Drivers for Innovation in China

R&D and consumer driven innovation and trends

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Dansk resumé

Den kinesiske regering har udnævnt innovation til at være den primære drivkraft for fremtidig økonomisk vækst. Dette betyder blandt andet stigende investeringer i F&U samt et fokus på forbrugerdreven innovation. Målet er, at Kina skal være et innovativt samfund i 2020 og verdensførende inden for videnskab og teknologi i 2050.

Kina er i dag verdens næststørste investor i F&U, og det kinesiske innovationssystem er en fast del af det globale F&U landskab. Den kinesiske model for innovation er karakteriseret ved at være meget markedsorienteret og skiller sig ud fra den vestlige innovationsmodel ved at have et større fokus på, at produkter, services og teknologier når hurtigt fra udvikling til introduktion på markedet. Fokus for den kinesiske innovation er i høj grad at kunne levere og tilfredsstille markedets og forbrugerens behov.

Innovation Center Denmark i Shanghai har i samarbejde med det Kina-baserede konsulentbureau China Skinny udarbejdet en analyse, der beskriver relationen mellem forbruger og innovation i Kina. De kinesiske forbrugere anses for at være verdens største gruppe mainstream forbrugere og gruppen vokser fortsat stødt. Særligt internetbaseret forbrug vokser eksplosivt. Ved udgangen af 2015 var der mere end 688 mio. online forbrugere i Kina. Relationen mellem de kinesiske forbrugere og innovation har derfor ikke kun betydning for udviklingen af innovation i Kina, men også for udviklingen af innovation globalt.

Første del af analysen beskriver den tætte forbindelse mellem trends i forbrugernes efterspørgselsmønster og udviklingen af innovation i Kina. Historisk set har den kinesiske økonomi været drevet af eksport, investering og produktion. I dag er fokus for drivkraften bag den økonomiske udvikling skiftet, og innovation, design, forbrug samt services spiller en langt større rolle. Det nye fokus for den økonomiske udvikling betyder endvidere, at hovedaktørerne bag udviklingen i vid udstrækning udgøres af forbrugerne, herunder særligt den hastigt stigende middelklase, der efterspørger nye og bedre varer og teknologier samt regeringen og virksomheder, der investerer i F&U og innovation.

De efterfølgende kapitler i analysen giver en indsigt i F&U, forbrugertrends, drivere, nøglespillere og samarbejde inden for følgende fem udvalgte områder af særlig interesse for Danmark:

- Mobile og smarte IKT-løsninger
- Fødevarekvalitet, -sikkerhed og sunde fødevarer
- Patientfokuserede og værdiskabende sundhedsløsninger
- Løsningsmuligheder på forurening og klimaforandringer
- Udvikling af uddannelsessektoren

Inden for hvert område er der beskrevet forbrugertendenser, socioøkonomiske og teknologiske udviklinger samt væsentlige hovedaktører inden for innovation, herunder virksomheder, myndigheder og forskningsinstitutioner, offentlig-private samarbejde og partnerskaber samt de udfordringer og muligheder der findes for eksempelvis danske SMV'er, der ønsker at komme ind på det kinesiske marked. Hovedkonklusionerne inden for hvert område er uddybet nedenfor.

Kina er i dag verdensførende indenfor forskning i smart home teknologier. Dette skyldes blandt andet,at kinesiske entreprenører har haft succes med at blive en integreret del af det etablerede produktionsapparat samt at produktionsvirksomhederne i stigende grad sælger direkte til kunderne. Hermed har den stigende efterspørgsel fra forbrugerne drevet fokus og investeringer i industrien.

Kinas forskning indenfor fødevarer er drevet af dels nødvendigheden for at reformere en fragmenteret og ineffektiv supply chain, dels er den drevet af uddannede og bevidste forbrugere, der kræver sundere og flere fødevarer samt en langt større fødevaresikkerhed. F&U og innovation er her, sammen med ny lovgivning og standarder på området samt investeringer i fødevareproduktion, nøglen til at gennemføre disse reformer og derved imødekomme forbrugernes krav.

Kinesiske produktionsvirksomheder på sundhedsområdet har bevæget sig op i værdikæden grundet faktorer som stigninger i lønningerne, en udviklet infrastruktur, globale ambitioner og et øget fokus på investeringer i F&U. En aldrende befolkning, forbrugernes øgede fokus på sundhed, livsstilssygdomme, sundhedsskadeligt miljø, skandaler og et ineffektivt sundhedssystem, har ligeledes været afgørende for udviklingen af innovative løsninger og investeringer i sundhedsindustrien og teknologiske virksomheder.

En af Kinas store udfordringer er miljøet og forbrugernes store bekymringer for deres sundhed grundet den massive forurening. Forbrugerne efterspørger i stigende grad teknologier, der kan beskytte dem for de negative effekter af forureningen. Forskning og innovation indenfor miljø er en topprioritet i den kinesiske regerings seneste 5-års plan fra foråret 2016, og de kinesiske virksomheder søger også nye løsninger både i Kina og i Vesten, baseret på ny banebrydende forskning og teknologier, der kan løse de miljømæssige udfordringer Kina står over for.

Den kinesiske regerings vision og ambition om at blive et af de mest innovative lande i verden i 2050, kræver en innovativ, entreprenant og kreativ arbejdsstyrke, der kan drive denne udvikling. Dette er en udfordring for Kina, hvor opbygningen af uddannelser og undervisningsmetoder ikke fordrer kreativitet. Flere initiativer og samarbejder mellem politiske og akademiske institutioner og senest virksomheder viser spæde tegn på forandringer af det kinesiske uddannelses- og undervisningssystem, der kan indikere, at et mere innovativt system er ved at blive etableret.

Executive Summary

The Chinese government recognises innovation as a primary driving force for economic development. In 2006 the government declared its intention to transform China into "an innovative society" by 2020 and a world leader in science and technology by 2050. The strong focus on innovation is reflected in the government's continuously increasing R&D spending and supporting policy.

China is now the world's second largest investor in R&D and the Chinese system of innovation is now firmly on the world R&D map. Yet the Chinese model for innovation and Chinese organisations' breakthroughs are different from the West; with greater willingness in China to go directly from development to manufacturing and shipping products. Innovation in China is primarily driven by the market and innovation from Chinese companies is characterised as "need seeker" with a strategy to identify the needs and desires of end users by engaging them directly, and a goal to be the first to market with breakthrough products serving previously unmet needs.

This ICDK analysis is made for Innovation Centre Denmark in Shanghai by the China based consultancy company China Skinny.

The first part of the report explains the tight link between consumer demand and innovation development in China. Historically, China's growth has been driven by export, investment and manufacturing, but as China moves up the development ladder, the growth is shifting towards design, consumption and services. Innovation based on consumer needs plays a key role in China's transition and development.

The remaining chapters look into R&D, consumer trends, drivers, key players and collaboration for the five selected areas: The mobile and smart living of the Chinese consumer; Food quality, safety & healthy foods; Patient centric and value-adding health care solutions; China's response to pollution and climate change and Striving for knowledge excellence. The key findings for each area are summarized below.

China is world leading in R&D in smart home technology as entrepreneurs have succeeded in tapping into the established manufacturing and engineering infrastructure combined with the transition of manufacturers from OEM[1] to selling direct to consumers. Growing consumer demand and support have driven focus and investment to the industry.

China's R&D focus on food is partly driven by necessity due to a fragmented and inefficient supply chain and partly by educated and aware consumers, demanding

[1] OEM (Original Equipment Manufacturer) refers to a manufacturer of non-branded products which are then branded by another company.

healthier, safer and trackable food sources and much more of it. R&D and innovation are key requirements to achieve this goal along with tighter regulations and investment in food production and standards.

Chinese health care manufacturers are being pushed up the value curve by higher wages, a developed infrastructure, global aspirations and increased focus and investment in R&D. An aging population and consumers with ever-growing health concerns due to greater awareness, 'white collar diseases', a poor environment, scandals and an inefficient health care system, are also pushing for change requiring innovative solutions and investment from the health care industry and tech companies.

China's environment is severely challenged and of great concern to consumers, who increasingly demand technologies that can protect them from the negative effects of pollution. Environmental R&D and innovation is a top priority in the government's latest Five-Year plan and companies are also chipping in and funding projects that are cutting-edge of research, technology and conservation with the aim to improve China's environment.

With the vison to become one of the most innovation countries globally, China needs creative minds, but the education is responding slowly. Multiple initiatives and cooperations between political and academic institutions as well as companies suggest that the change to a more innovative system is underway. Incubation centres and an increasing involvement of the private sector are driving creative education, advanced research and innovations.

Currencies in this project refers to Chinese yuan. On June 6, 2016 the conversion rate is:
1 Chinese yuan (¥) = 0.996623305 Danish kroner

1. Introduction

Historically, China's growth has been driven by export, investment in infrastructure, factories and housing as well as manufacturing, but as the market evolves and the economy slows, innovation is crucial for continued economic growth. Consumption is another key factor for future growth – in the first quarter of Q1 2016 China's GDP grew 6.7% and consumption contributed with 84.7 %[2]. Innovation is therefore tightly linked to consumers. Over the past three decades, Chinese companies have learned to adapt products from around the world to the needs of a rapidly urbanizing nation and have become very agile—moving goods into production quickly, then tweaking designs afterward to better address consumer needs.

1.1 Consumer Trends

1.1.1 The importance of lower tier cities' consumers

Chinese consumers are considered the world's largest group of mainstream consumers and the market continues to grow. In 2012 there were 256 million urban households, of which 17% had the disposable income to make discretionary purchases, contributing to the lion's share of consumption growth. Just ten years later and there will be 357 million urban households and 63% in the income bracket to buy more than just daily necessities[3]. The future growth of the middle class and wealth of China will come from lower-tiered cities due to increasing incomes and consumption. There are 76 prefecture level cities in China with more people than all of Denmark[4], and the lower-tier cities are contributing the lion's share of China's current growth. By 2020, 75% of China's affluent consumers will live in Tier 2 or smaller cities[5].

[2] National Bureau of Statistics of China, 2016
[3] McKinsey "Mapping China's Middle Class", 2013
[4] National Bureau of Statistics of China, 2016
[5] Boston Consulting Group "The Age of the Affluent: The Dynamics of China's Next Consumption Engine", 2012

Source: The Economist, 2016

1.1.2 Digital China

At the end of 2015, 688 million consumers were online in China. The Internet is even more part of Chinese consumers' lives than in Western countries. Chinese spend 26 hours a week online, and they access it everywhere, with 89% using mobile devices to go online[6]. Chinese consumers use apps for everything, and buy most things online. Online shopping is growing more than three times faster than physical stores as it offers convenience, larger ranges, competitive prices and more responsive service. China's 358 million mobile shoppers account for around 70% of online shopping[7], with mobile commerce growing three times faster than desktop shopping.

1.1.3 China's Important Youth Segment – Milennials

China's youth (aged 15-29), known as Millennials, are the country's main hope to lead the consumption revolution, contributing most to China's retail sales growth in 2015. Millennials have only known a prosperous China and they are relatively free spenders, without the frugal predispositions of their older peers. The youth are better educated - 68 million Chinese born in the 90s have a university degree, almost 10 times more than those born in the 70s[8]. Two-thirds are estimated to be in the 'high income bracket'[9]. The average age of China's 3.6 million USD millionaires is 38 years[10], versus over 50 globally. Chinese Millennials also are much more open to foreign products and influences, with 59% under 30 viewing America positively, versus just 29% of those over 50 according to Pew Research. They earn more, spend more and travel more than older generations and are the key segment driving consumption.

1.1.4 Chinese Brands Are Becoming More Competitive

In 2011 Chinese consumers had a significant preference for foreign brands and looked down on domestic brands – just 31% were willing to support Chinese companies by buying Chinese goods[11]. However, Chinese consumer preference for lo-

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[6] China Internet Network Information Center (CNNIC) "Statistical Report on Internet Development in China", 2016
[7] iResearch "China's Internet Industry Summary Report", 2015
[8] Goldman Sachs "Chinese Millennials", 2015
[9] High income refers to a monthly income of ¥10,000 or above
[10] Hurun "The Chinese Millionaire Wealth Report",2014
[11] McKinsey "The Modernisation of the Chinese Consumer", 2016

cal brands is improving due to increased investment in quality control, design and branding by domestic brands. Some Chinese companies even have notable R&D budgets. This coupled with a greater sophistication and self-confidence of Chinese consumers, who are now looking beyond the brand and evaluating the value, making Chinese products more competitive. According to a recent McKinsey study, 62% of Chinese consumers prefer Chinese brands over foreign. Most Chinese are proud of their Chinese roots and many support local brands if they measure up.

1.1.5 From Functional To Experience Based Consumption

With rising income levels and living standards, Chinese consumers' spending patterns are evolving and Chinese are allocating more of their income to lifestyle services and experiences. To Chinese consumers, entertainment beyond the house is all about enjoying life: restaurants, cinema and travel are popular as spending on services grows. In 2013, the Chinese middle class spent 44% of all money on services and according to McKinsey this is expected to grow to 50% by 2022, as young urbanites splurge via their phones on everything from massages to dining out, hairstyling, and nail salons.

1.2 Political Trends

1.2.1 Urbanisation

One of the key drivers of China's economic growth has been urbanisation and it has been growing at 2.85% a year[12]. Currently, around 56% of China's 1.4 billion people live in cities, leaving room for further growth[13]. The Chinese government acknowledges the importance of urbanisation for the growth of the economy as urban consumers earn over three times more than their rural equivalents, they are more educated, tech-savy[14] and likely to contribute to innovation. A new urbanisation mandate is therefore being pushed, with a focus on transforming migrant workers into urban citizens and deepening reform of the household registration system in order to give rural residents moving to the cities for work the same benefits as urban residents. China's urbanisation rate is targeted to be 60% by 2020, up from the current 56%.

1.2.2 Improving The Quality Of Education

As the government aims to make consumption a key pillar of growth, it also realizes the importance of improving the quality of education to bridge the gap between the rural and urban population. Therefore, the education targets focus on subsidizing education for poor students, promoting fairness in education and standardizing the process for urban and rural schools. The Government also aims to raise the quality of certain to universities and subjects to the standards of top ranking global universities. The Chinese government also encourages the private sector to invest and provide diversified education services.

1.2.3 Supply Side Reforms

The Government initiated supply side reforms will be carried out from 2016-2018 and are expected to generate sustainable, quality growth through tax cuts, entre-

[12] National Bureau of Statistics of China, 2015
[13] Ibid.
[14] The term tech-savy refers to people who are well-informed about or proficient in the use of modern technology.

preneurship and innovation. Companies will be encouraged to spend more on R&D and take steps to enhance product design and innovation. As a result, more varieties of Chinese branded high-end consumer goods will be available to consumers. The reform also encourages major consumer goods producers to meet international standards. The Government has specified nine types of consumer goods as the initial focus, including domestic appliances, watches, bicycles, goods for daily consumption, food as well as products in the culture and sports sectors.
Chinese consumers' spending overseas on high quality products and services has grown rapidly and it is hoped the supply side reforms will support Chinese companies to make products that can compete with imported goods.

1.3 Social Trends

1.3.1 Embracing Change

People in China have seen more change in 30 years than many Western countries have seen in a lifetime. This has impacted the way change and innovation is perceived – Chinese consumers have developed a knack for expecting progress and being optimistic about new technology. Over 500 new products are launched every day in the market. Rather than fighting the trend, consumers as well as companies are embracing change. Chinese are enthusiastic about technology and are the leader in Asia when it comes to early technology adoption and online technology purchases – 59% indicate they buy a new tech device as soon, or shortly after, it is available[15].

The readiness for change is also reflected among traditional industries — businesses from large retail chains to mom-and-pop shops[16] are accepting payments via Alipay and WeChat Pay[17] and integrate other offline to online initiatives; many municipal transportation bureaus have integrated mobile payments into subway gates, so that riders can wave their phones to get into the station; hospitals are taking doctor appointments on WeChat; TV networks are porting over content (sometimes handing over exclusive rights) to online video portals.

1.4 Economic Trends

1.4.1 Rising Disposable Income

Despite the slowing economy, the urban disposable income per capita is forecast to grow from ¥56.280 today to more than ¥208.430 in 2030. Today only 11% of the population has reached the middle class[18], but the middle class will continue to grow due to urbanisation and income growth. Of China's 770.4 million working population, less than 2% pay income tax[19].

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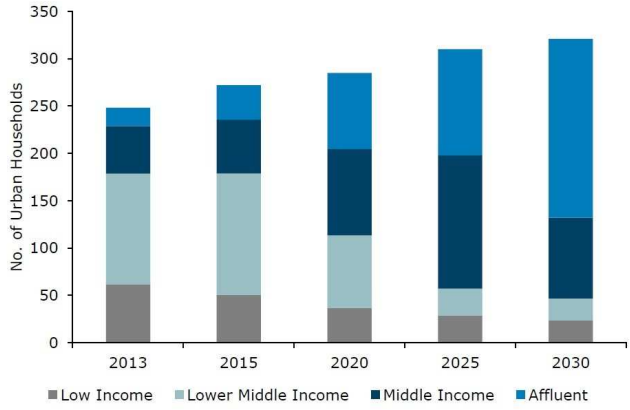
[15] Consumer Technology Association (CTA) "Asia-Pacific Consumer Tech Ownership and Opportunity Study", 2016
[16] The term refers typically small, independent stores run by families
[17] AliPay and WeChat Pay are China's two most popular online payment platforms owned by Alibaba and Tencent respectively. They are a combination of Paypal and ApplePay
[18] McKinsey defines the mass middle class in China as annual household incomes from ¥60.000-106.000 while the upper middle class has annual household incomes of ¥106.00-229.000.
[19] Goldman Sachs "The Rise of China's New Consumer Class", 2016

FIGURE 1. PROJECTION OF CHINA'S URBAN HOUSEHOLDS BY INCOME GROUPS

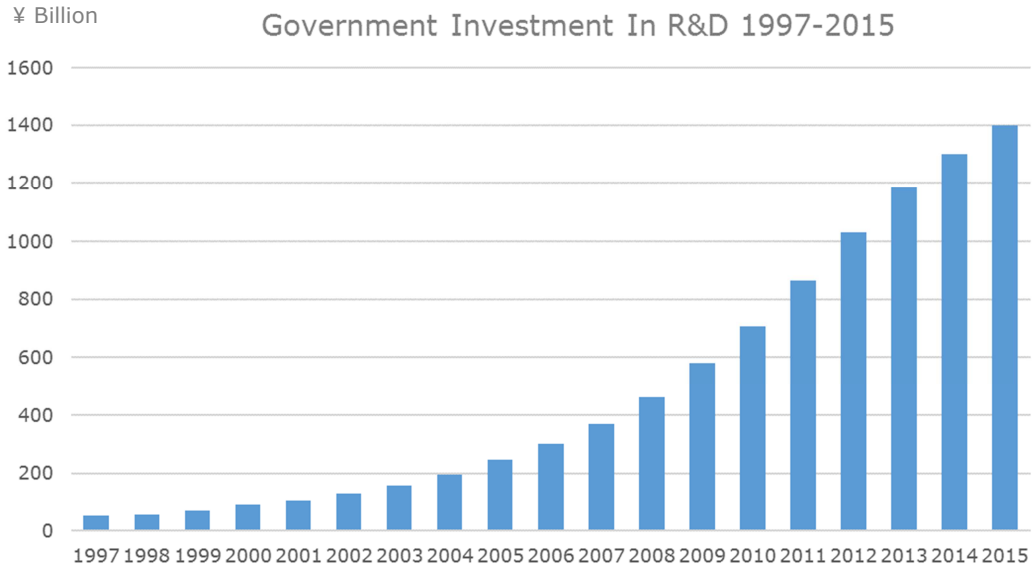


Source: ANZ Research

1.5 Technology Trends

1.5.1 Innovation Focus

Innovation is recognised as a primary driving force for economic development and the Chinese government is increasing its R&D spending (overall and as a percentage of GDP). China is now the world's second largest investor in R&D. Over time, the investment in R&D has increased from 0.5% of GDP in 1995 to 2% in 2014, on par with the investments of the European Union. The target is expected to reach 2.5 % by 2020, thus catching up with the relative investment in R&D in the United States.



Source: National Bureau of Statistics of China

1.5.2 Internet Plus

The Chinese government's Internet Plus strategy promotes cloud computing, online banking and mobile internet and seeks to drive economic growth by integration of Internet technologies with manufacturing and business. By combining the technology sector's ability of gathering and processing huge amounts of data with more traditional areas of the economy, it will provide more transparency and tracking of

domestic production and supply chains to instill a greater level of confidence in local products.

1.5.3 O2O

One of the current buzzwords in China is O2O (Online-to-Offline). The widespread adoption of smartphones has enabled consumers to easily integrate their physical and online
activities. Internet companies are innovating and investing to capitalise on this trend. QR code scanning has allowed many opportunities including online payments and purchasing, social sharing and marketing, and to aide research and purchase decisions. China's big Internet companies Baidu, Alibaba and Tencent are all working with offline retailers to integrate their platforms into the physical shopping experience, bringing significant data tracking, insights and intelligence.

Integrating online elements into offline retail and services was estimated to generate an additional ¥240 billion in 2014, growing 20% from a year earlier[20].
In 2015, 71% of online Chinese consumers have used O2O services[21].

1.5.4 Innovative Development

In its 2006 "Medium- to Long-Term Plan for the Development of Science and Technology" (MLP), the Chinese government declared its intention to transform China into "an innovative society" by 2020 and a world leader in science and technology by 2050.

The Chinese system of innovation is now firmly on the world R&D map with leading research universities, world-class public research centres, modern science and technology parks, a growing concern for intellectual property rights (as more and more Chinese companies need to protect their innovations) and a surge of companies investing in R&D. The Chinese model for innovation and Chinese organisations' breakthroughs are different from the West with greater willingness in China to go directly from development to manufacturing and shipping products.

More and more private Chinese firms are emerging, contributing a rapidly growing share of innovations. They are very active in the ICT (Information and Communication Technologies) and electronic games. The weight of the SOEs (State-Owned Enterprises) is decreasing, both as a factor in the GDP and in the production of innovative offerings, although they still have plenty of room for growth.

1.5.5 Rise Of The Entrepreneur

China has spent 30 years becoming the manufacturing capital of the world, so coastal cities like Shenzhen and Guangzhou are now crammed with electronics facilities. All have a deep knowledge of how to make things, so it was almost inevitable that home-grown entrepreneurs would get in on the act. Living next to the factories or being able to stroll the electronics markets, they're the first to know when trends in hardware emerge.

Chinese society is, by and large, highly entrepreneurial, eager to make money and

[20] McKinsey "China's iConsumer 2015: A growing appetite for choice and change", 2015
[21] Ibid.

able to extract value very effectively. With their market-oriented approach to innovations, they are ready to experiment and rapidly correct their product. Technology is only a tool to be successful in the market place. A Chinese entrepreneur may look at a Western product or service offering, deconstruct it and rebuild it in a leaner way, adapting it along the way to the Chinese consumers, and thus turning otherwise expensive products into big successes.

1.5.6 Consumer Driven Innovation

Innovation from Chinese companies is characterised as "need seeker" as the strategy is to identify the needs and desires of end users by engaging them directly, striving to be the first to market with breakthrough products meeting previously unarticulated needs.

Closeness to the end user is therefore of great importance and luckily, Chinese consumers also seem to be more willing than their overseas peers to participate in the innovation process by acting as perpetual beta testers. Consumer-facing companies routinely launch new models and continue to refine them based on market feedback.

1.5.7 R&D In China

China has used various regional clusters, pilot programs, and demonstration zones to consolidate R&D activity into specific areas of the country. Buoyed by local government support, advanced infrastructure, and preferential policies covering taxes and R&D expenses, these areas have developed into technology incubators for domestic and foreign companies alike. Examples of these zones include Zhongguancun Science Park in Beijing, Zhangjiang Hi-Tech Park in Shanghai, and the Tianjin Economic-Technological Development Area, although most figures suggest that higher-than-average R&D intensity activity is also concentrated in Jiangsu, Guangdong, Zhejiang, Shandong, and Shaanxi provinces. Despite the R&D concentration along China's east coast, companies are locating some of their R&D operations throughout China's interior regions as well.

1.5.8 *Importance Of Universities*

China's universities graduate more than 1.2 million engineers each year – more than any other country. Private colleges and universities now account for more than a quarter of all higher education institutions in China, and they are growing at a faster rate than public ones. Large companies are also getting involved. Alibaba's Taobao unit, for instance, has established 'Taobao University', initially to train e-business owners, managers, and salespeople. In time it will offer business education to more than a million online students.

Chinese Universities will soon deliver more PHDs every year than any other country. This is a key pillar in Chinese universities' plans to become sources of high-quality, creative research and a large contributor to China's R&D output. The Chinese government and many other sources are pumping enormous revenues into the leading institutions. Within 10 years, the research budgets of China's elite universities will approach those of their U.S. and European peers. And in engineering and science, Chinese universities will be among the world's leaders. As Chinese universities raise their game, they are becoming increasingly interesting innovation partners for a wide range of domestic and global companies.

China’s large and ever-more sophisticated talent pool is a common reason behind the rapid expansion of R&D facilities. As companies increasingly rely on local talent to support Chinese R&D, university agreements are becoming an important pipeline for talent recruitment, development, and retention. Companies who have opted to explore university partnerships stated that this route can be an effective “corporate branding” strategy. Company-sponsored textbooks, research laboratories, courses, and internship programs are all ways to bolster the company name and profile among engineering and polytechnic students entering the workforce. What seems to be changing is the growing use of Chinese universities as a form of “outsourced R&D,”. It is however suprising that businesses and universities do not communicate their partnerships more publicly as this news would benefit both parties – from a Corporate Social Responsibility and innovation angle for businesses, and a practical and prestigious association with industry for universities.

2. The Mobile & Smart Living of the Chinese Consumer

One of the leading areas of R&D in China is the mobile & smart living segment. Six of China's top-10 companies registering patents are in this sector and they have some of the largest R&D budgets. China developed manufacturing and engineering capabilities early in this area, traditionally for foreign companies, but as entrepreneurs have tapped into this infrastructure, and manufacturers have transitioned from OEM to selling direct to consumers, so to have R&D budgets and focus. The industry is supported by strong demand from domestic consumers whose purchasing power has helped fund research and driven investment.

2.1 Consumer Trends

Chinese consumers are seeking convenience and this combined with the rapid technological development has redefined the market for traditional home appliances to become smarter and more interactive. China's online users have some of the highest mobile penetration rates in the world (89%)[22] and home appliances were one of the fastest growing retail categories in 2015 at 13.5%[23].

Already in 2014, 97 % of Chinese consumers wanted smarter home appliances, especially TVs. According to a recent study by Gfk[24], more than 75% of Chinese consumers say that smart home technology will impact their lives in the next few years, compared to the global average of just over 50%. On an industry-wide level, smart washing machines, refrigerators and air conditioners have all increased their market share over the past year, according to figures from GfK, indicating consumer demand for such high-tech products.

[22] iResearch "China's Internet Industry Summary Report", 2015
[23] National Bureau of Statistics of China, 2015
[24] Gfk is Germany's largest market research institute, conducting consumer and market studies in more than 100 countries. Gfk "Smart Home Appeal in Asia", 2016

Imported luxury rice cookers and heated toilet seats are also in demand from comfort and convenience seeking Chinese consumers. This trend is driving Chinese companies to integrate smart functions into traditionally humble appliances in order to take their share of the market.

Appliances such as air purifiers are also gaining popularity as people become increasingly health conscious, worried about smog and other environmental hazards.

2.2 Opportunities

2.2.1 Outlook

The future of smart home technology in China looks bright as it is on par with mobile payments and wearable tech in playing a key role in pushing forward innovative technology in China. A recent study by Gfk shows that consumers in China are well informed and aware of smart home technology[25]. GfK analysts predict that the appliance growth rate will double this year as Chinese consumers become more receptive to innovative technology.

From mobile app-controlled washing machines, to refrigerators with touch screens and household robots, China's smart home appliances will see steady growth. Growth opportunities in the industry will be driven by demand from tech-savy Chinese consumers who embrace smart home technology to a greater extent than their global counterparts.

2.2.2 Potential For The Robot Industry

Aside from smart home appliances, the robot industry in China is another potential growth area. Service robots manufactured by industry players like Haier, Midea and Gree specialise in applications such as home security, detecting water or gas leaks, doing housework, and even telling stories to children.

With an increasingly ageing population in China, the home-caring and home-nursing robots is expected to have great potential. China's elderly population, or those above age 64, is expected to grow from 131 million currently to 200 million by 2025, representing 14 % of the total population, according to figures from the United Nations[26]. While the robot industry is still at an investment stage in China, the market demand for household robots is expected to increase in the coming years.

The progress of robot technology will ease the everyday life and make people feel good. Whilst China's robot industry is immature in comparison to global competitors, the industry is high on the Chinese government's agenda. In April, a five-year planning proposal vowed to make significant progress by 2020 in the production capacity, creativity and competitiveness of the industry, driven by a focus on R&D[27].

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[25] Gfk "Smart Home Appeal in Asia", 2016

[26] South China Morning Post, March 2016 http://www.scmp.com/business/companies/article/1929435/tech-savvy-chinese-consumers-drive-growth-smart-home-appliances

[27] South China Morning Post, April, 2016 http://www.scmp.com/news/china/policies-politics/article/1934071/chinas-five-year-plan-transform-its-robotics-industry

Breakthroughs were expected in core components of robots including sensors and servomotors, but it also called for building competitive advantage in 10 types of industrial robots capable of activities like precision welding, surgical applications and vacuum cleaning, performing an array of services and even programming themselves.

2.3 Socioeconomic Developments, Trends & Drivers

2.3.1 Adaptable Consumers

The Chinese consumers' hunger for change is powering the growth of the smart home industry in China - Chinese consumers are ready for the smart home, with 54.9% of respondents "very interested" in converting to a smart home, while 36.8% are "fairly interested" with the smart home idea[28].

2.3.2 Environmental Concerns

China suffers from a serious smog and pollution problem with 99% of the urban population breathing air that is considered unsafe by EU standards.

It is therefore not surprising that smart air purifiers and connected air conditioners are big business in China. These connected devices can inform consumers what the pollution is like in the room compared to outside, and when it is safe to open the windows. Third-party online services can signal connected air conditioners when the outside smog levels reach unhealthy levels. The connected air conditioner can then start filtering the air from outside.

China's major pollution issues ensure that any device that can make the air that Chinese consumers breathe in their homes and offices cleaner and safer is going to be a popular choice. If companies can make these devices smart while at the same time keeping the price tag low, then even better.

Following the growing environmental concerns, air quality forecasting and modelling is a focus area of the Chinese government. IBM and Microsoft have signed contracts in China for air quality forecasting, using emerging cognitive computing technologies developed in their China-based research labs.

2.4 Technology Developments, Trends & Drivers

2.4.1 Government Investment

To support the 13th Five Year Plan (2016-2020), the Chinese Government is expected to invest more than ¥2 trillion in key areas such as fiber optics, high-speed broadband and cloud computing.

Between 2010 and 2014, venture capital investments tripled, rising from ¥35.3 billion to ¥110.5 billion, with an investment focus on consumer and mobile-based innovations[29]. Through this, start-ups in China have access to a lot of capital, but it also means that there is an intense competition for the market share, providing

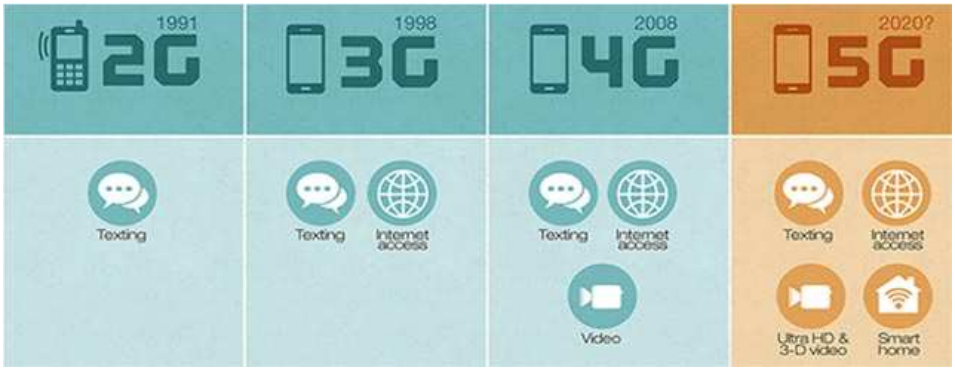
[28] Zol.com (a leading IT portal website in China) "Chinese Smart Home Market Outlook Survey", 2014

[29] Boston Consulting Group "The Mobile Revolution: How Mobile Technologies Drive a Trillion-Dollar Impact", 2015

further impetus to differentiate through R&D.

2.4.2 Internet Of Things (IoT)[30]

The IoT involves a technological revolution, which will impact everything we do. More connected "things", will enable the collection of more integrated information about customers' behaviour and preferences. Growing 20.4% annually, the IoT market is expected to reach a total value of ¥30.6 trillion in 2018. In 2014, China had more than 50 million Machine to Machine (M2M) connections — compared to the US' 32 million and Japan's 9.3 million according to the GSMA[31].



The coming fifth-generation wireless broadband technology will replace the 4G technology by 2020 for business and consumer use. 5G connections will be 40 times faster than 4G (up to 1 Gb/s) and include a double-layer infrastructure in order to give a preferential space for data flowing "M2M" rather than human to human. This will further pave the way for the development of the Internet of Things by increasing the productivity and interconnection among different "things". Thanks to faster download speeds, it will be possible to stream HD videos with no buffering or waiting time. This will accommodate the need of Chinese consumers to enjoy TV shows and branded videos from everywhere without necessarily download the videos from a WiFi spot. Higher speed and connectivity with machines will have positive spillovers towards many industries, as well as foster the introduction of new types of marketing strategies, while enhancing others such as gamification and interactive digital communications.

China and South Korea are taking the lead in 5G investments with Chinese telecommunication giant Huawei spending ¥3.72 billion in 5G-related R&D.

2.4.3 O2O

Smart home appliances are representative of the overall Online-to-Offline (O2O) revolution that China is leading the world in – connecting offline objects and actions with Internet-connected devices (please section 1.5.3). It is an increasing

[30] The Internet of Things (IoT) is a network of network of physical objects or "things" such as vehicles, robots, home systems and appliances, traffic lights and so forth. They are embedded with electronics, software, sensors, and connectivity that enable them to exchange data with the manufacturer, operator and/or other devices (Machine to Machine – M2M) connected to the same network.

[31] The GSMA is the representative association for GSM cellular networks, the world's dominant mobile standard. The association represents GSM network & device manufactures and operators.

trend coming from innovative Chinese manufacturers which is being supported by tech-hungry Chinese consumers.

2.5 Key Companies

2.5.1 Company Patents

Patents are often used as a measure for innovation in China with the country producing 928,177 new patent fillings in 2014, more than any other country. However, the value of many of these patents is regularly questioned. Nevertheless, patents are also an indication of companies' focus on Research & Development. Mobile and home appliance companies account for 6 of the top 10 Chinese companies by patents[32].

2.5.2 Huawei (41,813 patents)

Huawei is the world's largest telecommunications equipment manufacturer and leading information and communications technology (ICT) solutions provider. Driven by responsible operations, ongoing innovation, and open collaboration, Huawei has established a competitive ICT portfolio of end-to-end solutions in telecom and enterprise networks, devices, and cloud computing.

Huawei has consistently invested over 10% of its revenue in R&D every year. In 2015, approximately 79,000 employees were engaged in R&D, comprising 45% of the total workforce. Huawei's R&D expenditures totalled ¥59,607 million in 2015, accounting for 15.1% of the company's total revenue. Huawei has cumulatively spent more than ¥240,000 billion on R&D over the past decade.

2.5.3 ZTE Corp (32,649 patents)

ZTE Corporation is a global leader in telecommunications and information technology. The core products are wireless, exchange, access, optical transmission, and data telecommunications gear; mobile phones; and telecommunications software. It also offers products that provide value-added services, such as video on demand and streaming media.

The company's R&D costs for 2015 increased by 35.4% to ¥12.2 billion from ¥9 billion for 2014, and increased from 11.1% for 2014 to 12.2% for 2015 as a percentage of operating revenue, attributable mainly to the continuous increase in investment in the R&D of products such as 5G, high-end routers, LTE, SDN, GPON and core chips for the period.

2.5.4 Gree Electric Appliances (8,383 patents)

Gree Electric Appliances is the world's largest air conditioner enterprise integrating R&D, manufacturing, marketing and services. The company offers two types of air conditioners: household air conditioners and commercial air conditioners. Gree Electric Appliances also provides electric fans, water dispensers, heaters, rice cookers, air purifiers, water kettles, humidifiers and induction cookers, among others. The company distributes its products within China's domestic market and to

[32] Forbes, April 2016 http://www.forbes.com/sites/rebeccafannin/2016/04/02/china-innovation-power-far-out-ranks-u-s-and-japan-in-new-patent-applications/#2db43a77371d

overseas markets under the brand name of Gree. Gree invests around ¥1 billion per year in R&D.

2.5.5 Haier Electronics Group (6,406 patents)

Haier is a Chinese multinational consumer electronics and home appliances manufacturer. The company designs, develops, manufactures and sells products including air conditioners, mobile phones, computers, microwave ovens, washing machines, refrigerators, and televisions. Haier is one of the world's leading white goods home appliance manufacturers. Haier Group products are now sold in over 100 countries. Investment in R&D is one of the key drivers of Haier's success - 4% of annual turnover is invested in this area, with 8,150 staff employed in innovation programmes across the world.

2.5.6 Lenovo (4,874 patents)

Lenovo is a Chinese multinational technology company which designs, develops, manufactures and sells personal computers, tablet computers, smartphones, workstations, servers, electronic storage devices, IT management software and smart televisions. Lenovo has Research & Development centers in China, Japan, Brazil, Chinese Tapei and the US. The company invests around ¥4 billion in R&D globally per year and has about 3,500 R&D engineers.

2.5.7 BOE Technology Group (4,160 patents)

BOE Technology Group is the world's leading supplier of semiconductor display technologies, products and services. BOE's display products are widely used in a broad spectrum of applications such as mobile phone, tablet, notebook, monitor, TV, vehicle display and digital information display. In 2015 BOE Technology Group invested ¥3.3 billion in R&D, a year on year increase of 34%

2.5.8 Other relevant companies

2.5.9 Alibaba

NYSE-listed Alibaba is the world's largest ecommerce company, but has expanded its product portfolio across many areas including cloud computing, fintech, navigation, physical retail, entertainment, media and sport. Alibaba refers to itself as a 'big data' company, and utilises its extensive data to assist with R&D to develop consumer-relevant products with a strong focus on O2O integration.

Alibaba Group R&D institute was introduced in 2008 and has since invested heavily in R&D. Alibaba spent more than ¥13.7 billion on R&D in 2015, 47% more than in 2014. It has over 750 approved patents and has filed over 3,000 in total. It has partnerships with its Aliyun cloud computing arm and Midea to develop smart in home appliances.

2.5.10 Xiaomi

Privately-owned Xiaomi is one of the highest profile smart appliance companies in China. It aims to bring products with high-end features and functions at affordable prices to China's mass market. Xiaomi utilises its strong branding and sales channels developed through its smartphone division (it is the world's 5th largest small phone brand by volume) to sell smart home appliances such as in-house entertainment hubs and TVs, air purifiers, rice cookers and health products. Xiaomi has grown in this category through acquiring appliance manufacturers and integrating

its IP, it partners with companies in China and internationally such as Yunmi Technology in China and iHealth Labs of Silicon Valley, USA. In late 2014, Xiaomi acquired 1.2% of Midea Group, indicating its focus in the home appliances category. As a private company, Xiaomi does not disclose its R&D investments, however industry insiders believe it is lower than competitors, part of their strategy to keep their devices affordable. In 2015, Xiaomi set up its first R&D centre outside of China in Bangalore, India.

2.5.11 Baidu

Nasdaq-listed Baidu is best known as China's leading search engine, however it has recently made significant investments in offline integration, working with partners across categories as varied as home appliances, auto and retail. Baidu's open platform iHome was launched in late 2014 to encouraging more in-home innovation from Chinese appliance makers integrated by companies such as Lenovo, Haier, online video platform iQiyi and electronics manufacturer Foxconn. Baidu invests heavily in R&D, spending more than ¥10.5 billion in 2015, 43% more than 2014. Many of its focuses follow Google and are as diverse as self-driving cars and bikes, robotics and deep learning research which it will likely integrate into smart home appliances. It has an R&D centre in the Silicon Valley focused on artificial intelligence.

2.5.12 Midea

Shenzhen Stock Exchange-listed Midea is China's largest and most valuable appliance brand, with revenues of ¥162.1 billion in 2014. It has a strong focus on smart appliances and has products higher on the value curve than many Chinese appliance brands. Midea invests 3% of company-wide revenue into R&D, much of it through its Guangdong-based Midea Research Centre focusing on air conditioning, refrigeration, laundry, motors, dish washing and kitchen appliances. In addition to Xiaomi's 1.2% ownership of Midea, the company also works with Alibaba in developing Internet-connected appliances. Midea has actively applied for China's 'light' utility model patents, and was granted 2,070 in 2014 alone. In March 2016, Midea acquired 80.1% of Toshiba's home appliance division, obtaining more than 5,000 IP-rated assets mainly made up of patents.

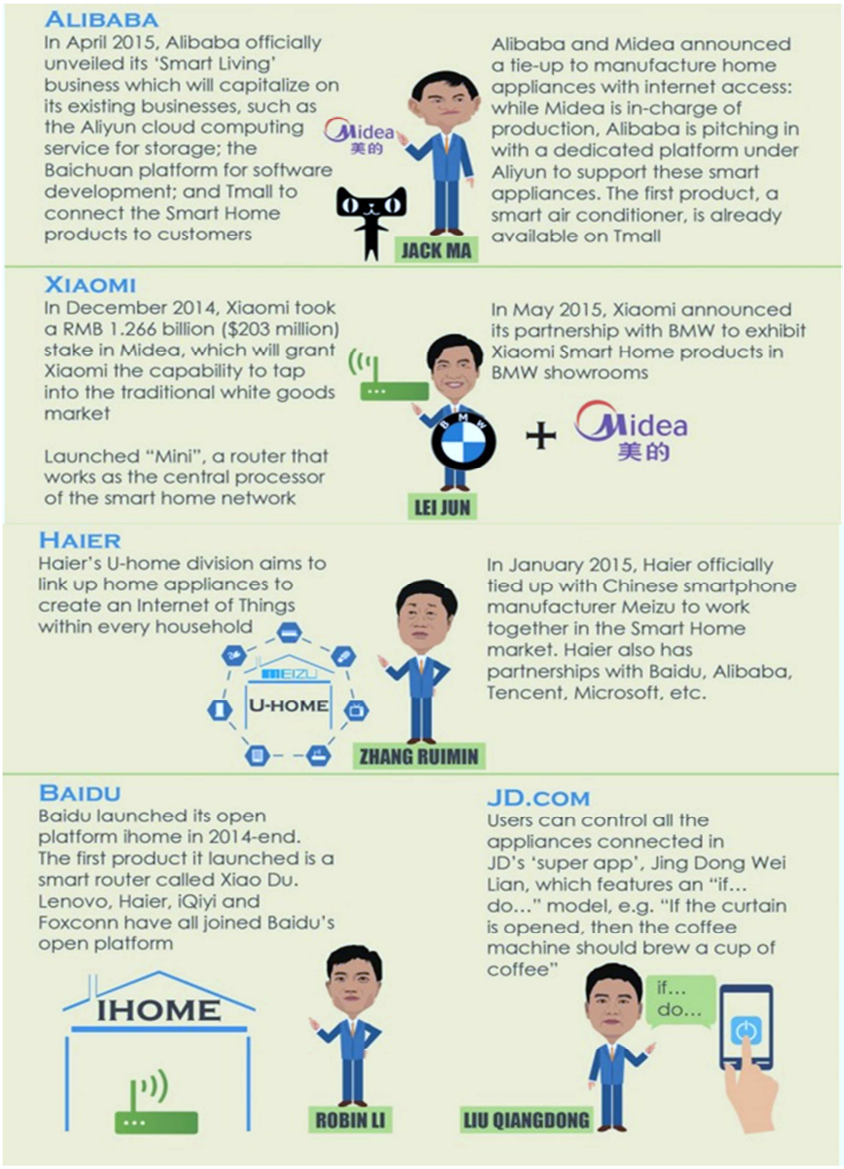
2.5.13 JD.com

Nasdaq-listed Jingdong is China's second-largest ecommerce company, 15% owned by Tencent. In late-2014, JD.com introduced China's first super APP that allowed users to manage and control over 40 smart products from different manufacturers. JD's R&D is focused on mobile applications, cloud computing and big data infrastructure. In late 2015, the company opened an R&D centre in the Silicon Valley, USA, with its main focus developing and enhancing new and existing technologies that will improve the user experience for its customers.

2.5.14 Cross-Industry Partnerships

Sharing and partnering between tech and white goods companies has been pivotal for the growth of the industry. All companies have their boundaries, but by combining capabilities it is possible to provide the perfect user experience to consumers.

Examples of Cross Industry Partnerships



2.6 Industry & Academic Partnerships

In the smart home technology industry, cooperation and openness are perceived as crucial drivers of innovation. This is reflected in the cross industry partnerships, but also in the cooperation between companies and the academic world. The partnerships are mutually beneficial –giving rise to new technologies at a faster pace, spurring the innovation spirit, attracting talent and modernising the role of universities by promoting the application and commercialisation of technological achievements.

Huawei - Leading in R&D Collaboration

- Huawei worked with European universities to research key component behavior models. To address the dense deployment of base stations in the future, the company explored a business model for crowdsourcing-based network construction for micro base stations integrated into intelligent street lighting.

- Collaborated with research institutes to propose a novel server architecture that enables a Programmable Architecture for Resourcing on-Demand (PARD) and full hardware virtualization for data centers. The proposed architecture won high acclaim from academics.

- Worked extensively with prestigious universities, companies focused on technological innovation, and open source organizations in the areas of distributed storage, storage class memory (SCM) systems, cloud computing platforms, Big Data, artificial intelligence, knowledge libraries, and HD video, in order to drive technological innovation.

- In November 2015, Huawei introduced the Huawei Innovation Research Program (HIRP). The HIRP has attracted around 100 academic institutions and over 1,000 scholars, and has funded the research of thousands of graduate students. In 2015, the HIRP sponsored over 100 new research projects to further strengthen basic research and technological innovation.

2.6.1 Other Examples Of Partnership With Universities

University	Company(ies)	Project
Tsinghua University	Intel and China electronics	A three party cooperation about the research and development of China's semiconductors
Fudan University	Shanghai electron Ltd	The project focuses on cloud computing and big data
Nanjing University	Nanda electronic information Ltd	The project includes cloud computing and intelligent robot

2.7 Challenges

China's innovation focus for mobile and smart living over the past few years has been predominantly home grown, with significant investment in locally-based R&D. This R&D has usually focused on improving or localising technologies seen elsewhere without infringing on patents, however there is an increasing focus to better meet Chinese consumers' unique needs from local innovations.

Danish SMEs will need to provide a significant point of difference over locally innovated technology to be attractive partners, technology sellers or acquisition targets for Chinese firms. Nevertheless, there are examples of large Chinese firms in this sector setting up R&D centres in globally-recognised innovation hubs such as the Silicon Valley and Bangalore, and acquisitions such as Lenovo's buyout of Motorola for its patents and Xiaomi purchasing patents from Microsoft.

With most technology in this area linked to the Internet, data will need to be accessible and hosted within China to ensure acceptable performance. In many cases, this will require a firm to provide Government access to data and often algorithms or a JV with a local business, both which pose risks such as IP theft.

As smart homes are now spreading into almost every item in a household, Denmark can capitalise on its enviable reputation for furniture and fashion design and general lifestyle leadership, to incorporate smart technologies which will make discerning Chinese consumers and businesses take notice, while developing a localised component, allowing opportunities for academic and business partnerships.

3. Food Quality, Safety & Healthy Foods

China's focus on food R&D has been driven by a number of factors. Firstly, China has 21% of the world's population and just 9% of the world's arable land requiring efficient technologies to create more with less. This is compounded by the fact that a significant share of China's food producers is made up of millions of peasant farmers from the early Communist Party mandate, resulting in a fragmented and inefficient supply chain desperate for improvements. Increasingly affluent, educated and aware Chinese consumers are also demanding healthier, safer and trackable food sources, and much more of it. This is most effectively obtained through innovation. Increased investment in food production and standards, coupled with tighter regulations, has been a key focus for the Government who aims to build confidence in Chinese supply chains, keep health scares to a minimum and maximise self-sufficiency. Savy companies are also learning that this investment is required to stay competitive for increasingly discerning consumers.

3.1 Consumer Trends

The poor environment and China's track record for rotten, tampered and unsafe food and food chains have made Chinese consumers the least trusting and most food-safety conscious in the world. The source of food has become a matter of life and death.

80% of Chinese consumers are not satisfied with food safety, with 58% concerned about production and processing[33]. Scandals spread like wildfire on social media meaning consumers are more discerning and stringent when buying both local and foreign brands. They trust and favour better-known brands. In addition, consumers are more educated and are aware of unhealthy environmental factors and take maintaining health into their own hands.

Foreign brands typically represent safe and healthy to Chinese consumers but they are growing increasingly more aware that this is no guarantee. Between 2013 and 2015 the fast food chain KFC saw negative growth due to a lack of trust in the supply chain and healthier preferences, and Oreo, whose sales were once doubling every two years, now sees low single-digit growth as consumers opt for healthier alternatives, forcing its parent company Modelez to alter its offerings.

According to a 2016 study by McKinsey, 72% of consumers now worry that the food they eat is harmful to their health, up from 60% in 2012. Over 50% of consumers are now focused on eating healthy and nutritious foods. 38% of consumers mention 'organic/green food' among their top three criteria to identify the safety of food, despite the absence of a credible organic certification in China.

3.2 Socioeconomic Developments, Trends & Drivers

3.2.1 Growing Population

With China's population set to surpass 1.4 billion by 2030 and become increasingly affluent, demand for food continues to grow. This is putting pressure on both food supplies and suppliers that produce that food. One example is cereal grains, were demand is rising as the population eats ever more beef and pork. The country needs a quantum leap in agricultural productivity if it is going to feed its population in a generation's time. Food shortages, or spiking prices for food, have been a recipe for unrest, rebellion, and imperial downfall in China for hundreds of years. Food security is a key political priority and agricultural innovation is on top of the nation's wish list.

3.2.2 Urban Lifestyles

Chinese consumers' busy, urban lifestyles have led to an increase in obesity and other white-collar associated diseases. The prevalence of diabetes in Chinese adults has increased from less than 1% in 1980 to 9.4% in 2014[34], far exceeding global growth in the disease. On the bright side, urbanisation has also led to more interest in proactive health via food and food safety.

3.2.3 Rural Skills Gap

As a result of poor education in rural China, 70% of people working on the land have only received a primary or middle school education. In recent years, those who are better educated have moved to the cities. Following this brain drain, farmers now tend to have a lower ability to adopt modern farming techniques. In response, local governments have rolled out various training programmes. While

[33] Horizon Research (a Beijing based research company) Food Safety Survey, 2014 http://www.chinadaily.com.cn/china/2014-07/25/content_17920201.htm

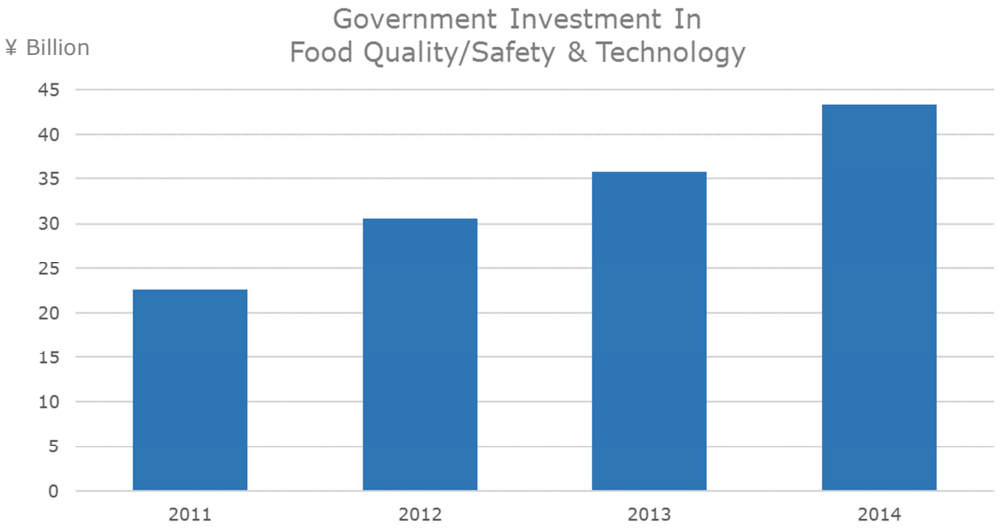
[34] World Health Organisation "Global Report on Diabetes" 2016

these have been fruitful, the technical levels achieved are still below the needs of rural development. The old ways of farming can no longer ensure reliable and sustainable food supplies, and new techniques are often misunderstood such as the over-use of pesticide, meaning new technologies and processes are needed to solve the problem which is driving R&D investment in the sector.

3.2.4 New Food Safety Law

One pillar of China's 13th five-year plan is to tighten food safety including steps to advance a stringent and highly efficient food safety management system. The new law bans highly toxic pesticides, regulates food labelling and, increases punishments for those who violate China's existing laws. This new national food safety law imposes significant new safety requirements on producers, distributors, retailers and even online marketplaces.

To compliment the new laws, government investment in food quality/safety and food technology almost doubled from 2011 to 2014.



Source: National Bureau of Statistics of China

3.3 Technology Developments, Trends & Drivers

3.3.1 Modernisation of Agricultural Farming

Over the last 30 years, Chinese agriculture has been shaped by intense modernisation, industrialisation and rapid levels of urbanization and its citizens have become richer. But the trade-off has been depletion in arable land due to urban creep and excessive use of fertilisers, pesticides and plastic sheeting. Structural inefficiencies in the food value chain have also made it difficult to provide safe, accessible and affordable food to the market.

Farmers remain China's largest consumer group and modernisation of agricultural practices would not only improve productivity and food safety, but also increase farmers' incomes. Modernisation requires a shift from production volumes to consumer demands and innovation in agricultural investment and financing mechanisms, follow-up or supporting projects for medium- to large-scale irrigation facilities, water-efficient technology, and achieving breakthroughs in environment-friendly production systems.

The interest in sustainable food production is growing and modern technologies such as smart cards, hybrid seed technology to improve crop yields, corn farming mechanization and high-rise pigpens are now being taken up by Chinese farmers. The introduction of drones that utilise advanced sensors, low-cost aerial camera platforms and autopilot capabilities can give farmers the ability to view their crops from above, detect and assess irrigation issues, pest infestations, plant health and provide soil analysis.

World Bank Project With Guangdong Farmers

Farming innovation comes in both high-tech and simple forms. A ¥1.3 billion project supported by the World Bank helps Guangdong farmers benefit from new technologies that promote sustainable agriculture. The project provides subsidies and technical support to more than 100,000 households to enable them to adopt environmentally friendly crop production practices.

Participating farmers receive an IC card that contains their name, the size of their land, the amounts of subsidized fertilizers and pesticides they can get and the corresponding subsidy level. By reducing the amount of pesticides and fertilizers used, farmers no longer pollute local water systems or overwhelm their products with excess chemicals.

According to the project management office, fertilizer application dropped by 24% for the spring rice and 12% for the autumn rice in 2014, while applied pesticide amounts for rice dropped by 27%. The spring rice yields grew six percent and autumn rice yields rose by 19%.

3.3.2 Supply Chain Connectivity And Integration

China is rapidly integrating and connecting the most important links of its food supply chains. Food production, distribution, processing, marketing and consumer purchasing are all undergoing a period of rapid electronic integration which when fully realized will represent the world's most expansive food traceability system.

The use of QR codes on food labels integrated with popular mobile social media platforms like WeChat allows customers to interact with brands, verify product authenticity, view marketing information, avail of promotional offers and ultimately purchase in an extremely convenient way. Using smartphone applications and online solutions, consumers can now easily scan and receive information regarding products' farm-table cycles.

3.4 Key Companies

3.4.1 COFCO Group

COFCO Group is the largest supplier of diversified products and services in the agricultural products and food industry in China. It is devoted to utilizing renewable natural resources to provide healthy and nutritious food, high quality lifestyle and services, as well as contributing to improve people's living standards, social prosperity and stability.

Technology innovation at COFCO focuses on achieving balance between economic growth and environmental sustainability. The company has registered patents for core technologies in this area, resulting in a continuous operation of the cellulosic ethanol pilot trial project. Some key indicators of the project, such as conversion rate and cost, are now global best practice while the low-carbon clean energy has been developed without sacrificing more grain.

COFCO Nutrition and Health Research Institute focuses on life sciences and is committed to health and nutrition and oriented towards the customer. The institute is dedicated to offering technical support for the value chain and developing innovative quality products so as to lead the Chinese people's dietary habits and ultimately promote the nation's health and improve the life expectancy of Chinese people.

3.4.2 Alesca Life

Alesca Life produces shipping containers that are modified with hydroponic systems, designed to house more produce per square meter than any other method. The systems are pesticide and herbicide free, and are almost wholly run on software, meaning each container requires no more than two hours of labour to maintain each week.

Using Alesca Life's solution, plants grow faster with the highest quality and freshness. By combining hydroponic cultivation techniques and advanced software management, it is also dramatically more water and land efficient than traditional field methods. The biggest difference between industrial agriculture and Alesca Life's solution is that vegetables are grown in water rather than soil and using LEDs in place of sunlight. The company has products designed for restaurants and homes to make urban farming more affordable and accessible to everyone.

3.4.3 DJI

DJI is a Shenzhen based company and a world leader in unmanned aerial vehicle technology. The innovation focus of the company is to transform complex technology into easy to use devices.

In November 2015 the company launched a smart, crop-spraying agriculture drone. The drone can load more than 10 kilograms of liquid for crop-spraying and can cover between seven and 10 acres per hour. It is over 40 times more-efficient than manual spraying and can improve the efficiency of agricultural production. The drone can fly up to eight meters per second and adjusts spraying intensity to flying speed, ensuring even coverage.

3.4.4 Yili Group

The Yili Group is the largest dairy manufacturer in China and is dedicated to producing 100% safe and healthy dairy products. Yili has an open and flexible approach to innovation and is at the forefront of agricultural food research, thanks to its wide-spanning partnerships from the academic world to international companies. Yili accommodates Chinese consumers' growing demand for health and safe supplies, forming the first dairy research institute in China, constructed the first Chinese breast-milk database, launched the mother-baby nutrition research center, and released the first China Breast Milk Research White Paper, leading the China mother and baby nutrition research into systematical and formatted research era.

3.4.5 Baidu

As a response to gutter oil scandal in 2014, Baidu, the country's leading search engine, is developing "smart" chopsticks that tests whether cooking oil is contaminated. The chopsticks have sensors that can detect the freshness of cooking oil by measuring indicators such as its pH level, peroxide value and temperature. The product is not launched yet, but the vision is to make it possible to test the origin of food, whether it is contaminated and the nutritional value.

3.4.6 Gliding Eagle

Due to China's reputation for fake and counterfeit products, the American company Gilding Eagle has built a unique cloud and mobile based technology system to track a product's complete supply chain from the producer to the end consumer anywhere in the world. The technology has a strong focus on the China market. The company connects premium American brands and Chinese consumers and initially started with branded high end wines and natural consumer products.

3.4.7 Lenovo & Joyvio

Lenovo started Joyvio, an agricultural company that tracks fruit from planting to delivery with the vision of creating a consumer trusted brand of safe and high quality agricultural products. Joyvio controls everything from picking what seeds are planted, then tracking and collecting data each step of the way. Today Joyvio is looking to expand into the tea and wine industries.

3.5 Acquisition of Foreign R&D

3.5.1 China National Chemical Corporation Acquires Syngenta

Self-sufficiency for food production is high on the Chinese government's agenda and the strong focus was clearly demonstrated when the state-owned company China National Chemical Corporation in February 2016 announced that it will shell out ¥283 billion to buy the Swiss company Syngenta. It is the largest foreign acquisition to date. Syngenta is one of the world's biggest producers of crop protection products, including pesticides, fungicides and seeds that can increase harvests of corn, rice, and wheat. Furthermore, the company develops genetically engineered seeds that may help further open the tightly-regulated Chinese market for biotech crops.

3.6 Industry and Academic Partnerships

3.6.1 COFCO Group and CAAS

COFCO and the Chinese Academy of Agricultural Sciences (CAAS) cooperate in the scientific fields of modern seed industry, protected agriculture, the processing of cereals, oil, fruit and vegetables, food quality and safety, animal nutrition and feed, nutrition and health, and joint training programs has been brought forward and delivered remarkable results. The COFCO Farm, co-established with CAAS officially opened to the public in October 2015.

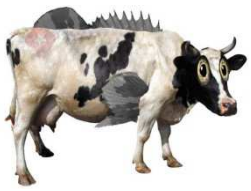
3.6.2 Yili Group and Wagenigen University

Yili has entered into comprehensive partnership with a wide range of world-class universities, research institutes, and organizations in terms of nutrition and health, product development, food safety, agricultural science, animal husbandry and veterinary medicine, eco-environment protection, business management, and talent cultivation.

Yili Group co-established an R&D centre located in the Netherlands together with the nation's Wageningen University in 2014. The R&D centre will focus on developing Yili's milk-cow cultivation, product research and food safety standards, thus becoming the most important entity within the company's global R&D operations.

3.6.3 Nestle Food Safety Institute

The Nestlé Food Safety Institute (NFSI) works closely with authorities to help provide the scientific foundation for food safety policies and standards. The company opened a food safety research centre in Beijing. Support will include early management of food safety issues and collaboration with local universities, research institutes and government agencies on food safety issues. It will also promote scientific communication and help run food safety training programmes. Nestle has three R&D centres in China: Dongguan, Shanghai and Beijing



Chinese Scientists Catering to Health Focus

As a response to Chinese consumers' growing demand for healthy and protein rich diets, scientists from Northwest A&F University and the National Beef Cattle Improvement Center in Shaanxi have bred cattle that contains higher levels of omega-3 fatty acids, typically associated with fish.
The team introduced a gene known as fat1 into foetal cells from Luxi Yellow cattle – increasing the levels of beneficial oils by over five times.

The researchers believe the results of their study will contribute to better beef in the future. They also acknowledge that there
is still much to learn about best practice, scientific techniques and the best husbandry required to make beef a rich animal source of omega-3 oils for human nutrition, but it all represents progress.

3.6.4 Other Examples Of Partnership With Universities

University	Company(ies)	Project
Shandong University	Jinan Shunan Luyuan Health Food	Research on organic food
China Agricultural University	Mengniu dairy Ltd	How to improve feed conversion rate and feed quality control
Jilin University	Little Swan Instrument Co Ltd	Research of detection for beneficial and harmful components in food
Jiangnan University	Suya food Ltd	Optimization of sprouts production process
Zhejiang Ocean University	Zhoushan Yingzhou Fisheries Ltd	Quality and safety control on fisheries industry

3.7 Challenges

The Chinese Government's focus on the modernisation of agriculture presents significant opportunities for farming technology. Food related research by China Skinny has found Nordic countries are considered leaders in developing and maintaining food production systems and technologies. The reputation would put Denmark on the front foot when establishing business development pipelines or potential partnerships. However, like everything in China, IP theft should always be a consideration and practices should be taken to minimise the risk of this.

The consumer demand for technologies such as trackable supply chains can also capitalise on Denmark's reputation for safe and transparent food production and supply chains. However, incorporating technology and the Internet on a medium-large scale is likely to require some Government participation and/or a JV. Academic partnerships could be a feasible option for this.

The Chinese Government places utmost importance on China's food chain and has issued some of the strictest rules globally. However, these rules are often open to interpretation and implementation can vary significantly between regions.

4. Patient Centric & Value-adding Health Care Solutions

Chinese manufacturers have traditionally created low-cost health equipment, but higher wages, developed infrastructure and global aspirations have pushed health manufacturers up the value curve, which has been met with increased investment in R&D. Health innovation is also being pushed by the ever growing health concerns from consumers and inefficient processes, along with an aging population and worsening health as a result of 'white-collar diseases' through urbanisation and increased pollution. The lack of trust in health suppliers following countless scandals, has created a large source of demand for innovative solutions, which has seen health-focused R&D span far from traditional health and medical companies and institutions, but increased significant investments from tech companies, companies such as Alibaba, Tencent and Huawei.

4.1 Consumer Trends

New urban lifestyles have led to Chinese consumers to become increasingly docile. Changing diets including more processed food have led to 20% of children in China being obese and 92.4 million adults suffering from diabetes. Combined with stress in their professional lives, health problems are rising among Chinese consumers. With limited faith in China's public health service, growing wealth and education, Chinese are placing increased emphasis on proactively maintaining their health, driving consumption trends and developments.

Due to an expanding middle class and rapid urbanisation, private spending on

health care services is rising, accounting for 7% of per capita expenses in 2014.[35] In addition to increasing expenditure and awareness, access to health care services is on the rise; however, 67% of Chinese patients do not trust the professional diagnosis and treatment of doctors due to poor services and facilities.

As a result, 60,000 Chinese are travelling abroad yearly to treat chronic diseases or cancer; giving birth and anti-aging therapies and two thirds of China's millionaires would consider seeking health care overseas.[36] In order to respond to Chinese patients' needs and demands, domestic health care institutions are working on improving facilities and reputation, creating innovations such as smartphone applications that ease communication processes and even enable the consultation of overseas doctors before visiting a hospital nearby.

4.2 Socioeconomic and Technology Drivers

While Chinese consumers in urban areas have a vast choice of hospitals and clinics, logistics in rural areas are less developed with smaller villages only providing clinics that have the means to treat basic diseases. Many innovations aim to develop the rural infrastructure in order to improve health supply in remote areas. The aging population and digitalisation are the main drivers for health care innovations.

4.2.1 Digital Health Care Innovations

China's size and regional differences are driving demand for technologies that facilitate access to health products and services, particularly in rural areas where patients have limited access to physical treatment institutions that often only provide basic diagnosis and treatments. Digital is a main driver of health care with spending in this sector is expected to grow 37-fold from 2014 to reach ¥724 billion in 2020.[37]

Businesses with apps in physician-to-patient communication services and disease management rise in popularity, receiving funding of ¥4.6 billion in 2014,[38] accounting for 23% of the sector's overall spending. Top digital companies are additionally leveraging on their expertise such as Tencent investing ¥460 million into China's largest online health care service community DXY. Other incentives include booking doctor appointments online, joining hospital queues online, paying via digital providers or improving hospitals' efficiency through digital tools.

4.2.2 Ageing Population

There are over 200 million Chinese over the age of 60, making China's elderly population the largest in the world. This number is expected to rise to 243 million by 2020 and 400 million by 2050.[39] With life expectancy increasing from 74.8 years in 2010 to 77 years by 2020,[40] China's aging population will contribute significantly to the growth of the health care sector.

China's position as the largest market for elderly globally will continue to grow,

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[35] National Bureau of Statistics of China, 2015
[36] Statistics from Shanghai Medical Tourism Products and Promotion Platform
[37] Boston Consulting Group "China's Digital Health Care Revolution", 2015
[38] Ibid.
[39] Statistics from China National Committee on Aging
[40] Statistics from China's Ministry of Health

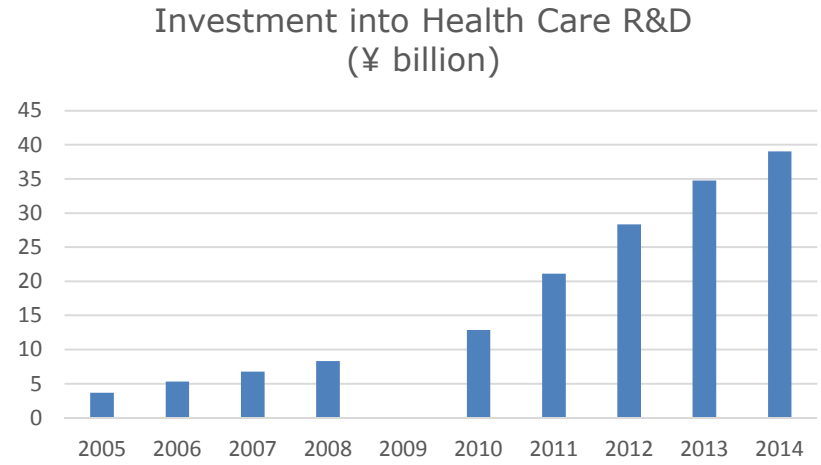
goods and services for China's aging population will account for 1/3 of the economy by 2050, reaching ¥112 trillion, compared to ¥4.3 trillion in 2014. Health care will be a major component of elderly's spending, being a main driver of the industry.

4.3 Government Investment

China's investment in health care is historically low but has grown by over 600% since 2000[41] and is expected to rise to ¥6.6 trillion by 2020.[42] Drugs treating cancer and rare diseases will bear a special focus and are expected to increase at a CAGR[43] of 6-9% to account for one fifth of the overall health expenditures. With insurances only covering the most basic treatments, out of pocket payments currently account for 72.3%[44] of health care services, compared to 14% in Denmark.[45]

In order to improve health care for Chinese citizens, the State Council established the 'Outline of National Health Care Service System Planning (2015-2020)', a five-year blueprint focussing on key areas for development by 2020. The three sectors emphasised were infrastructure development, reduction of cost and new investment, with the plan set to reduce shortages and enhance health care availability in rural areas.

The following chart showcases the shift in China's health care R&D expenditure as an attempt to improve the status quo. Data for 2009 was not available.



Source: National Bureau of Statistics of China

China's Ministry of Health spent ¥7.2 billion on new drug development in the past five years and plans to invest an additional ¥62.5 billion to digitalise hospital records and implement data exchange and regional health care systems.

[41] Nuviun, 2014 http://nuviun.com/content/digital-health-in-china-part-II-what-solutions-are-available-to-meet-healthcare-challenges
[42] McKinsey "Health Care in China: Entering 'Uncharted Waters'", 2012
[43] The compound annual growth rate (CAGR) is the mean annual growth rate of an investment over a specified period of time
[44] World Bank, 2015 http://data.worldbank.org/indicator/SH.XPD.OOPC.ZS
[45] OECD "How Does Health Spending in Denmark Compare?", 2015

4.4 Key Companies

With the opportunities and size of the pie in China's health care market many companies and organizations, both within and outside the industry, are taking actions to be a part of the industry and health care companies are increasing their R&D budgets.

4.4.1 Huawei

Huawei is a prime example of a company expanding into new sectors with the growing demand for IT technologies in the healthcare industry. The company has developed new solutions specifically for the industry such as advanced telemedicine applications, remote HD video, remote surgery demonstrations, medical video on-demand and remote doctor visits. The mobile healthcare solutions make it possible for patients to seek medical advice and information from a distance and improves the efficiency of the healthcare system and reduce the costs.

4.4.2 Apricot Forest

To solve some of the inefficiencies of China's health care system and doctor's lack of data about their patients, their records and illness, the Beijing based tech company, Apricot Forest, offers three apps. The primary app, MedClip, is an all-in-one patient system where doctors can photograph, store, and organize patient records; dictate notes directly into a patient's chart; send patients reminders and educational materials via WeChat and consult with other doctors on difficult cases. The second, e-Pocket, contains reference materials, such as drug formularies and specialized calculators. Finally, Medical Journals helps doctors stay up-to-date on the latest research literature. 25% of China's 2.5 million doctors now use at least one of Apricot Forest's apps, and about 2,000 new physicians sign up every day[46].

4.4.3 Alibaba Healthcare Unit

Alibaba Health Information Technology is the healthcare subsidiary of e-commerce giant Alibaba Group. In 2014 the company acquired the drug data company, CITIC 21CN, with the purpose to create an app that make it possible for users to verify the authenticity of their drugs through barcode scan. Alibaba Health's mission is to build an online community in order to connect participants in China's healthcare market and is one step closer to improve healthcare technology by using cloud computing with the investment worth ¥225 million in a medical imaging company called Wanliyun Medical Information Technology in March 2016.

4.4.4 Guahao

Guahao is a health care start-up responding to China's inefficient appointment system with its quick-booking service and easing access of information through its large database of information on doctors, specialists and procedures. Companies such as Hillhouse Captial, Goldman Sachs, Tencent, China Development Bank Capital and Fosun have in total invested ¥2.6 billion in the start-up. Guahao plans to build a nationwide internet platform for diagnosis and treatment, and another ¥987 million to create five surgery centers in cooperation with top-end local medical companies.

[46] Fast Company "Most Innovative Companies", 2015

4.4.5 Mindray

Mindray Medical International, located in Shenzhen, is one of the world's biggest providers of medical devices and solution in the fields of Patient Monitoring & Life Support, In-Vitro Diagnostics, and Medical Imaging. Inspired by the needs of the patients, the company adopts advanced technologies and transform them into accessible innovation. Mindray has built a global R&D network with research centers in Seattle, New Jersey, Shenzhen, Beijing, Nanjing Chengdu and Xi'an. Mindray spends around 10% of its sales income each year on R&D.

4.4.6 Microport

MicroPort is a leading medical device company with business focusing on innovating, manufacturing, and marketing high-quality and high-end medical devices globally. The company covers 10 major medical disciplines including interventional cardiology, orthopaedics, interventional radiology, electrophysiology, diabetes and endocrine management and surgical management. Mindray has a strong focus on technology innovation with over 1,600 issued patents, and a global workforce of over 3,000 employees. The goal is to continually develop leading technologies and products for physicians, with life-saving solutions and treatments for patients. Microport's investment in R&D doubled from ¥192.1 million in 2013 to ¥397.4 million in 2015.

4.4.7 Chi-Med

Chi-Med is a China based healthcare group with a global focus. The innovation side of the company focuses on discovering and developing innovative therapeutics in oncology and autoimmune diseases, while the commercial side rapidly sells the pharmaceuticals and health-related consumer products once approved in China. Chi-Med's investment in R&D increased from ¥196.7 million in 2014 to ¥311.4 million in 2015, an increase of 59%.

Chi-Med's partners include AstraZeneca and Lily in oncology, and Nestlé Health Science and Janssen in immunology. The partners have invested in the company's clinical development programmes, allowing Chi-Med to realise their potential in China and the rest of the world.

4.5 Industry and Academic Partnerships

4.5.1 Mindray

Mindray has long been a leader in blood analysis and the advances in automated blood analysis have provided critical insights with rich data and detail into patients' health for doctors. Through the development phase of Mindray BC-6800 the company worked with research partners such as Fine Chemical Laboratory of Dalian University of Technology, 863 Program of the China's State High-Tech Development Plan, the Institute of Haematology of Suzhou University, the National Centre for Clinical Laboratories as well as top hospitals.

4.5.2 Qualcomm and the George Institute for Global Health

Qualcomm and the George Institute for Global Health have established the China Centre for mHealth Innovation (CCmHI) in November 2014. The goal of this partnership is to support the Chinese government's goal of improving community healthcare in China. Working with central and provincial governments, CCmHI will

help improve community healthcare in China by developing mHealth solutions, implementing clinical evaluations and contributing to strategies for the implementation and scale-up of effective and affordable mHealth tools.

4.5.3 Bayer Partnership with CNHDR

In June 2015, China National Health Development Research Centre (NHDRC) and Bayer HealthCare Company signed a cooperation agreement to build a sustainable medical quality improvement and evaluation system in county public hospitals in China. The project is expected to serve as a reference for the nationwide public hospital reform.

4.5.4 Other Examples of Partnership With Universities

University	Company(ies)	Project
Tsinghua University	Shanghai RAAS Ltd	R&D and achievements transformation for blood products
Peking University	Founder Group	Research on mental health care
Shanghai Jiao Tong University	Hua Han health industry holdings Ltd	Research on new drugs
Fudan University	Vanke Group	The construction of International Children's healthcare hospital
Huazhong University of Science and Technology	Grand Pharmaceutical (China) Co, Ltd	New drug Development
Sun yat-sen university	Jin Jia gene Ltd	Edit and altered the gene for healthcare purpose
Sichuan University	Apeloa Pharmacy Ltd	Development of biotech drugs
The Second Military Medical University	Shanghai Pharmacy Ltd	Development of drugs and medical instruments
Zhejiang University	Aux Ltd	Development of private hospital for healthcare
Central South University	Truking science and technology Ltd	Medical robot project

4.6 Acquisitions and Foreign R&D

Many Multinational Corporations (MNC) have shown interest in the Chinese healthcare market as seen by the deals signed between MNC's and Chinese firms: Pfizer said in February that it will own 49% of a ¥1.9 billion venture with Zhejiang Hisun Pharmaceutical to develop off- patent drugs in China, and Merck & Co. inked a deal with Nanjing-based Simcere Pharmaceutical to produce cardiovascular medicines. According to Sequoia Capital China with the government support, emergence of healthcare talents, and the development of China's capital markets, the sector has become burgeoning and innovative.

4.6.1 Wenzhou Kangning Hospital

Among the listings this year is Wenzhou Kangning Hospital, China's largest private psychiatric hospital operator by revenue, raised ¥579 million through a Hong Kong IPO in November 2015.

4.6.2 Biostime International

Guangzhou-headquartered infant formula manufacturer Biostime International acquired Australian vitamin maker Swisse Wellness Group for ¥5.9 billion in September, making it the largest-ever outbound health-targeted acquisition.

4.6.3 iKang Healthcare Group

Leading preventive healthcare provider iKang Healthcare Group announced it had received a non-binding ¥9.9 billion acquisition offer from a consortium of investors including its main local rival, Meinian Onehealth Healthcare.

4.6.4 Hao Capital

In September 2015 Hao Capital invested ¥82.2 million in hospital IT provider, DJ HealthUnion Systems, one of the latest private equity firms to back China's push to improve healthcare for its aging population.

4.6.5 Olympus Capital Asia

Olympus Capital Asia recently invested ¥263.2 million in China's Tian Jian Hua Xia Medical, or Tendcare Medical, a private hospital management company, to help fund the company's expansion program.

4.6.6 Fresenius Medical Care

In November 2015 Fresenius Medical Care, the world's leading renal company, inaugurated the new China Design Centre (CDC) located in Caohejing Hi-Tech Park in the Minhang District in Shanghai with an opening ceremony in October 2015. The new state-of-the-art facility signals an important step towards consolidating the company's position as the global leader in dialysis products while servicing millions of renal patients in China and the AsiaPacific region

4.7 Challenges

Whilst Chinese health equipment manufacturers have previously only focused on low end health equipment, manufacturers are increasingly dominating the mid-range, and providing products and services of equal performance for a lower cost. Companies such as Mindray are also making notable R&D investments and creeping into the high end sectors. The low cost of entry for manufacturing health equipment in China, also means the market is fragmented, with many small play-

ers working on paper-thin margins. For example, there are 4,800 optical equipment manufacturers in China, but just 200 generate revenue of ¥20 million or more[47].

With increasingly more affluent Chinese consumers unprepared to fight the crowds in public hospitals, there is a growing preference for consumers to use expensive private hospitals. These hospitals will be open to investing in premium health equipment and solutions to cater to wealthy patient expectations. This growing segment poses the greatest opportunity for Danish health innovations who are more likely to compete on performance and service than price.

In saying that, 92% of China's hospital admissions were to public hospitals in 2012[48], meaning the Chinese Government is still the dominant decision maker on purchasing health equipment and are very price-focused, creating a difficult sell for higher-priced Danish solutions.

Danish companies considering solutions for lower tier cities and rural areas should consider that these customers are more price sensitive and can be harder to reach through well-known distribution partners. Electricity supply can also be less reliable than in developed cities.

Scalable consumer-level health technologies face a similar challenge to other Internet-connected tools and are likely to require Government participation, particularly with sensitive customer data. Joint ventures could provide a solution for this, as could academic partnerships, but due diligence should be performed to ensure that partners can be trusted.

[47] Research Report of China's Optical Industry' by China Center for Health Development at Peking University

[48] The Hospital of the Future in China: China's Reform of Public Hospitals and Trends from Industrialized Countries by The London School of Hygiene and Tropical Medicine

5. China's Response to Pollution & Climate Change

China's environment is facing severe challenges that are influencing consumer demands and technological developments. With 19.4% of China's soil being dangerously polluted, 80% of groundwater in major river basins being unsafe for human contact[49]and rising smog levels, Chinese consumers are increasingly demanding technologies that help protect them from the impacts of pollution. The Chinese Government is acknowledging the need for reforms in the 13th Five-Year Plan, investing ¥6-10 trillion[50]in environmental innovation. Companies like Alibaba are contributing to R&D initiatives, funding projects that are cutting-edge of research, technology and conservation with up to ¥330,000 per project. Driven by consumers' demand, government emphasis as well as the private sector, multiple incentives and cooperations invest into research and innovations that aim to improve China's environment.

5.1 Consumer Trends

A China Skinny study in early-2013 found that education was the main reason for migrating, but only 12 months later 80% of Chinese consumers stated air pollution as the primary cause for moving abroad. With Chinese consumers becoming more aware and conscious about the importance of a clean environment, the number of air purifiers sold nearly quadrupled between 2010-2015 to 4.4 million units, constantly improving functionality and efficiency.

Even though initiatives such as the 'Under the Dome' documentary helped raise

[49] National Bureau of Statistics of China, 2016
[50] Ibid.

awareness among Chinese consumers about problems and individual accountability, many still mostly rely on the government to solve pollution issues. While numerous efforts are being initiated, the Chinese Government is simultaneously concerned about social instability as Chinese consumers' awareness for pollution is rising, banning reports that become too viral and stir up discussions.

59% of consumers consider environmental quality as important when buying food and beverage products and many surveys indicate that they are prepared to pay a premium for products and services from environmentally responsible companies, but this rarely translates in reality. Much of the sustainable activity that China scored well in the 2014 National Geographic Greendex survey is more out of circumstance than environmental consciousness. Similarly, SUVs are the fastest growing auto category in the Mainland, showing that consumers are not taking responsibility even though they are seeing the effects of a poor environment around them. Consumer education still leaves room for significant growth, offering opportunities for Danish businesses and green technologies.

5.2 Socioeconomic and Technology Drivers

With China's worsening environment, many initiatives and innovations aim to improve the soil, air or water situation. Increasing emphasis and subsidies for renewable energies, has helped drive China to become the biggest producer of solar and wind energy, while simultaneously shutting down coal mines, which is slowly reducing emissions and creating a more sustainable network. The economic slowdown has contributed to lowering outputs for high polluting segments such as manufacturing, construction and electricity generation, causing an overall improvement in air quality.

5.2.1 Electric Vehicles

While cities are banning street BBQs in an attempt to improve air quality, local Electrical vehicles (EV) companies and imports are tackling problems with bigger impacts: Tesla, for example, is providing charging stations for electronic cars, in hope of decreasing the number of fuel-powered vehicles on China's streets. Cooperating with the Chinese Government, all charging stations are bound to meet national standards to make them available for other car brands in order to increase the network and mobility for electronic car owners. This is an important consideration for Chinese drivers when choosing a car and is likely to fuel growth in the segment.

While the amount of electric cars on the China market only accounted for 0.25% of 20 million vehicles sold in 2014, the Chinese Government aims to increase the total number to 5 million by 2020. The industry is not without its challenges though; subsidies encouraging EV purchases have been fraught with fake sales by companies claiming subsidies on fictitious sales for vehicles.[51]

[51] With electric cars being sold to producers' sub-businesses, revenue is generated through receiving fundings from local and regional governments which account for up to ¥55,000 for cars and ¥300,000 for busses. China's central government launched a fraud investigation early-2016 as only 63% of electric vehicles sold were registered for plates in the previous year.

It should also be kept in mind that with two thirds of electricity generated through coal in China[52], EVs aren't always environmentally friendly. Some standards have not been nationalised such as plugs for EV buses which can vary by city.

5.2.2 Property Sustainability

Until recent years, environmental sustainability was perceived as a feature that was nice to have, but not necessary in construction. This perception has now shifted to become a major point of difference for building owners that want to stand out from competitors. Solar panels and air quality monitors are the most popular features for landlords that aim to make their property more energy efficient. Green certified buildings and offices now contribute to 12% of PM2.5 reductions in China's cities with installed fresh-air systems accounting for an additional 16% according to a JLL white paper[53].

This is of high interest for companies in China as JLL's research found that good air quality correlates with an 100% enhancement in productivity versus average air quality. Losses in terms of labour costs are intended to drive innovation in the property segment. Many offices have additionally introduced recycling systems for paper, plastics and used electric appliances in order to increase their efficiency in using resources.

5.3 Government Investment in Environmental Protection

The Government is increasingly acknowledging China's pollution problem such as issuing Red Alerts in Beijing when air pollution gets too high. Part of this acknowledgement is investing in R&D, such as green development being a key point in the 13th Five-Year Plan, which will see ¥6-10 trillion invested in environmental initiatives with low-carbon industry systems being set up and a green development fund established. Environmental protection enterprises are incentivised with a low tax rate of 15% i. Companies with stationary pollution sources will additionally be integrated into an emission permit system as a further directive for reduced emissions.

Focussing on the development of green technology, the government investment for this sector will account for a total of ¥1,720 billion between 2015-2020. Establishing monitoring systems for groundwater and real-time environmental observation nationwide, is likely to help by increasing efficiencies and determining areas that are most gravely affected by pollution and need support in improving their situation. An improved forest protection plan bans commercial deforestation, protects grassland and intends to grow farmland and forest areas.

Beijing's vast investment shows the shift of focus and new emphasis on developing a green China. Investment records prior to this introduction are not available. It is expected that future government investment will allocate additional funds to meet the goal of peak pollution by 2030 and an environment-conscious society, but regulations for subsidies will become stricter as well.

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[52] Reuters, 2015 http://www.reuters.com/article/china-coal-idUSL3N0WL32720150326
[53] JLL White Paper "Every Breath We Take – Transforming the Health of China's Office Space", 2015

5.4 Companies and Green Initiatives

With increasing awareness of environmental issues in China, businesses are becoming more involved in tackling the problem with different initiatives. Establishing branded and endorsed projects contributes to raise consciousness about worsening impacts among China's population and the need for action. However, since there are limited perceived financial incentives by private companies, and programs against pollution heavily rely on government funding.[54]

5.4.1 Alibaba's Green engagement

In order to support Chinese scientists and environmentalists, Alibaba and the National Geographic Society launched an air and water conservation fund in 2012. Supporting projects that are cutting-edge of research, technology and conservation, funding will range from ¥132,000 to ¥330,000, including risky or unproven approaches. This can contain scientific research, community conservation programs, technological innovations and communication initiatives that directly bear on novel solutions in air and water conservation. Alibaba is dedicating 0.3% of its annual total revenue to environmental causes contributing to the combat against China's environmental struggles.

Further incentives include a water mapping project that aims to determine the quality of water sources across China. The project empowers Chinese individuals to measure water standards with a toolkit, and upload the results with a smartphone app, incorporating the information in a nationwide database. The project aims to give more detailed insights into China's water situation and educate the public. Tool kits that are easy to implement were issued before Spring Festival 2014 for the first time to leveraging on the masses of Chinese returning to their home towns.

Alibaba is also supporting entrepreneurs in China and abroad that are involved in green solutions such as a Philippine-inventor who developed a lamp that runs with seawater. Alibaba's founder Jack Ma is a leading advocate for corporate social responsibility and improving China's environment and is involved in NGO initiatives such as being a member of the Conservancy's Board of Directors.

5.4.2 Green bonds

In order to help China's transition to a green economy, capital of ¥2 trillion per year to finance climate solutions is needed according to the Green Finance Committee. 85% of this investment is hoped to be sourced in the private sector (domestically and abroad), much of which could come from bonds. Rules on issuing 'green bonds' were published by the People's Bank of China and the Green Finance Committee of China Society of Finance and Banking in January 2016, the first country to do so.

The market opportunities in the area are vast as multiple trials show: Xinjiang Goldwind issued a ¥2 billion green bond that received orders of ¥9.2 billion while Agricultural Bank of China issued the first Renminbi and US Dollar denominated

[54] Reuters, December 2014 http://www.reuters.com/article/us-china-environment-idUSKCN0JH04S20141203

green bonds, contributing a total of ¥6.5 billion to the Chinese green bond market.

As a result, the Industrial Bank of China launched the first Chinese green asset-backed securitisation early this year that was valued around ¥2.6 billion and 2.5 times oversubscribed. Due to recent changes that allowed entry into the stock market, institutional investors such as pension funds, insurance companies and non-bank institutional investors are increasingly becoming important for financing the private sector. With these companies being active players in the traditional bond market, their role as domestic green bond buyers is expected to grow.

5.4.3 Studio Rosegaard

Based on a concept from Dutch Delft University researcher Bob Ursem, Studio Rosegaard is developing a 'pollution vacuum cleaner' that is designed to collect nano-particles from the air and using electrostatic protons. Prototypes showcased a 99% reduction of air pollution.

The first wind-energy powered tower is currently being tested in Rotterdam before being moved to Beijing in summer 2016. The 30,000 cubic metres of particles collected per hour will be transformed into high-end jewellery that can be purchased to further fund the development of the project.

5.5 Industry and Academic Partnerships

Green initiatives in China are often funded by the government or follow Beijing's directives. Funds usually support projects, but don't specify the amount of research conducted before the execution. Projects typically operate under one big brand name, and research partners are often not specified. The following cases aim to give an overview of the types of green projects that offer many opportunities for cooperations with Danish technologies and innovations.

5.5.1 IBM Green Horizon

While many companies are engaged in boosting China's environmental research sector, much of it is conducted privately under the umbrella of the company's name. For example, IBM's Green Horizon project is a 10-year initiative that was launched in 2014 to support sustainable urbanisation and help transform the national energy system in China.

Leveraging on IBM's network, the project involves 12 global research facilities covering three segments: Air Quality Management, Renewable Energy Integration and Industrial Energy Efficiency. Integrating IBM's technologies and new solutions, China Business News awarded the project with the 'Green Technology Innovation Exellent Practice" in November 2014.

5.5.2 SEE Foundation

Founded in 2008, the SEE Foundation aims to establish **s**ocial responsibility among local **e**ntrepreneurs with the objective to protect the ecological **e**nvironment. Initially being a cooperation of 100 Chinese entrepreneurs to prevent desertification in the Alxa desert area, more SME's and start-ups are joining the NGO, donating ¥100,000 per year.

Working with multiple enterprises, entrepreneurs, Greenpeace, the China Natural

Conservancy and government departments, the SEE foundation also supports projects that aim to protect water resources, produce clean energy and prevent of air pollution. Monitoring the effects of efforts, candidates that were granted funding had to provide evidence that their initiatives follow certain standards and improve the living environment.

5.5.3 Saintyear

Saintyear Holdings Group is a large scale textile printing and dyeing enterprise that supplies to multiple domestic and international brands. Due to several pollution violation records, brands like Uniqlo, GAP and H&M demanded a wastewater treatment plant to reduce discharges.

As a result, Saintyear connected with environmental protection organisations to determine changes in their production chain. In cooperation with the Institute of Public and Environmental Affairs and the local NGO Lǜsè (Green) Jiangnang a system for a centralised water intake and drainage management was developed and implemented. These optimisations and additional renovations led to a reduction of the average annual discharge concentration of 9.5% between 2014 and 2015. It is expected that more suppliers will follow due to continued pressure of brands to reduce discharges.

5.5.4 Applied Research

With lean manufacturing becoming increasingly popular among academic researchers who are engaged in improving manufacturing performance, multiple universities have shifted their focus from theories and schemes to applied research that can be implemented with businesses. Concentrating on certain companies and sectors such as power, coal, oil and gas, findings feed directly into improving company structures and procedures to efficiently use available resources.

In order to reduce waste, universities like Peking University, Shanghai University of Finance and Economics as well as Renmin University are assisting companies to optimise their processes. This also includes lean management training for raising awareness among companies' staff.

5.5.5 Other Examples Of Partnership With Universities

University	Company(ies)	Project
University of Chinese Academy of Sciences	Sinoclean environmental technology group	Development of air evolution systems for houses and apartments
Beijing Normal University	Scimee Ltd	R&D and application of magnetic separation water purification technology
Tsinghua University, Beijing	Toyota	Technology for emission reduction
Harbin Institute of Technology	China energy conservation and environmental protection group	Development of energy saving and environmental protection building material

5.6 Challenges

With China's green development being a top priority on Beijing's agenda, businesses in the Mainland are bound to adopt greener production practices. Unfortunately – similar to the fraud case described in chapter 5.3 – production methods are often 'greenwashed' meaning reports and marketing measures are presenting companies as more sustainable than they are in reality.

One of the largest oil companies globally, Petro China is representative of a number of companies that was recently fined and shamed for making false statements about their plants and oil production. Presenting themselves as a top sustainable energy provider and claiming to operate with low carbon emissions and energy saving measures, several accidents and crude oil leakages in Petro China's production plants were covered up. The government reacted with a fine of ¥200,000, but there is little evidence on how Petro China followed up to enforce changes in their production and processing.

Uncovering similar cases, the Ministry of Environmental Protection ordered 207 businesses to cease operations in 2015. Large-scale companies are often involved such as Ronghua Industry & Trade, which was shut down and fined ¥3 million for funnelling 83,000 tons of untreated waste water into desert areas of Gansu province. Other cases of companies accused of greenwashing include COFCO Coca-Cola, laminate manufacturer Kingboard Chemical Holdings, the national electricity supplier China Guodian Corporation and smartphone brand Xiaomi.

The resulting trust and reputation damage could mean these companies bear opportunities for Danish technologies and businesses to target. Companies accused of greenwashing are likely to be receptive for innovations that will help raise their image and establish them as a leader in environmental efforts. These businesses might be some of the lowest hanging fruit for Danish companies involved in green initiatives.

6. Striving for Knowledge Excellence

China is aiming to become one of the most innovative countries globally. Businesses are in the need of creative minds in order to stay competitive, but the education sector is responding slowly, leading to students enrolling in extracurricular programs. Multiple initiatives and cooperation between political and academic institutions as well as companies suggest that the change to a more innovative system is underway. Businesses like Baidu and Tencent and also officials like President Xi Jinping are endorsing education incentives. Incubation centres and increasing involvement from the private sector are driving creative education, advanced research and innovations.

6.1 Consumer Trends

With most families having one child in China, parents have just one chance for their offspring to succeed and provide for them in their retirement. Chinese parents place great importance on education, and it is not unusual for them to spend more than 30% of their household income on education.

Education would be Chinese parents' number one priority upon a 25% increase in discretionary spending according to Boston Consulting Group. The expected rise in incomes between 2016-2019 will drive spending on education. Education-related services that complement existing schooling and enhance poorly provided areas such as creativity are on the rise, e.g. Lego classes in Beijing that are trending within the upper middle class.

Vocational training and learning languages (English) are the most popular programs for extracurricular studies, with 23% of Chinese consumers spending more than ¥500 for single lessons online. 95% of graduates from vocational colleges find an employer right after graduation, making this system attractive to Chinese who seek practical experience during their education. ¥23.6 billion was spent on learning languages in 2015, showing the rising emphasis on education for an interna-

tional environment.

6.2 Socioeconomic and Technology Drivers

6.2.1 New Learning Techniques

Under the pressure of the national university admission exam *gaokao*, most students focus their learning strategies purely on content that is relevant for the exam. Multiple reforms have attempted to shift the focus from quantity to quality education in order to replace learning for exams by learning for knowledge. A few years ago, art and physical education were considered unessential, but creative disciplines are increasingly part of curriculum. Innovative concepts further encourage critical thinking and student engagement rather than teacher-centred learning with the credo that to every question there should be more than a single answer.

6.2.2 Smartphone Usage

Chinese's preference for mobile devices such as smartphones and tablets will drive adoption of scalable, tech-based educational tools. Education tools represent 10% of the app marketplace in China, with an estimated 100 million e-learning users in China in 2014. Opportunities in online education are not confined to university students, with online applications available to pre-school and school-age students, as well as specialised applications and programmes for test preparations and professional development. Leading apps include Wanxue, XiaozhanJiaoyu and Genshuixue. With 89% of online Chinese accessing the internet via mobile devices, the online education market is expected to grow around 20% each year to ¥204.6 billion by 2018.

6.2.3 Massive Open Online Courses

A major component of the trend towards online education are Massive Open Online Courses (MOOC). MOOCs are part of the Chinese Government's education agenda to reduce inequalities in access to education between urban and rural areas. Subsidising online courses provided by China's top universities, the Chinese Ministry of Education is aiming to build the 'Open University of China'. MOOCs in China are characterised by their diversity: from state-sponsored initiatives like a joint project with Peking University and Alibaba, to small unaccredited grassroots start-ups such as Wanmen University that is offering online courses for different education levels. China's vast extracurricular tutoring market today is worth ¥200 billion in total.

6.2.4 GDP Growth

China is transforming from a manufacturing hub that adapted existing technology and knowledge, to an innovation leader worldwide. In order to realise this transition and achieve the economy's yearly growth goal of 5.5%-6.5%, innovations will have to contribute two to three percentage points to China's annual GDP growth over the next 10 years.[55] Innovations are expected to contribute around 40% to the increase in total factor productivity in higher-level manufacturing and internet-related services by 2025 as well as future break-throughs, equalling ¥7.9-13.2 trillion.

6.3 Investment in Education Innovations

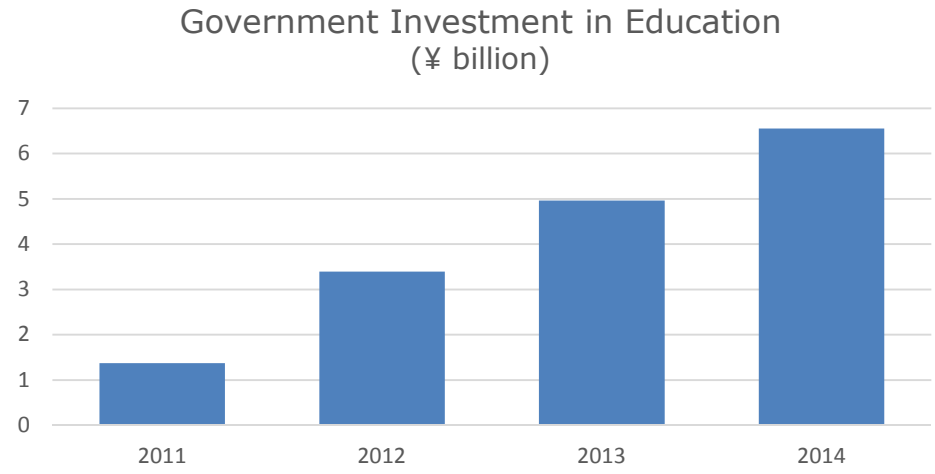
With education being one of the main pillars for China's future development, the

[55] McKinsey "Gauging the Strength of Chinese Innovation", 2015

Chinese Government and private sector are increasingly supporting education and innovative institutions. Opening a new university almost every week, it is predicted that Chinese graduates aged 25-34 years old will increase by 300% until 2030, compared to a rise of only 30% in Europe and the U.S.

6.3.1 Government Investment

To provide high-quality and innovative learning, the government's investment into the sector doubled between 2012 and 2014 to ¥6.55 billion (see chart below).



Source: National Bureau of Statistics of China

In addition to the overall education spending, the Chinese Government invests ¥1.2 trillion in research to drive innovations. According to McKinsey, new innovation opportunities are expected to contribute up to 24% to China's GDP growth which equals ¥6.6-14.5 trillion.

Beijing released ¥15 billion in 2015 in an attempt to improve the quality of vocational schools and colleges, as well as teacher training, with an additional ¥4 billion being spent on the infrastructure of secondary vocational schools. 92% of secondary vocational school students enjoy free tuition, with low-income families receiving yearly allowances from ¥2,000-5,000. In addition, 165 trial projects were launched to connect schools with businesses and enhance the practical implementation of content learned.

6.3.2 Investment from the Private Sector

SadThe increasing focus of education for companies is reflected in more businesses investing in innovative learning and research programmes that aim to enhance learning experiences and help develop skills beyond technical knowledge. With many students lacking the soft-skills that are an important feature for employers, programs that are developed to fill this gap find increasing attention. 32% of private investment globally went to 20 learning technology companies in China in the first half of 2015, totalling ¥5.3 billion.[56]

[56] Ambient Insight (U.S.-based market research firm) "2015 International Learning Technology Investment Patterns", 2016

6.4 Companies and Initiatives

6.4.1 Baidu

One of China's three internet giants, Baidu, is investing in several extracurricular education companies that offer innovative programs and support creative thinking. With investment amounts ranging between ¥66-658 million, beneficiaries include test-prep provider Wanxue Education as well as online education sites Chuanke, SmartStudy and SmartPigai.

Aiming to facilitate learning processes, Baidu also launched the Homework Helper App in 2014 – a tool that assist students completing difficult assignments within a community. Incentivising correct answers through e-coins that can be collected and redeemed for anything from iPhones to laptops, the app achieves a success rate of 80%. Proving very popular, Baidu's Homework Helper was downloaded 5 million times in the first months after its launch.

6.4.2 Yidan Prize by Tencent's Founder

Charles Chen Yidan, a philanthropist and one of the co-founders of Chinese internet giant Tencent launched the Yidan Prize in May 2016. The prize aims to recognise and support innovators in the education system with an independent fund of ¥2.1 billion, being the largest monetary education award globally.

Honouring education research as well as education development, winners of their category will receive a project fund of ¥12.7 million in addition to a prize of the same amount. In cooperation with the Economist Intelligence Unit, trends in education worldwide until 2030 are identified as basis for the judgement of Chinese education projects.

Being an advocate for innovative learning solutions, Chen invested in the Wuhan College at the Zhongnan University of Economics and Law in 2009 and donated an additional ¥2 billion for a new campus and to transform the college into a private non-profit university.

6.4.3 China Innovation Works

Established in 2009, China Innovation Works is funding entrepreneurs and working closely with new businesses to realise the success of innovative concepts. Their aim is to establish an online network for exchanging ideas and experiences.

To support Chinese entrepreneurs, the International Finance Corporation (IFC) invested ¥98.7 million into China Innovation Works. Acknowledging innovation and entrepreneurship as China's future growth engines, IFC's development priorities include technologies in innovation fields such as education, the internet and finance.

6.5 Industry and Academic Partnerships

Innovations and creative minds are high on the agenda of many universities and institutes as well as businesses who seek to hire young and independent thinkers. Multiple initiatives are intensifying the international exchange and dialogue between education facilities aiming to create sustainable partnerships.

6.5.1 EU-China Co-Funding

The EU-China Co-Funding (CFM) aims to enable a stronger and more balanced collaboration between Chinese and European universities, research institutes and enterprises under Horizon 2020.[57] Designed to support China-based research and innovation organisations that participate in Horizon 2020 project, thematic areas include food, agriculture, biotechnology, information and communication technology, space, aviation, energy, health, transportation, water resources, energy conservation, advanced manufacturing, new materials, sustainable urbanisation, and exchanges of young scientists.

The 2016 budget of ¥200 million enables beneficiaries in China to connect with prominent research teams and scientific networks with access to world-leading knowledge and research data. Selected Chinese researchers are integrated in research teams that are supported by the European Research Council, enhancing excellence-based cooperations and promoting the mobility of researchers between the EU and China.

6.5.2 Imperial College London

Cooperations between the Imperial College London and Chinese institutions date back to 2005. Within a decade, the amount research papers co-authored by Imperial and Chinese academics rose from 3% to 22%, manifesting an increasing emphasis on cooperations with Chinese researchers. Endorsed by Xi Jinping who visited the college in October 2015, Beijing-based financial services provider China UCF Group invested ¥28.6 million into the Data Science Institute and Hamlyn Centre for Medical Robotics.

Collaborating with businesses such as Huawei and China Southern Railway, cooperations are perceived as beneficial not only for China, but also for the UK. Scientific research partners include Tsinghua University, Zhejiang University, Shanghai Jiaotong, Wuhan and Peking Universities, and the Chinese Academy of Science. There are also plans to create a centre for transnational entrepreneurship together with Zhejiang University that aims to enhance communication and exchange between UK and Chinese innovators.

6.5.3 University Incubation Centres

China's government is driving incubation centres to promote innovations and cooperations between universities and businesses. The centres have been set up in multiple universities across China. Donghua University in Shanghai combines this centre with an Entrepreneurship & Innovation programme which encourages stu-

[57] Horizon 2020 is a Research and Innovation programme initiated by the European Union that funds innovation and research, emphasizing on excellent science, industrial leadership and tackling societal challenges in different thematic areas. The programme aims to create a genuine single market for knowledge, research and innovation in order to drive economic growth.

dents to develop creative and innovative business concepts. Being the 9th most international university nationwide, it offers opportunities for informational and intellectual exchange.

The Donghua Incubation Centre is mainly endorsed by SME's but also several Fortune-500 companies like German automotive and industry provider Schaeffler. The centre helps realising multiple research and innovation projects. A similar program at Shanghai Business School sees Chinese students cooperate with Rotterdam Business School.

Encouraging open thinking, the program matches students with partners at another university and the task is to come up with a business idea and to establish a company in China. The aim is to build international exchange and encourage creative learning and innovative research.

6.5.4 Applied Research

Innovations are becoming one of the main drivers for China's growth and businesses increasingly acknowledge the need for creative and forward-thinking staff. Large companies with up to 200,000 employees are becoming aware of entrepreneurship being an important driver with rigid company procedures blocking initiatives.

Workshops linking academic consultants with staff from large companies are growing as they combine academic innovations and concepts with practical ideas and implementations. While being part of a large team often leads to low effectiveness and efficiency, innovation workshops are proving to drive creative ideas for new concepts and enhance the motivation of employees.

6.6 Acquisitions and Foreign R&D

China has been transforming from manufacture-based to an innovation driven economy, and trends suggest that a third step will lead to Chinese innovations driving the market. This is reflected by Chinese companies buying foreign companies such as the acquisition of Motorola Mobility by Lenovo, Zhejiang Geely buying Swedish carmaker Volvo and Dongfend Motors (ranking 31st among automobile firms by R&D expenditure globally) bidding for Peugeot-Citroën.

In order to realise the shift to a service-based economy, Chinese companies are aware of the need to enhance their knowledge in this sector. This is reflected in China dedicating two thirds of offshore investments to services to gain expertise by acquiring and developing foreign technologies, brands and marketing concepts. Furthermore, Chinese corporate R&D centres are created in the U.S. and Europe to fill the knowledge gap for understanding and operating in an increasingly sophisticated market.

6.7 Challenges

While recent developments in the industry are promising, there are some hurdles that have to be overcome and even might bear opportunities for Danish businesses if addressed in the right way.

Although young talents are becoming increasingly interested in alternative learning and research methods, the majority of China's 2,300 universities follow a system with exam-focused programs. Educators are often very traditional and perceive new technologies like online learning as a threat rather than a useful complimentary tool.

As a result, Chinese graduates have a vast knowledge asset, but often lack soft-skills and lateral thinking – competences that are equally important for employers in an innovative environment. Extracurricular courses increasingly emphasise these skills in their programs, but industry insiders believe that a real impact can only be achieved through reforms and international relations.

Current investments into educational and research innovations predominantly come from private cooperation that are usually not officially specified. Universities see the need for intensified collaborations and funding, but are concerned about compromising relations with the government as cooperation with businesses often lead universities to take a stake in potential successful outcomes.

About ICDK Analysis

ICDK analysis is written or managed by the Danish Ministry of Higher Education and Science's Innovation Attachés. The Innovation Attachés are a part of Innovation Centre Denmark which is a partnership between Denmark's Ministry of Foreign Affairs and the Ministry of Higher Education and Science. Together the two ministries manage six centres in Brazil, China, India, Korea, Germany and the USA. ICDK analysis is a concept where the attachés provide new knowledge and inspiration about opportunities or trends within a given topic with relevance for stakeholders within higher education, research and innovation. Find out more about Innovation Centre Denmark on www.icdk.um.dk, where you also can find all ICDK analysis.

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