ways; technology acquisition, technical cooperation, commissioned research and joint development. Universities prefer technologies being purchased as a one-off activity by enterprises. Enterprises would prefer universities to stay involved in the project and to provide technical advice even though the technologies have already been sold. The best solution is that the universities provide technical support and resources and the enterprises provide financial support. An example eco-system is shown below.<sup>101</sup>

Chart 13: Exo-Systems



<sup>100</sup> <http://society.people.com.cn/n/2015/1117/c136657-27822218.html>

<sup>101</sup> <http://www.doc88.com/p-7354585947487.html>

Joint research between universities and enterprises has been an important channel for business technology innovation. Zhejiang University is one of the top universities in China and is often the first choice for many enterprises in Zhejiang that have joint research intentions. One company in Zhejiang had expertise in designing and manufacturing hydroelectric equipment and their products were exported to more than 50 countries and regions. However, with the development of new technology, their products struggled to find a place in the changing market and consequently lost market share. In order to change this situation, the enterprise started to cooperate with Zhejiang University, China Institute of Water Resources and Hydropower Research (IWHR) and International Centre on Small Hydro Power (ICSHP). During the ten years of research cooperation, they have jointly developed several projects, some of which have been included in the 2014 Major Science and Technology Projects in Zhejiang Province.

Universities with strong research and development capacities will proactively reach out to enterprises. In 1995, Tsinghua University set up a University-Enterprise Cooperation Committee. In 1996, the overseas department of this committee for international technical cooperation was set up. The committee now has 190 member companies from China and overseas including; Baosteel, China Telecom, SAIC, China Metallurgical Group, Boeing, Siemens and Microsoft. Member companies and Tsinghua University have signed more than 1,600 research and development contracts and more than 30 joint R&D centres have been set up.<sup>102</sup>

### **Technology Match-making Conferences**

Match-making conferences are the most-frequent technology transfer channel applied by provincial or municipal government. The local government will liaise with technology owners in universities or research institutions from China, and with international countries and businesses, to find the technologies required by them. The government will proactively reach out to enterprises in their province to collect their technology demands. If the enterprises have specific requirements of the technology developed by a university or research institution, the government will also help approach the organisation to persuade them and bring the technology to the match-making conference.

During CBBC's interview with Zhejiang Science and Technology Department, we were told that they organise technology match-making conferences each year in Zhejiang province, in line with the Zhejiang International Trade and Investment Symposium. In June 2016, it took place in Ningbo. As well as local representatives, there are representatives from international governments, research institutions, businesses and technology transfer organisations from countries including Japan, USA, Italy, Canada and the UK.

Match-making also takes place across regions, where one region has stronger technology development capacities and the other region has fewer universities and research institutions. Following the implementation of Beijing Tianjin Hebei Coordinated Development Plan, Hebei province now proactively reaches out to research institutions, universities and government organisations in Beijing and Tianjin, two of the cities with the largest talent pools. In Beijing, there are considerably more creative clusters than in Hebei. For example, one third of the national key laboratories are in Beijing and half of the academics of the Chinese Academy of Sciences and Chinese Academy of Engineering.<sup>103</sup> It is beneficial for Hebei to borrow talents from Beijing and Tianjin, which also have high technology bases, such as Beijing Zhongguancun. In 2014, a Jing-Jin-Ji (Beijing-Tianjin-Hebei) technology transfer base was established in Baoding, Hebei Province. The responsibility of this base is to investigate technology demands from enterprises and to find suitable technologies for them. In 2015, Baoding invested RMB 600 billion on joint

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<sup>102</sup> [http://www.bj.xinhuanet.com/bjfs/2010-10/16/content\\_21148405.htm](http://www.bj.xinhuanet.com/bjfs/2010-10/16/content_21148405.htm)

<sup>103</sup> <http://hebei.news.163.com/15/0702/15/ATHEH0RI02790AB2.html>

projects with Beijing and Tianjin,<sup>104</sup> with Baoding focusing on automobile manufacturing, new energy and new material.

### **Technology Auction**

Technology auction is a channel of commercialisation that came up for discussion during CBBC's interview with the Science and Technology Department of Zhejiang Province (ZJSTD). ZJSTD releases technologies in advance and invites companies to the Zhejiang Science and Technology Market, which is held twice a year. This year's auction was their 7<sup>th</sup> and took place in April 2016. It published 139 technologies in the fields of information technology, mechanical and electrical technology, energy-saving and environmental protection technology, agriculture and animal husbandry, biotechnology, new material and the chemical technology industry.<sup>105</sup> 103 technologies were finally at auction, of which 70 were from universities and research institutions in China, 31 were from enterprises in China, one was an individual project and one was from a Japanese organisation. The final transaction price was RMB 150 million. The highest selling technology was new drug technology which was sold to a pharmaceutical company in Zhejiang at a price of RMB 11 million.<sup>106</sup>

The previous auction, held in December 2015, focused on electronic information, advanced manufacture, biological medicine, chemical engineering, new material, agriculture and the animal husbandry industry.<sup>107</sup>

### **Secondary R&D**

During CBBC's interview with Jiangsu Industrial Technology Institute, secondary R&D was also mentioned. They welcome international cooperation and would be very keen to understand which specific Scottish technologies have potential. Where possible, they would welcome Scottish technologies to be industrialised in Jiangsu. For technologies that are not suitable for local companies, the institute is prepared to cooperate with Scottish universities and institutions to help localise the technologies and target them towards Chinese enterprises specifically.

### **Public Technology Transfer Platform**

Central and regional governments have all launched technology transfer online platforms. Universities and research institutions can publish the technologies on the website, while enterprises can look for and purchase technologies they need online. Some of the main platforms are:

- China Technology Exchange <http://us.ctex.cn/>
- Keyi <http://www.1633.com/>
- Zhejiang Technology Online Market <http://www.51jishu.com/index.do>
- SITEC <http://www.shcnect.com/>
- Jiangsu Industrial Technology Institute Technology Exchange [www.jitrie.cn](http://www.jitrie.cn)
- Shanghai Technology Innovation Centre <http://www.shtic.com/structure/index.htm>

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<sup>104</sup> <http://www.chinanews.com/sh/2015/02-05/7039389.shtml>

<sup>105</sup> <http://st.zjol.com.cn/system/2016/04/27/021128227.shtml>

<sup>106</sup> <http://news.eastday.com/eastday/13news/auto/news/china/20160504/u7ai5600160.html>

<sup>107</sup> <http://www.chinanews.com/cj/2015/12-10/7665708.shtml>

## 8.4 Appendix 4 - The legal and IP environment

Innovation and commercialisation can pose risks, challenges and uncertainty in terms of; the actual technology being developed and how successful it will be, the regulatory environment it is being produced in and the state of the market and the viability of purchase.

Government support is of course essential in order to mitigate uncertainties and potential risks in innovative commercialisation. Government funding helps to ease the pressure on risk-averse scientists in the development of their research and technologies. Multiple policies, regulations and encouragement from MoST on science and technology innovation are in line with this ideal, but it is important to note the significant role and importance of market forces in the development of innovative technologies and government support.

### Understanding legal frameworks

Scottish universities should not underestimate the importance of understanding the national policies and building relationships with key stakeholders within provincial and local Government. Regulatory environments in China vary by region and the extent of government relationship may be dependent on the long term academic or commercial objectives of the research. It is essential to map out how extensive a government relationship will be in terms of building a legal framework, particularly in the early stages of development. With commercialised research, universities should ensure that their research and findings serve the strategic purpose of China and its government, as this is likely to be a significant condition of continued funding.

### Intellectual Property

IP management is one of the most significant challenges facing Scottish universities when collaborating with Chinese universities in research commercialisation. Despite China's high patent registration (it topped international rankings in 2013 for filings for the four types of IP), China is often plagued by questions on the quality of the patents and the actual commercialisation potential of patents filed in China.

To mitigate any risk that might relate to IP management, Scottish universities need to make sure all legal agreements are clear on how credit and generated revenue will be split between contributing parties. CBBC's China Business handbook introduces in detail the processes for registering IP rights (Section 4.6, pages 115-119) and enforcing IP rights (Section 4.7, pages 120-126).

### Regulations and policies relating to IP management

The following outlines China-specific laws, regulations and practices relating to IP ownership and management.

### R&D Laws

- The Contract Law – specifically recognises technology development and technology transfer as classes of contract. The law generally allows each party to agree their own terms of the contract but lays default rules as a precaution.
- The Patent Law – joint owners can independently license patents but all royalties must be shared.



- Technology Import and Export Regulations – designed to limit unfair terms that might restrict competition and technological advancement, and ban technology transactions that might impact national security.

### **IP Ownership**

In regards to jointly owned patents, commonly Chinese universities will ask or expect joint ownership of any resulting IP from jointly conducted research and development; however, this will require a deep level of trust between parties for effective and continuous commercialisation. China's Contract Law allows UK partners to fully own R&D resulting IP on the agreement of compensation to the Chinese side, either through monetary compensation or a free limited licence grant.

For any joint development agreements, all background IP elements brought by either party must be documented, agreed and recognised by both sides. This includes a description of know-how in addition to any registered patents or IP. Equally, each party must agree how any foreground IP is managed and for what purpose it can be used. This practice helps to clarify respective ownership of technologies prior to collaboration. China's Patent Law does provide a mechanism for dealing with ownership disputes of IP in the event that one party files a patent on an invention or research that is claimed by another party; however, since these cases are typically very difficult to present, all collaborations should have agreements that cover and prevent this from happening.

In the UK, universities have their own IP policies that generally follow the practice whereby academics own everything, except in cases where university funding is involved with patents. However, this general practice may have to be adapted when seeking to commercialise research with a Chinese university partner and stakeholders in China.

Scottish universities should check the employment status of all individuals involved in the research collaboration. Individuals that are not registered employees of the Chinese universities may not be bound by the agreement set between universities.

Both parties should be aware that they must register their contract with the Ministry of Commerce (MOFCOM) and establish which MOFCOM category the technology or research they intend to develop falls into, for example prohibited, restricted or free. which are subject to different levels of approval. Registration of the contract must fall within a 60 day period from the signing of the contract.

### **IP Management**

Scottish universities should practice due diligence in IP management, ensuring the protection of confidential information and securing non-disclosure agreements before any information is shared.

#### *Utility Models*

Scottish universities should be aware of Utility Model patents that are widely used in China but are not a class of patents in the UK. Utility models can be used to protect incremental inventions and in particular product improvements and additions that might not necessitate a full invention patent.

They have many advantages:

- Significantly faster to obtain than invention patents, taking up to 10 months as opposed to 2 or more years.
- Cheaper.
- Enforced in the same way as invention patents.

It is also possible to file for both an invention patent and a utility model at the same time, meaning the invention can obtain quick protection and once the invention patent has been fully granted the utility model can be abandoned.

#### *Patenting Strategy*

Many foreign companies make the mistake of not filing for patent protection in China due to uncertainty of whether or not it can be enforced. However, China has an effective system for enforcing IP rights and claims that also protects foreign parties. For more detailed guidance on patent registration in China, please refer to the China Business Handbook Section 4.6.

For research commercialised or inventions completed in China, Scottish universities also have to think about filing patents in Scotland that are written in English and whether first filing in China is required. China's Patent Law stipulates that anything "substantially completed" within mainland China has to be submitted to the State Intellectual Property Office (SIPO) for security reviews. While just a formality it is important to comply as failure to submit for review can result in loss of patent right for China.

Patent filing in China is growing rapidly due to local government incentives for innovation that has led to a number of low quality, low cost patents that allow companies to file for additional benefits such as lower tax rates. Scottish universities should ensure that when filing for patents in collaboration with the Chinese entity they should maintain the patent filing strategy in line with international best practice. Should the drafted patent application not meet appropriate standards then it will be difficult for the patent to obtain a broad international scope.

CBBC recently published a report on Innovation and joint R&D in China - Intellectual Property Rights and Legal guidance available here: <http://www.cbbs.org/sectors/innovation-joint-r-d-in-china-toolkit/>