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Not Just a Pretty Building: The Case for Sustainable Architecture in China

China has one of the fastest growing economies in the world, as well as the largest population, and many rapidly growing cities. As of 2010, almost 50% of people in China lived in cities¹, and the number has only continued climb higher. As a result, existing cities have sprawled outwards, hastily planned to meet pressing demand, and new cities have been built. These new cities have, since the 1980s, come to spread across a total area the size of Switzerland² and use 40% of the world's concrete and steel in construction³. As these cities grow, they require more energy, most of which is provided by coal. If these cities continue to grow unsustainably, China will face an increasingly serious environmental dilemma. Due to the considerable monetary and environmental cost posed by conventional buildings, China would benefit from more ecological renovation and construction of green buildings, which can be accomplished through a combination of a committed national policy on architecture and the promotion of Chinese sustainable architecture firms

China's Environmental Dilemma

China is notorious for having a disastrous environmental record detailed by headlines on rivers full of dead pigs, trash mountains, and air pollution. There is less publicity for environmental progress in China, even in academia. Scholars pay a considerable amount of attention to China's environmental shortcomings, resulting "in numerous accounts that paint a very bleak picture of China's environmental challenges. These accounts have been reinforced by similarly somber descriptions of China's recent efforts to build a legal culture and system to address these challenges.⁴" While China's environmental problems must not be underestimated, China has made a great deal of progress in recognizing the need for and implementing sustainable development contrary to such accounts mentioned above⁵.

The 12th Five Year Plan presented by the National People's Congress has a particularly strong focus on the environment, showing consistent commitment to environmental protection since such concerns first appeared in the 10th Five Year Plan. China's body of environmental law has also grown more comprehensive and sophisticated, as Richard Ferris and Hongjun Zhang write in "Environmental Law in the People's Republic of China". For example, the State Environmental Protection Administration was

¹ Central Intelligence Agency, The World Factbook, [/library/publications/the-world-factbook](https://www.cia.gov/library/publications/the-world-factbook) (23 March 2013).

² Jeremy Smith, "Inside China's Booming Cities", chinadialogue, 28 March, 2013.

³ Dong, Huijuan, Yong Geng, Jia Fu, Bing Xue. "Chinese Green Building Standards". *Sustainable Development* 20 (2012): 212

⁴ Richard J. Ferris, Jr., and Hongjun Zhang. "Environmental Law in the People's Republic of China: An Overview Describing Challenges and Providing Insights for Good Governance", in *China's Environment and the Challenge of Sustainable Development*, ed. Kristen A. Day (Armonk, New York: M.E. Sharpe, 2005), 66.

⁵ Ferris and Zhang 66-7.

recently promoted to ministerial level, and is now known as the Ministry of Environmental Protection, furthering the environmental commitment in the upper echelon of Chinese politics. The National People's Congress has also created around twenty statutes dealing with issues like pollution and resource conservation, as well as numerous non-environmental statutes that touch on ecological issues as well⁶.

Of course, this is not to say that China is ready to roll out the green carpet. China's environmental protection capacity has certainly increased, aided by the growing body of laws and the discourse at the top of the party ladder. But considering the current rate of economic growth, the environmental legal culture provides a flimsy shield against ultimate environmental deterioration. Simply put, the economy has been and will continue to outpace environmental reform unless further action is taken.

Architecture and the Environment: Possibilities for Sustainable Growth

Many factors go into sustainable urbanization, from macro issues like city planning to micro issues of individual buildings. This paper focuses on the individual buildings, making the case for green buildings in particular. An architect designing a green buildings looks to use as little energy as possible, sometimes generating energy in-house to offset its consumption, and generally seeks to construct a building that has minimal impact on the surrounding city.

Since one particularly pressing environmental problem is urbanization, there is considerable need for green buildings. In Chinese cities, there are around two billion square meters of new buildings constructed every year that use a staggering amount of the world's raw materials⁷, while China's urbanized area more than doubled in the past fifteen years. This kind of growth is a great drain on resources—China's building sector consumes 30% of China's total energy use⁸, most of which is generated by coal. In addition, were China's urbanization rate to level off, perhaps this growth and energy consumption would not pose such a threat to China's environment. However, the urbanization rate has only increased, totaling over 50% as of 2011. And China is committed to further growth, with leaders in Chongqing promising to urbanize 70% of the municipality by 2020⁹.

More growth means larger cities with more buildings. More buildings mean overall increased energy consumption, but also a greater need for air conditioning and heating units (which consume more than half of a building's energy supply¹⁰), more lights, and more raw materials that, in recent years, must be imported¹¹. More buildings also mean higher CO₂ emissions, which is particularly alarming as Asia's building sector is responsible for 35% of global emissions¹². Thus, it appears that, in coming years, urban demands on an already strained environment will only grow.

⁶ Ferris and Zhang 79

⁷ Dong et al. 212

⁸ Li, Baizhan and Runming Yao. "Urbanisation and its impact on building energy consumption and efficiency in China". *Renewable Energy* 34 (2009): 1995

⁹ "China's Chicago", *The Economist*, 26 July, 2007.

¹⁰ Hou, Ruili, "Building Energy-Frugal Homes", *China Today*, September, 2010, 13.

¹¹ Peter Wonacott, "China Saps Commodity Supplies", *Wall Street Journal*, 24 October, 2003.

¹² Regional Resource Centre for Asia and the Pacific, "Eco-Housing Programme for the Asia Pacific Region", United Nations Environmental Programme, <http://www.rrcap.unep.org/ecohouse/index.htm> (accessed 9 October, 2012).

China has made much progress in regulating pollution, but urbanization still goes largely unchecked. To give the issue a global perspective, China is the world's largest producer and consumer of coal, and the second largest overall energy consumer¹³. Not only, then, is energy consumption in China spectacularly high, but the energy the country consumes is very polluting, accounting for 70% of the smog that clouds the air¹⁴. If China is already at this stage and shows no signs of relenting in its quest for growth and urbanization, what will that mean for the future? With more than one billion people China physically cannot afford to continue constructing conventional buildings. The Chinese already must import a significant amount of resources needed to build, which means fewer resources for the rest of the world as well. In a world of finite resources and limited physical capacity, quick and dirty urbanization is simply not sustainable. One can argue that the Chinese are free to abuse their own resources as they see fit, but when their seemingly limitless consumption extends beyond China's considerable borders, depleting foreign resources and contributing to air pollution, unsustainable architecture becomes a threat to many other countries.

Unfortunately the solution is not as simple as realizing the threat dirty urbanization poses and flipping a green switch. We must look at the reasons China may not be implementing as many sustainable practices as it should. Partially this is because the country operates under the assumption that the economy must take absolute priority over other issues. Considering China's very recent history with mass poverty and famine, this is not surprising. Particularly on the provincial level, though, economic growth often takes precedence over all other issues because "The more investment of capital a city can attract, the more impressive its built environment becomes, and greater are the chances for the promotion of city leaders; making the cities 'entrepreneurial'"¹⁵. In an undemocratic but meritocratic nation where provincial and municipal leaders must impress the top brass of the Chinese government in order to move up in the bureaucratic hierarchy, city planning designed to maximize economic growth is often a ticket to the top. Thus in the race to urbanize ever faster and larger, the environment often gets overlooked in favor of the economy. In addition, even when the central government does try to implement sustainable development objectives, since China has abandoned central planning mandates without creating free-market incentives, it is difficult to force provinces and municipalities to comply¹⁶.

Eventually, however, China must realize that unsustainable urbanization is dangerous. Because of the race to grow local economies, city planners often act irresponsibly:

¹³ US Energy Information Administration, "China", US Energy Information Administration, <http://www.eia.gov/countries/country-data.cfm?fips=CH&trk=m> (accessed 11 October, 2012)

¹⁴ Elizabeth Economy, *The River Runs Black: The Environmental Challenge to China's Future* (Cornell University Press, 2004), 72

¹⁵ Akhmat, Ghulam and Bochun Yu, "Rapidly Changing Dynamics of Urbanization in China; Escalating Regional Inequalities and Urban Management Problems", *Journal of Sustainable Development* 3.2 (June 2010): 154

¹⁶ Cann, Cynthia W., Michael C. Cann, and Gao Shangquan. "China's Road to Sustainable Development: An Overview", in *China's Environment and the Challenge of Sustainable Development*, ed. Kristen A. Day (Armonk, New York: M.E. Sharpe, 2005), 23

“Blindly seeking for the increase of population and the enlargement of urban size leads to not only wasting resources but also menacing the sustainable development of cities. The city development is lacking holistic characteristics, and serious and scientific planning.¹⁷”

It is clear, then, that cities are on a self-destructive path. Alleviating pollution, preserving greater swaths of wildlife, protecting indigenous species, and moving to cleaner energy sources will help China’s environment, but even these efforts will not be enough as the rural landscape gets consumed by the growing urban sprawl. Chinese society will never be truly sustainable without cleaner cities, and the first step towards building cleaner cities is practicing sustainable architecture.

The primary difficulty in implementing sustainable development is the lack of economic incentive. In fact, sustainable development is its own economic incentive. Broadly speaking, overall environmental degradation costs China 8-12% of its GDP¹⁸. More specifically, as concerns sustainable architecture, China’s buildings consume an incredible amount of resources, both in terms of energy consumption and raw materials used in construction. The China Chemical Reporter has said that “energy consumption in Chinese buildings far exceeds western levels¹⁹” and that therefore China must “contend with its present low standards on buildings’ energy efficiency, pressure to save energy by renovating existing buildings, insufficient technological support and inadequate utilization of construction resources²⁰”. Considering these factors, were Chinese cities to build sustainable buildings in the first place, governments and companies would save money on construction, energy, and renovations later on (which are usually necessary since the life expectancy of a Chinese building is circa 30 years²¹). Green buildings would also reduce waste by utilizing recycled building materials, as well as saving the cost of imported raw resources. This is not to say that green buildings are miraculously cheaper, however. Energy-saving technology is costly. However, the long-term benefits are such that they should reasonably outweigh the short-term costs. The difficulty comes in convincing developers of this fact.

The State of Sustainable Architecture

There are two main approaches to sustainable architecture in China. The first is generally practiced by big-name foreign firms like SOM, OMA, and Leo A Daly, and focuses on high-tech, expensive environmental innovations. The second approach is a more organic one, generally centered around renovation and using local materials to build low-energy, inexpensive structures. The second approach is practiced more often by smaller Chinese firms like those headed by Wang Shu and Yung Ho Chang.

One example of the high-tech approach is the Chicago firm SOM,²² commissioned by the China National Tobacco Company to build a zero-energy superskyscraper in Guangdong. A zero-energy building is, as

¹⁷ Akhmat and Bochun 157

¹⁸ Economy 88

¹⁹ Residential and commercial buildings consume 10.8% of energy in the US according to the Energy Information Administration

²⁰ “China Promotes Greener Buildings—Likely to Create a RMB1 Trillion Market”, *China Chemical Reporter*, May, 2012

²¹ Dong et al. 212

²² Skidmore, Owings, and Merrill are responsible for the Sears Tower, the John Hancock Tower, and the Trump Hotel and Tower in Chicago, and the Time Warner Center and Random House Tower in New York, as

defined by the firm, a building that does not require the surrounding community to generate any additional energy, generally by creating as much energy in the building as the structure consumes²³. This allows the city to develop cleanly and increase space usage without the environmental expense of conventional buildings. Although it became impossible to construct such a large zero-energy building²⁴, the Pearl River Tower is still very energy efficient. Frechette and Gilchrist, of SOM, report a 58% overall reduction in energy consumption through their sustainable technology²⁵.

The result: the unusual structure of the building²⁶ accelerates wind entering on the mechanical floors to maximize energy gain, with an AC system 80% smaller than in conventional skyscrapers²⁷. There are many high-tech features on the building such as mechanized blinds that are operated by solar power to prevent overheating and a double wall that provides insulation at low cost. Many of these measure are costly, but “the cumulative benefit of all the environmentally beneficial strategies included in the design of the Pearl River Tower will significantly reduce the amount of energy needed to operate the building.²⁸” If developers in China exercise the same long-term view as SOM and the China National Tobacco Company, they will see that sort-term costs are ultimately outweighed by the lasting benefits of green buildings.

The second approach to sustainable architecture is perhaps more realistic, and certainly more cost-effective. This approach is very well characterized by the work of the 2012 Pritzker winner, Chinese national Wang Shu, co-founder of Amateur Architect Studio. Rather than use the high-tech, initially costly methods of sustainable architecture like SOM, Wang and his wife, also an architect, return to sustainability’s roots, as in the History Museum of Ningbo, which is built with more than one million pieces of recycled brick, stone, and ceramic²⁹. Aside from the poetic beauty of the couple’s work, the buildings they design are sustainable and, perhaps more importantly for Chinese developers, very cheap. SOM’s Pearl River Tower will pay for itself in the coming years, certainly, but Wang’s buildings are inexpensive from the very beginning.

The most impressive project for the firm was the new campus of the Xiangshan campus of the China Academy of Art in Hangzhou. Wang used yew wood for the walls and doors and bamboo for the railings, which are cheap, local alternatives to more popular building materials and grow quickly. The campus cost from \$235 to \$392 per square meter, in contrast to \$952 per square meter for an office building in

well as countless other projects in China. Thankfully my paper does not rest on SOM’s aesthetic appeal, or I would have very little ground to stand on.

²³Roger E. Frechette III and Russell Gilchrist. “Towards Zero Energy”: A Case Study of the Pearl River Tower, Guangzhou, China”. Skidmore, Owings & Merrill LLP. 2010. Skidmore, Owings & Merrill LLP, 2

²⁴Roger E. Frechette III and Russell Gilchrist, “Seeking Zero Energy”, *Civil Engineering* (January 2009): 43– the Guangzhou utility refused to connect the planned microturbines to the often-unreliable electrical grid, which took away the justification for the cost of the turbines, and thereby eliminated the possibility of a zero-energy building.

²⁵ Frechette, Gilchrist, “Towards Zero Energy”, 11 and Brett Hansen “China to Construct ‘Zero-Energy’ Skyscraper”, *Civil Engineering News* (January 2007): 11

²⁶ Specifically the differences in pressure throughout the building that manipulate wind-flow

²⁷ Brian Dumaine, “World’s Greenest Skyscraper”, *Fortune Magazine*, 24 February, 2010.

²⁸ Frechette and Gilchrist, “Seeking Zero Energy”, 46.

²⁹ Christopher Hawthorne, “Pritzker Prize Goes to Wang Shu, 48-year-old Chinese Architect”, *LA Times*, 27 February, 2012, Arts and Culture section.

Beijing, according to the New York Times³⁰. Since China must import a large amount of the raw materials used in construction, or else transport them across the country, Wang's methods are ideal. Amateur Architect Studio provides a model for sustainable architecture in China, using cheap, local resources.

The studio also promotes renovation over rebuilding, which is much cheaper and sustainable, since it requires lower construction cost and fewer resources. Wang was recently successful in renovating houses in a village outside of Hangzhou with the original tiles and bricks rather than tearing them down and building new ones. In this case, even fewer raw materials would be required, further lowering the cost of the buildings. Wang's approach is therefore ideal in China, where buildings have such short life expectancy. This approach is also ideal because, while the Pearl River Tower is very impressive and uses innovative sustainable methods, not every developer or company can afford to build a superskyscraper.

However, sustainable architecture meets resistance in China because it is often pioneered by foreign firms like SOM and Leo A Daly. Some critics complain that foreign "starchitects" are using China as an architectural playground for radical designs that could never be approved in their home countries³¹. This could certainly be said of the Pearl River Tower, which is the most ambitious of SOM's projects in its 76-year history. Wang has rejected much of the work of his Chinese contemporaries, saying that they were trying to copy Manhattan, and had too much Western influence in their work³². Certainly this view is beginning to take hold in the Chinese architectural community, as "a commonly held opinion, often expressed in vitriol on the country's micro-blogging service, Weibo, is that these projects lack any consideration for domestic architectural traditions.³³" This cultural resistance is significant because in a nationalist country that highly values its sovereignty, it is important that such a vital movement in sustainable architecture be at least partially homegrown³⁴. As Mr. Pritzker said when announcing the prize,

"The fact that an architect from China has been selected by the jury represents a significant step in acknowledging the role that China will play in the development of architectural ideals... In addition, over the coming decades China's success at urbanization will be important to China and to the world. This urbanization, like urbanization around the world, needs to be in harmony with local needs and culture.³⁵"

Thus, Wang's work satisfies the economic demands of Chinese developers while using sustainable methods, and also sets a precedent for Chinese architects to continue the move toward sustainable architecture independent of foreign firms.

³⁰ Jane Perlez, "An Architect's Vision: Bare Elegance", *New York Times*, 9 August, 2012, Art and Design section.

³¹ Vaughan Winterbottom, "Architecture with Chinese Characteristics", *China Today*, August, 2012, 72.

³² Perlez

³³ Winterbottom 72

³⁴ There isn't nearly enough space here to talk about the importance of nationalism in Chinese architecture, but *On the Edge: Ten Architects from China* (ed. Ian Luna and Thomas Tsang) details the issue very well

³⁵ Josh Chin and Lara Day, "Will Pritzker Be Pivotal for China?" *Wall Street Journal*, 29 February, 2012, Arts and Culture section.

Unfortunately, it is still difficult for smaller Chinese firms to land large commissions like government buildings or the Pearl River Tower. In an interview with art collector Uli Sigg, dissident/artist Ai Weiwei and architect Yung Ho Chang have said that big commissions never go to “architects like us”—i.e., architects from small Chinese firms. Instead, the government holds competitions for commissions and invites many foreign architects to compete alongside a few state owned firms. Ai summarized the problem this presents to urban development, giving a good indication of how China views architecture and its role shape cities:

“And the result depends on who is in the jury. In most cases the jury members are Chinese, so the result is a disaster... Chinese top experts... would walk up to the models and ask ‘How do you clean the windows?’ or ‘Why does this building have no windows?’ It’s unbelievable. They don’t see architecture as part of urban development or how people are going to use it or in what way it will serve the area. All you get is stupid questions.³⁶”

Thus, even though there is a great deal of architectural talent in China, and much of it is geared towards sustainable urbanization, there is a disconnect between the central government and the architecture scene. For all the progress in environmental protection made in the past couple of decades, the central government still does not see the connection between green architecture and the environment.

The foreign architects who win major commissions do often focus on sustainability, as seen in SOM’s Pearl River Tower, but these projects are often costly in the short term and only the government or major companies can afford them. By contrast, small Chinese firms get overlooked for big projects even though their designs are often cheaper, as in the case of Wang Shu, and are better for the environment for using low-cost, local material, as many of Yung Ho Chang’s buildings do. Both approaches are ultimately beneficial for the environment and for development in China, but the second approach should be encouraged far more for reasons outlined in the section below.

The Future of Sustainable Architecture

Sustainable architecture is both environmentally friendly and a good long-term investment. Implementation, however, continues to be a problem. I have mentioned the growing legal culture surrounding environmental issues, but even a vast body of laws is virtually useless without the ability to enforce those laws. Liu Jianguo, director of Michigan State University’s Center for Systems Integration and Sustainability writes that “Of the >100 environmental laws and policies enacted since the 1970s, most have ineffective implementation and enforcement. Although sustainable development has been a national strategy since 1994, short-term economic gain still has priority³⁷”.

There is a saying in China that “the sky is big and the emperor is far away”. In such a large country, it is understandably difficult to regulate every move every provincial, municipal, or city leader makes, as Elizabeth Economy writes:

³⁶ Ai Weiwei, Uli Sigg, Yonghe Zhang, and Peter Pakesch, *Art and Cultural Policy in China: A Conversation Between Ai Weiwei, Uli Sigg and Yung Ho Chang*, (Springer, 2009) 85.

³⁷ Jianguo Liu, “China’s Road to Sustainability”, *Science* 328.5974 (2 April, 2010): 50

“Without a strong, independent environmental protection apparatus, the devolution of authority to provincial and local officials has given them free rein to concentrate their energies on economic growth, pushing aside environmental considerations with few consequences from the center.^{38”}

As I mentioned and as Liu writes, when economic success equals future political power, the motivations are understandable, but ultimately damaging to the environment. Additionally, Economy discusses how the central government’s attempt to consolidate energy providers in order to better implement green technology has resulted in local governments circumventing these efforts and encouraging “the proliferation of small, inefficient, and highly polluting coal-fired power plants to meet growing local energy needs.^{39”} This speaks to the difficulty the central government faces in creating a coherent national sustainable development policy that meets the needs of such a diverse country.

The willingness to go green exists, but the implementation and even the capability of the central government leaves much to be desired. Partially implementation is difficult because local leaders wish to advance in a political system that rewards economic growth over environmental stewardship. However, there are more practical reasons that implementation is difficult to achieve. Considering the fact that China has five very different climate zones and therefore greatly varying energy needs in non-residential buildings, having a national standard does not make sense⁴⁰. Local governments can make more discerning standards, but the fact remains that China treats non-residential building energy efficiency standards as a “one-size-fits-all” situation in a country with an enormous landmass. In very cold regions, for example, energy efficiency is more difficult to achieve in the winter. This would explain why local leaders subvert national directives and promote the spread of coal plants to meet energy needs.

If the problem is both difficulty in getting local leaders to comply with policy and creating sufficient policy in the first place, how can China improve implementation of a sustainable architecture policy? China’s progress in the central government for sustainable development is admirable, and certainly the government should carry on with its current efforts. However, the central government must also create the incentive for sustainable architecture. Liang et al. write that “There is no market guidance for energy efficient buildings and this causes low sensitivity to energy efficient buildings on the property market. The property developers under-estimated the demand for energy efficient buildings from property buyers.^{41”} If developers and local leaders are not aware of the built-in economic incentive, the government must make this benefit clear. The government already provides indirect incentive to local leaders by promoting those who foster economic success—perhaps replacing “economic” with “environmental” and promoting leaders who advocate sustainable architecture would make implementation of environmental policy easier.

³⁸ Economy 63

³⁹ Economy 73

⁴⁰ Kevin Mo, Lane Burt, Bin Hao, Jie Chang, Andrew Burr, and Sonal Kemkar, “Comparative Analysis of US and China Building Energy Rating and Labeling Systems”, *2010 ACEEE Summer Study on Energy Efficiency in Buildings* (August 2010): 3

⁴¹ Liang et al. 1106

Additionally, rather than creating a catch-all national standard, the central government can in turn promote grassroots architecture—awarding grants and commissions to architects like Wang Shu and his wife or Yung Ho Chang who understand regional needs and design buildings that act as extensions of the natural environment would solve the problem of trying to create a policy that applies to an entire, diverse country. And while China’s recent opening to foreign architects is encouraging from a political perspective, the country might do well to look inward for important building construction rather than leaving commissions in the hands of international competitions, many of which result in firms like Goetsch and SOM⁴² increasing their presences in China’s built landscape. While these firms doubtlessly invest much time and effort in understanding China’s natural landscape and almost exclusively design sustainable buildings, it is more sustainable to promote a robust architecture scene within China than to rely on foreign imports.

Conclusions

It is very easy to focus on China’s environmental problems and to draw conclusions of imminent demise, particularly considering China’s difficulty in enforcing existing environmental law. To highlight China’s problems, however, belies the great progress the country has made in establishing an environmental legal culture from scratch and attempting to implement national policies across an enormous, geographically diverse country. This is not to dismiss greening China as a problem solved, however. To truly promote sustainable architecture, the central government must be at once more decisive in enforcing policy and more willing to encourage public participation, rewarding grassroots architects like Wang Shu.

The costs of unsustainable architecture are too great to ignore, both for China and for the world. Current construction methods contribute enormous amounts of pollution to the atmosphere, which spreads beyond China’s borders, and demand a great deal of natural resources that are often consumed faster than they can be replenished. There are simply not enough resources in the world to accommodate China’s rising demands and waste production, and the economic and environmental costs will be high if China does not implement a sustainable architecture policy now. China is particularly well equipped to implement the kind of incentivization that would drive up demand for sustainable architecture because, in an authoritarian regime, the central government has the capacity to compel its citizens to follow policies. For example, by setting aside some given amount of money dedicated to constructing green buildings, China could successfully implement sustainable architecture across the whole country, with each province determining how best to allocate its funds considering differing energy needs.

Given these potential solutions and the country’s political system, China is uniquely poised to set a global precedent in putting sustainable architecture into practice quickly, efficiently, and at no great economic cost. Particularly because China is a developing country that frequently plays the victim in international relations, for China to take environmental responsibility would be momentous. Everyone is looking to China because of its economic power, its rapidly growing population, and its increasing urbanization rate. Some are waiting for China to fail, others for China to take over the world. For China to become a major force in promoting sustainable architecture would surely have a tremendous impact on China’s environment, but would also galvanize the rest of the world to take similar action.

⁴² In fact, according to Goetsch, SOM, and VOA employees, each firm has very active offices in several cities around China, indicating a largely increased foreign presence in the country

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