Post-Socialist Biotech: Labor, Value and Risk in China's Transitional Economy

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Introduction

Scholars in science and technology studies have charted the emergence of biotechnology as a distinct industry in the late 20th century, describing how it has reshaped the cultural, institutional, and economic terrain of life sciences. This scholarship has traced the development of pioneering firms, such as Genentech (Hughes 2013) and Cetus Corporation (Rabinow 1996), demonstrating how the biotech industry transformed where life sciences were conducted, how research was organized, and who could claim authority over it. At the same time, historians of science highlighted the continuities between biotechnology firms and earlier industries, such as agriculture, pharmaceuticals, and brewing, underscoring the embeddedness of biotech innovation in existing commercial and industrial infrastructures (Bud 1994; Rasmussen 2014). One of the major themes across these works has been to demonstrate how biomedicine and the life sciences have become imbricated into the value economies of capitalism. The emergence of new regimes of "biovalue" (Waldby 2002) inextricably linked biological production and reproduction with the global systems of capital accumulation, speculation, and financialization (Fortun 2008). Kaushik Sunder Rajan (2006) refers to this entanglement of life sciences and capitalist enterprise as "biocapital." Capitalist and neoliberal agendas have shaped the goals, institutional structures, and legal and regulatory frameworks of universities and corporations from which bioscientific knowledge and products emerge (Mirowski 2011; Jasanoff 2012). At the end of his essay attempting to classify "species" of biocapital, Stefan Helmreich (2008, 474) asks: "What if we asked not what happens to biology when it is capitalized, but asked whether capital must be the sign under which all of today's encounters of the economic with the biological must travel?"

This paper is not an attempt to answer that question in general. What it does attempt, however, is to examine the emergence and development of a biotechnological industry within the specific context of China's transition from a planned to a market economy, which began in 1979. The processes of China's non-linear post-socialist transition have simultaneously enabled and restricted the participation of Chinese biotechnological entrepreneurs in capital accumulation, speculation, and financialization. Taking place within the broader context of the Cold War's thaw and the eventual dissolution of the Socialist Bloc, China's economic transition differed markedly from the experiences of Eastern Europe and Russia, characterized by its gradual approach to economic liberalization and the maintenance of one-party rule. By increasing the

autonomous decision-making power of local governments, by reserving a continuing role for the planned economy, and by insulating market experiments within enclaves such as the Special Economic Zones (SEZ), the Deng Xiaoping administration used the economic devices of decentralization, dual-track marketization, and disarticulation to reorient China's development strategy while maintaining macroeconomic stabilization (Naughton 1995, 5-12). To date, China's economic and political institutions governing private ownership, financial liberalization, and property rights remain underdeveloped (Huang 2008, 31). Moreover, over the past decade, there has been a growing trend toward an expanded state role and the suppression of competitive forces, prompting some observers to characterize the Chinese economy as state capitalism, authoritarian capitalism, or corporate Leninism (Bremmer 2010; McGregor 2012; Lee 2012).

In the following pages, we bring analyses of the Chinese political economy into conversation with scholarly literature on the biosciences. Political scientists have identified institutional continuities acrosss the pre- and post-1979 reform period, particularly in methods of economic management and patterns of social mobilization. (Perry and Heilmann 2011; Ang 2016). Similarly, scholars of the biosciences have argued that China's recent emergence as a biomedical powerhouse is best understood in a broader historical context. Sigrid Schmalzer (2015) and Lijing Jiang (2017) have highlighted the path dependency between Mao-era biological initiatives and more recent attempts to revive the life sciences in order to boost China's economy. Beyond offering further evidence for these continuities, we join scholars like medical anthropologist Priscilla Song (2011) in showing how state power and individual agency intersect under the conditions of marketization. Song's work shows how reform-era medical entrepreneurs co-opt socialist structures such as public health facilities for private gain, we examine the lucrative opportunities as well as the dilemmas and dangers the post-socialist biotech entrepreneurs faced, showing the complex conflicts, compromises, and collaborations that occur between the state and entrepreneurs in a transitional economy.

Specifically, we argue that post-socialist biotech distinguishes itself from its biocapitalist counterparts in three key aspects: labor governance, value creation, and the conceptualization of risk. These three axes—labor, value, risk—comprise a model of biotech that reflects the economic structures of gradual and incomplete marketization. In this article, we focus on two Chinese biotech companies, Weiguang Biological Products Co., Ltd and BGI (*huada jiyin*). We set the stage for our analysis by first situating our two case studies in the city of Shenzhen, China's first and most successful SEZ and the forefront of China's economic liberalization. We then examine how the institutional inheritance of socialism enabled the two Shenzhen-based biotech companies to recruit, organize, and deploy labor in distinctive ways. As a result, their approach to innovation—such as their "handmade" cloning technique and "muddy-legged biotech" discussed in detail later—differ from the capital-intensive model of scientific research in controlled corporate laboratories. While the Shenzhen-based biotech firms pursue similar scientific and commercial goals to their Euro-American counterparts, they are also tasked by the state with contributing to boosting China's global technoscientific profile and strengthening the Chinese national identity for a domestic audience. While conforming to statist agendas and forging close ties with specific state officials help these enterprises counter certain economic

risks, the growth and creativity of these firms remain confined by the continuous state domination in strategic sectors.

Shenzhen: An Institutional Frontier and a Biocapital Borderland

The two case studies in this paper are situated in the city of Shenzhen in the southern Guangdong Province of China. During the Mao era, Shenzhen functioned as both a geographical and political frontier to neighboring capitalist Hong Kong. During the reform era, Shenzhen became an economic frontier. In 1980, the city was the location of one of China's first SEZs, designated areas for testing market practices before they were introduced to the core of the socialist economy. Modern Shenzhen itself emerged from a series of economic, social, and political experiments (O'Donnell, Wong, and Bach 2017; Du 2020).

Shenzhen's frontier status gave rise to a vibrant scene of technological innovation. As the location for the first Foxconn factory in China, Shenzhen soon became a global center for electronics production and earned the label of the "Silicon Valley of hardware." From the late 1980s, Shenzhen developed a unique and freewheeling culture of hardware experimentation that attracted many talented engineers, hackers, and tinkerers[1] to the city (Kera 2014; Lindtner 2020). Shenzhen is the birthplace of some of China's most well-known technology companies, including Huawei, Tencent, and BYD.

Shenzhen has also been a biocapital borderland, a zone of economic exchange for people, plants, animals, and later biomaterials. Historically, the geographical predecessor of Shenzhen, Bao'an County, served as the hinterland for the thriving entrepôt of Hong Kong, providing the latter with raw materials, most importantly, food items. During the Mao era (1949-1976), the socialist state extracted foreign exchange by monopolizing the cross-border trade of vegetables, oysters, and other agricultural products (Zhou 2021). The decentralization and liberalization under reform allowed Shenzhen's local government and private entities to also benefit from cross-border bio-exchanges. For instance, through Hong Kong, BGI generates revenue by serving as a "contract sequencer" for Western scientific projects and institutions that outsource mundane DNA sequencing work. In some cases, foreign DNA was shipped to Hong Kong for sequencing (where BGI also maintained a cache of machines), and bioinformatics technicians could log in from BGI headquarters in Shenzhen to process the data (Stevens 2018). BGI and other tech firms have leveraged their geographical location to gain both economic and scientific advantage from cross- and trans-border exchanges.

Labor: Migration, Management, and "Handmade" Cloning Techniques

With little exaggeration, the history of Shenzhen can be said to be a history of migration. During the Mao era, Bao'an County was infamous for being the gateway for illegal migration to Hong Kong. From 1951 to 1980, at least one million undocumented immigrants from the mainland

entered Hong Kong via Bao'an. In 1980, the year the Shenzhen Special Economic Zone was established, only around 330,000 residents remained in Shenzhen, most of whom were elderly, sick, women, or children (Zhou 2021). By 2022, the resident population of Shenzhen had exceeded 17 million (Shenzhen Statistics Bureau n.d.). The massive domestic migrant inflow made Shenzhen one of the largest migrant cities in China to emerge during the period of market reform. Ordinarily, the term "migrant" in the Shenzhen context evokes an image of rural youths who remain in a marginal or liminal state in the city, unable to obtain the *hukou* (household registration) that would grant them full residency rights, while remaining vulnerable to labor exploitation (Pun 2005).

The labor forces at the two Shenzhen-based biotechnological enterprises we examine here are not the stereotypical rural-to-urban migrants concentrated in the city's electronics industries. Shenzhen's first biotechnology company, Weiguang Biological Products Co., Ltd, originates from a socialist-era state farm staffed with refugee labor from Southeast Asia. The Guangming (which means "bright" in Chinese) Farm, although located at a remote north-western corner of Shenzhen, had been a "melting pot" where people mixed, cultures blended, and animal breeds hybridized. In 1958, the Chinese government established Guangming as a military farm—a model commonly used during the Cold War to organize the resettlement of people in border regions. Its initial inhabitants included Communist Party cadres from northern China and urban youth from Guangzhou, whom the government relocated to rural areas during the Cultural Revolution. Additionally, Guangming also welcomed ethnic Chinese individuals who had been expelled from Malaya, Indonesia, and Vietnam under local ethnonationalist policies. Notably, refugees from the Third Indochina War (1975-1991), numbering over 4,000, significantly altered the demographic makeup of Guangming Farm. Following their arrival in 1979, Southeast Asian Chinese residents outnumbered the local population, eventually becoming the majority within the community. Consequently, the farm was renamed the "Guangdong Guangming Overseas Chinese Livestock Farm" (*Guangdong sheng Guangming Huaqiao xumu chang*) (Zhou 2023, 711-712).

In contrast with the rural-to-urban migrants who lack or have restricted access to healthcare, education, housing, and other social rights at their workplaces, the Southeast Asian Chinese on the Guangming Farm were entitled to state-sponsored welfare benefits, including stable salaries, subsidized housing, free medical care, and pensions. Prior to the early 2000s, Guangming operated as an agricultural production area under state control and guidance, characterized by key aspects of a planned economy (Zhou 2023, 208). Overseas Chinese farms are unique socio-economic institutions that emerged in socialist China, created to accommodate ethnic Chinese expelled from South and Southeast Asia. As one of the more than 80 overseas Chinese farms across the country, Guangming was unique because it was founded when the rest of China was embarking on reform. In Shenzhen, an enclave for experiments with economic liberalization, the Southeast Asian migrants lived in a special zone within a special zone, where the state, rather than the market, served as the leading provider of their livelihood (Zhou 2023, 209).

The Chinese state offered protection and privilege to the Southeast Asian migrants on the overseas Chinese farm to demonstrate its "co-ethnic fraternity" with the global Chinese diasporic communities and shore up international prestige (Ho 2018, 2 and 18). However, this welfare was

not freely given. In return, the Southeast Asian migrants formed a disciplined labor force engaged in state-directed, export-oriented food production, most prominently dairy farming. Guangming started supplying Hong Kong with fresh milk in 1975 and became the British colony's largest milk supplier between the 1980s and early 2000s, claiming 60-70 percent of the market share in Hong Kong (Zhou 2023, 715). The Southeast Asian migrants were a key labor force that propelled Guangming's growth. They performed tasks such as milking the cows (which were milked by hand on the Guangming Farm until the early 1980s, when the farm imported mechanized milk production facilities), growing cow feed, cleaning barns and stalls, monitoring the animals' physical health, and other similar tasks. Since most of the cows were imported from temperate zones, the human migrants worked diligently to help the animals adjust to the subtropical climate in Shenzhen (Zhou 2023, 714). Due to the prolonged military conflicts in Indochina, most of the refugees from Vietnam did not have the opportunity to receive proper education and could only work as low-skilled labor on the Guangming Farm. Nevertheless, the day-to-day work they performed laid the foundation for the emergence of biotechnology in Shenzhen. As we will explain later, Guangming's flagship biotechnological company, Weiguang, began with experiments using blood drawn from the calves fed and raised by Southeast Asian migrants.

Despite the existence of Weiguang, Shenzhen was not known for its biotechnology industries in the first decade of the 21st century. To develop an emerging high-tech industry, in 2007, the Shenzhen government offered rent-free spaces in an old shoe factory in Yantian, on the outskirts of the city, to BGI, a biotech company founded in 1999 in Beijing by four Western-educated Chinese scientists. BGI founders hoped to find opportunities to accelerate China's scientific and financial investments in biotechnology and biomedicine. One such opportunity lay in the ongoing Human Genome Project, which began in 1990 and was led an international consortium backed by wealthy US and UK institutions (McElheny 2010). In 1999, BGI's leaders managed to convince the consortium to let them join the global project; the project's DNA samples were then shared with China. In 2001, the Human Genome Project was declared complete, and BGI had contributed 1 percent of the completed sequence to the project (Wang et al. 2017). Between 2001 and 2007, BGI contributed to several other large-scale genomics projects, including the International HapMap Project (Saenz 2010). BGI's 2007 move to Shenzhen aimed to capitalize on the city's technological, geographic, and economic advantages.

One of the attractions of Shenzhen was its diverse and talented migrant population. Like the state farm workers at Guangming, the BGI employees generally enjoy a far higher level of financial and job security than factory workers. However, unlike the Southeast Asian Chinese refugees, the migratory trajectories of BGI employees were shaped by market mechanisms rather than state responses to humanitarian crises. Most BGI employees voluntarily relocated to Shenzhen, drawn by the city's economic opportunities and prospects. Many were young and well-educated (usually with at least a college degree) and highly competitive in the labor market. Although some employees complained about the mediocre pay, salaries and working conditions at BGI afforded a great deal more autonomy than would be typical for rural-to-urban migrant workers. BGI promised, too, that it could resolve *hukou* issues for its employees due to its strong relationship with the local government (Wong 2017).

BGI labor management drew on the socialist model of *danwei*, or work unit. The danwei system was the fundamental organizational unit of urban social life under communism in China (Bjorkland 2016). BGI borrows both social and spatial elements from danwei life. Spatially, the company compound is a place where employees both work and live together, as well as spend a significant part of their social lives within and around the lab (such as eating and socializing together). The overlaps between work and life are partly due to the physical characteristics of the lab: like a traditional danwei, BGI's headquarters in surrounded by a wall and access to the compound is via a gate with a guard. The gate is equipped with turnstiles that can only be opened by a lab ID card, strictly regulating the flow of people in and out. Although some workers live outside the compound, their apartments, also enclosed within walls and gates, are only a short distance away.[2] Some aspects of this collegiality may bear resemblance to forms of socialization in early US biotech (see Hughes 2013, for example), yet the underlying social structures remain different in these two cases. While the culture of US biotech owes much to the casual, non-hierarchical forms of interaction inherited especially from West Coast tech firms (Saxenian 1996), the danwei imposes more hierarchical, totalizing, and formal obligations (Walder 1984).

The lab also takes some degree of social responsibility for its workers, including educational, health, and insurance needs. BGI leaders often talk and act in highly paternalistic ways, treating BGI employees almost as if they are part of an extended family that they must provide and care for. BGI founder Wang Jian addresses his staff in a "fatherly" mode in many of his messages. After all, "old Wang" (as some posters and slogans around the lab refer to him) is far senior to most of his staff.[3] The presence of extended families in worker accommodation also contributes to the sense that BGI is a "social unit" rather than merely a workplace.

Perhaps most significantly, BGI staff exhibit high levels of social cohesion. For many young people coming to BGI—most of whom are without siblings of their own due to China's one-child policy—their coworkers are like a family. Living and playing together is not merely a convenience but rather an element critical for fostering effective collaboration. According to one senior member of BGI in Hong Kong, these "socializing" activities were essential for shaping employees into effective scientific teams. Basketball teams, hiking clubs, and other social activities laid the groundwork for teamwork in the lab (Stevens 2018).

The post-socialist, danwei-style of labor management played a key role in BGI's ability to adopt a "handmade" (*shougong*) or factory approach to biotechnological work, utilizing manpower to replace expensive, imported machinery. Besides DNA sequencing, BGI expanded its operations in animal cloning. These cloned animals could be used for testing pharmaceuticals and for biomedical and agricultural research. To do so, the cloning had to be able to scale up easily. In other words, part of the scientific challenge for BGI was to create a large number of clones using a factory-like approach. The leader of BGI's cloning project, Du Yutao, completed a PhD in Denmark in 2005 and returned to China with a new technique for cloning pigs. In 2007, she initiated this process at BGI. Du describes the process as "handmade" (*shougong*): "We managed to reduce our reliance on expensive machines and replaced them with trained operators making the cloning process quicker and easier" ("Decoding the Future" 2017). Rather than relying on micromanipulators, Du's method allowed about fifty technicians to train in cloning procedures that used ordinary microscopes. BGI scaled up this work to what Du herself called a "factory," producing as many as five hundred cloned pigs per year (Phillips 2015).

BGI's "handmade" approach was further applied to the production of genetically modified animals. In 2012, Du's technique was adapted to sheep cloning to produce "Pengpeng," a genetically modified sheep that could express omega-3 polyunsaturated fatty acid in her muscle tissue ("World's First Handmade Cloned Transgenic Sheep Born in China" 2012; Zhang et al. 2013). Lamb from such an animal could provide an important source of this nutrient. By 2014, BGI's cloning programs had become more ambitious and more creative. Du's "handmade" techniques were now applied to a small breed of pigs called "Bama." A novel genetic modification technique (known as TALENs) was used to turn off growth hormones in the pigs, rapidly producing miniaturized animals for biomedical and agricultural research. A smaller-sized animal meant that pigs were cheaper and easier to maintain. It also meant that drugs could be tested on them in smaller doses. The following year, BGI announced that it was intending to sell genetically modified and cloned "micropigs" as pets for RMB10,000 (about USD1,600). In the future, a BGI official promised they would even be available to customers in different colors and patterns (Cyranowski 2015). These "handmade" animals were central to BGI's reputation and image as a cutting-edge scientific institution with Chinese characteristics.

Although both Guangming and BGI workers differed from typical Shenzhen migrants, both institutions critically depended on the movements of people driven by post-socialist market reforms. Moreover, both have drawn on models of socialist-era labor organization, while reshaping and redeploying them in ways that have had a lasting impact on their operations. It is important not to exaggerate the differences between these Chinese examples and early biotech in capitalist contexts, which also relied on some degree of labor-intensive practices (Hughes 2013; Franklin 2007). However, in the Chinese case, "hand-made-ness" was not only born of necessity but also a feature of the work that was deliberately designed (and celebrated); labor-intensive, factory-like lab work had a particular political and social resonance and purpose.

The emergence of biocapital has been predicated on a particular class of workers and particular forms of work. These have primarily been white-collar, educated workers circulating through elite universities on the West Coast and East Coast of the US. Where this work has involved any significant human movement, capitalist biotech has involved a "suburbanization" (Kaiser 2004) of the life sciences, removing the biosciences to the peripheries of cities like Boston or Cambridge, UK. In contrast, the two Shenzhen-based companies we describe here relied on multiple streams of migration, including technological professionals who relocated within China for economic reasons; international refugees displaced by war and subsequently resettled by the Chinese state in Shenzhen, where they became unskilled laborers; and migrating animals imported for agribusiness purposes. The work of biocapital has taken place in corporate laboratories and offices centered on clusters such as Silicon Valley/Cell Valley, the Greater Boston Area (Rasmussen 2014), or Cambridge, UK. In Shenzhen, socialist institutional legacies, such as the work unit (danwei) and state-owned farms, exert a strong influence on biotechnological firms' approaches to corporate governance and social responsibility.

Value: "Muddy-legged" Biotech and Bionationalism

While labor-management styles at Weiguang and BGI bear a resemblance to socialist-era institutions, the products created by the two companies—from milk to genome sequences—were not merely commercial products for market exchange. Beyond monetary profits, these products generated values that were ideological and social, including ties of indebtedness between Shenzhen and Hong Kong, as well as an imagined community of the Chinese (ethnic) nation. Reform has enabled Chinese entrepreneurs to leverage biomaterials for profit-seeking purposes. However, like other Asian countries, the Chinese biotech industry has been subjected to nationalist mobilizations (Ong and Chen 2010).

Under socialism, the predecessor of Weiguang, the Guangming Farm, supplied fresh milk and other high-protein food items to Hong Kong as part of a broader PRC political gesture of goodwill toward the British colony. The introduction of market mechanisms under reform incentivized Guangming farm employees to expand their export for financial gain. Hong Kong's rapid economic development in the 1970s triggered changes in the local diet, resulting in an increased demand for meat and dairy products. However, as the price of land in Hong Kong increased, animal husbandry became unprofitable in the British colony. As a result, Hong Kong primarily relied on imports from countries such as the Netherlands, Denmark, Australia, New Zealand, and Thailand. Due to the long distances and the limits of transportation technology at the time, the imported dairy products from these countries were mostly milk drinks reconstituted from powder. However, Cantonese culinary traditions place great emphasis on the freshness of the raw materials, so the Guangming management saw a great business opportunity given the farm's advantageous location bordering Hong Kong (Guangming State-Owned Overseas Chinese Livestock Farm 1984).

In the 1980s, Guangming began to industrialize and scale up its agribusiness through investment in more technologically advanced equipment as well as in what anthropologist Sarah Franklin (2007) calls "animal capital"—hogs from Belgium and the US, ducks from Australia, cows from New Zealand and Denmark, and pigeons of an Australian-American mixed breed. Modern machinery and foreign animals went hand in hand—the specific breeds imported to Guangming were explicitly made to survive and thrive in industrial conditions. For example, the Belgian hog could convert a relatively small amount of feed into a high amount of lean muscle (more than 60 percent of its total weight) within 170 days (Guangming State-Owned Overseas Chinese Livestock Farm 1984, 106). Their short lives were spent in the temperature- and humidity-controlled environment of a Confined Animal Feeding Operation, an American technology that delivered feed and cleaned their droppings automatically (Lander et al. 2020). Similarly, an Australian-made automatic incubator could hatch 70,000 ducklings within 28 days. The ducklings, an Australian breed, could mature within 56 days, weighing more than 3 kilos, with tender meat and soft bones. Guangming also imported more than 1,000 cows from New Zealand and 300 from Denmark. With sturdy hoofs and robust immune systems, these Kiwi and Danish cows produced high-quality, creamy milk. Roasted pigeon is a delicacy in Cantonese cuisine. To meet the market demand in Hong Kong and the broader Pearl River Delta, Guangming built the largest pigeon farm in Asia by importing 3,600 flocks of an Australian-American mixed breed

that featured meaty and large bodies (Guangming State-Owned Overseas Chinese Livestock Farm 1984).

The bovine, swine, and avian migrants to Guangming embodied a long history of selective breeding, a form of practical innovation in animal husbandry. Around the world, newer biomedical innovations are usually closely connected to older agricultural practices, famously represented in the case of the cloned sheep Dolly, which emerged from Britain's long tradition of sheep breeding and agricultural experiments (Franklin 2007). Weiguang's emergence as a biotechnological company on a state-owned refugee farm followed a similar pattern. In the words of its first manager, Wang Jincai, Weiguang's development trajectory can be summarized as a style of "muddy-legged (*ni tui zi*) biotech" (Yang 2020).

By the mid-1980s, Guangming farm had accumulated significant "breed wealth" (Franklin 2007) by importing cultivated animals. Beyond market success in the traditional agricultural sector, technicians on the Guangming farm began to explore ways to maximize the productivity of the animals beyond their primary use as food. Among them was Wang, who was assigned to work at the Guangming Farm in 1976 after completing a degree in veterinary medicine. Although Guangming paid keen attention to importing breeds with strong disease resilience, the animals were inevitably prone to illness due to the expanded scale of livestock farming and greater exposure risks. In response, Guangming upgraded its animal medical team to an animal pharmaceutical factory, the Guangming Biochemical Pharmaceutical Factory. In 1983, Wang Jincai was appointed as the factory manager and began to capitalize on a resource that had previously been regarded as "useless" on the farm—the male calves, which, unlike their female counterparts, had no value in milk production (Yang 2020).

Instead of selling the male calves cheaply as a source of food, Wang worked to transform the animals into pharmaceutical products with the potential to improve human health. He discovered that serum extracted from the thymus of calves could yield a substance called thymosin, which could enhance human immunity. Wang brought this idea to the Wuhan Institute of Biological Products, one of China's major bioscience research institutes, which eagerly sought commercialization opportunities from the SEZ in the early reform era. In November 1984, the Guangming Farm, in collaboration with the Wuhan Institute of Biological Products, jointly founded Shenzhen Weiwu Guangming Biological Products Factory, the predecessor of Weiguang. Following the same pattern of transforming low-value animals into high-value pharmaceutical products, in May 1985 the company purchased 60 retired military horses from the People's Liberation Army troops stationed in Shenzhen. The horse serum, produced from purified horse plasma and promised to boost human immunity, became a star product, generating sizable profits (*Rongyao sanshi nian* 2015).

Weiguang's "muddy-legged biotech" bears some resemblance to the emergence of biotech from agricultural and paramedical institutions in capitalist contexts. The Roslin Institute's creation of Dolly the sheep (Franklin 2007), as well as the mobilization of slaughterhouses (Rasmussen 2002), human urine (Oudshoorn 1994), and Mexican jungles (Soto Laveaga 2009) as sources of hormones, suggest the diverse origins of early biotechnological and pharmaceutical products. These products—even when collected under the auspices of collectivist ideals (Swanson 2014)—

were immediately integrated into the flows of capitalist medical and pharmaceutical industries, often erasing their diverse origins. Weiguang also sought to turn its products into profits. However, the post-socialist context of Weiguang's work meant that it had priorities and aims that went beyond merely selling high-value products —reflecting a long legacy of Chinese enterprises that sought to balance profit-making with political and social goals (see, for example, Jiang 2017, Song 2011, and Schmalzer 2015). The "muddy-legged" and collectivist origins of their products were part of their significance and value. Weiguang's role as a state farm made its political and social goals just as important as its economic ones.

Weiguang's business innovations were built on a Cold War food supply project serving the highly political purpose of cultivating affinity across the border with Hong Kong. Likewise, BGI's scientific projects suggest that market incentives remained entangled with the need to embody political symbols and national prestige in China's biotech sector. One of the first projects that BGI initiated upon its move to Shenzhen was an effort to sequence the genome of the Giant Panda. As an iconic animal representing the nation, sequencing the panda was a symbolic effort to demonstrate China's (and BGI's) emerging scientific status. The lucky individual to be sequenced would be Jingjing, the panda who also served as the model for the mascot of the 2008 Beijing Olympics. Researchers planned to complete sequencing and assembly within six months so that Jingjing's genome would be ready for the big event in Beijing in August. A project to sequence China's "national treasure" was designed not only to assist with panda conservation but also to raise BGI's profile and status within the country ("An Interview with a Leader in Genomics" 2008). The Giant Panda genome, eventually published in *Nature* in December 2009, was one of the first genomes to be sequenced entirely by next-generation machines (Li et al. 2010).

Another of BGI's earliest projects in Shenzhen aimed to generate the full DNA sequence of an individual Han Chinese person. Called "Yanhuang Number 1 Project," this became the first full genome of an Asian individual and only the third full human genome to be published, following those of James D. Watson and J. Craig Venter earlier in 2007 (Wheeler et al. 2008; Levy et al. 2007). The sequencing of an anonymous Chinese individual marked only the beginning of BGI's ambitions for a broader "Chinese genome" project, which they called "Yanhuang." Yanhuang has several interconnected meanings. The phrase "*yan huang zi sun*" ("Descendants of Yan and Huang") refers to the ancient Chinese emperors *Yan Di* (the Flame Emperor) and *Huang Di* (the Yellow Emperor). According to Chinese mythology, Yan and Huang led two tribes that inhabited the Yellow River basin in the third millennium BCE. Around 2700 BCE, Huang defeated Yan and amalgamated their tribes to form a more powerful community. As such, the two emperors are regarded as the ancestors of all Han Chinese and the originators of Han Chinese customs and culture. "Yanhuang," therefore, not only refers to the emperors themselves but to the ethnic group that are supposedly descended from them: the Han Chinese (Chen 1996).

In the context of BGI's genome project then, "Yanhuang" carries a range of meanings. Most obviously, it links BGI's work explicitly to the Han ethnicity and, by extension, to "unifying" ethnic and racial narratives. By linking this genomics project to the mytho-historical origins of China and the Chinese people, BGI signals that biotechnologies can have significant value for reinforcing national and ethnic identity.

The kinds of value created in post-socialist biotech differ from those in capitalist exemplars. In the post-socialist context, the forms of value to be realized go beyond transmuting biomaterials into commodities, to serving geopolitical and humanitarian purposes, stoking nationalist sentiments, and overall conforming to statist agendas. One of the enterprises we discussed has evolved from a state farm that employed ethnic Chinese refugees from Vietnam to produce high-protein food items for export to Hong Kong, to win hearts and minds in what was then a British colony. The other company has gained fame for sequencing the genes of the national treasure, the Giant Panda. The two Shenzhen-based biotech enterprises are not merely pursuing monetary profits: they are also forging particular social ties and staking out political futures for China.

Risk: Opportunity and Precarity in State-Business Relations

The modes of labor management and value creation at the two Shenzhen-based companies reflect the long shadow of China's socialism as well as the continuously dominant role of the Chinese state in the national economy. The institutional irregularities during the market transition allowed profit-driven biotech entrepreneurs to take advantage of insufficient controls, as well as to form and benefit from patron–client relationships with government officials. However, the enterprises' dependency on the state constituted a form of risk itself, rendering the post-socialist biotech sector vulnerable to global market volatility, as much as the upheavals in the careers of their patrons and the unpredictable trajectory of China's reform in recent years. [4]

Both Weiguang and BGI have been embroiled in scandals related to the development and sale of risky and potentially faulty products. Building on its success in animal-based pharmaceuticals, in the early 21st century Weiguang expanded its production line to human blood products, including human albumin and human rabies, tetanus, and hepatitis B vaccines (Product manuals, Weiguang Biological Products Co., Ltd. n.d.). In 2003, Weiguang manufactured SARS immunoglobulin within two months. Weiguang was listed on the Shenzhen Stock Exchange in 2017 ("Fazhan lichen" n.d.). Its commercial success brought monetary benefits to its employees but also incurred social costs. Weiguang's laboratories relied heavily on plasma collected from socio-economically disadvantaged regions of China (usually frontier regions with a high percentage of ethnic minorities, such as the Baise county of Guangxi bordering Vietnam and the Wanning City of Hainan, the southmost island of China with Indigenous Austronesian communities) (Weiguang Biological Products Co., Ltd. 2023; "Wanning Weiguang dancaixuejiang zhan wei 82 ming zhundaxuesheng fafang zhuxuejin 10 wan yuan" 2021). Beyond ethical issues of exploitation, blood collection from these communities also involves high risks of disease transmission if not adequately regulated. A key Weiguang product, freeze-dried human plasma, was suspended in the early 1990s, possibly due to HIV or hepatitis B infections (*Rongyao sanshi nian* 2015).

Similarly, in July 2018, an article on Huxiu.com claimed that BGI's NIFTY prenatal genetic tests were fundamentally flawed and that several expecting mothers who had taken the tests had given birth to children with physical disabilities (Botong 2018; Zhang 2018). "BGI directly and

indirectly sent the family into the abyss," the author wrote (Botong 2018). The article also claimed that BGI's advertisements for prenatal genetic testing were misleading and that BGI's associations with the Chinese tobacco industry showed that it was now an immoral company: "Non-invasive DNA testing has become a medical product that uses human vulnerability marketing" (Botong 2018). The post went viral in China and soon other customers came forward with similar stories. The scandal posed a significant threat to BGI's business. The company attempted to explain that all such tests carried risks and the possibility of false negatives. Moreover, BGI argued that its tests fully complied with the regulations and standards of all the relevant authorities, and that the company informed patients of the risks with proper informed consent procedures ("Huada jiyin huiying 'Huada aibian'" 2018). However, the damage had been done.

The NIFTY scandal unfolded against the backdrop of the company's expansion into the real estate sector. In September 2017, BGI signed a deal with Vanke, a large real estate company founded by Shenzhen businessman Wang Shi, and Suzhou New District Hi-tech Industrial Co. Ltd. to develop a town near the high-tech zone of Suzhou. Called "BGI Life and Health Town," the two-square-kilometer district was slated to include residences for scientists, two scientific institutes, an agricultural field-testing site, a college, and space for company labs and offices (Lin 2018). Never completed, the health-themed high-tech zone and science park aimed to become a base for the development of genetic and medical technologies. BGI would support the development of scientific activities and also own a 25 percent stake (Wang and Jia 2018). The collaboration with Vanke was one among many deals that BGI had struck with Chinese companies and local governments to develop labs, research centers, "cities," industrial parks, and innovation districts (Huang 2018). The expansion of BGI's business into real estate fueled consumer distrust of the company. The kinds of activities that BGI has engaged in—rapid scaling up, rapid expansion into different domains and new geographic areas, and aggressive marketing of "quick-fix" products—have left it open to widespread suspicion.

Like BGI, Weiguang has also run into disputes and controversies related to real estate development. In 2020, Weiguang started the construction of a more than 30,000 square meter life sciences park, marketing it as a "maker space" and "incubator" for start-ups, an "accelerator" for existing biotech companies, and ultimately a biotech "industrial port" (*chan ye gang*) with an ecosystem that supported the entire process from research to drug commercialization (Weiguang Biological Products Co. Ltd. n.d.). In the Shenzhen government's strategic planning, Guangming, now no longer a farm but a formal administrative division of Shenzhen, will serve as an innovation hub, or a "science city" (*ke xue cheng*) in the official language, for the Guangdong-Hong Kong-Macau Greater Bay Area ("About Guangming" n.d.). These developments were made possible by the restricted ownership rights of Southeast Asian migrants. As China's market reform progressed, the state farm was ultimately shut down and restructured into a State-Owned Enterprise (SOE) in 2002. Through the dissolution of the farm, Southeast Asian migrants were prevented from building private houses to generate income from rent, as the state claimed ownership of their land (Zhou 2023, 720). In 2012, the Southeast Asian migrants staged a collective action and pressured the local government into approving a compensation scheme ("Tudi huishou bu jian peikuan: Guangming jituan zhigong 14 wan naqule?" 2012). Although the scheme provided an economic safety net for the returnees, it

significantly reduced the state's financial and operating costs for acquiring the land needed for the construction of an innovation hub in Guangming.

The two Shenzhen-based biotech companies benefited from collaborating with the state when accessing land, yet their association with individual officials could become a liability when the state tightened its control over graft and corruption. The BGI founder, Wang Jian, had established a close relationship with Shenzhen Mayor Xu Zongheng, who invited BGI to relocate to Shenzhen, wooing the company with grants and tax breaks. Wang had boasted to reporters that the mayor had invited him to his home and personally cooked for him. However, soon after BGI arrived in Shenzhen, the central government began investigating Xu for a "serious breach of discipline" (Mitchell 2009). In May 2011, Xu was convicted of accepting bribes worth (RMB33 million or US$5.5 million) and sentenced to death, which was later commuted to a life sentence ("Shenzhen Mayor Spared Execution" 2011). BGI's ties to the disgraced mayor may have affected BGI's business prospects. BGI's initial attempts to go public in the United States and Hong Kong failed. A 2016 BGI attempt to list on the Shenzhen Stock Exchange was also blocked by Chinese securities regulators, citing insufficient documentation (Li 2017; Mottl 2016). In 2017, BGI finally succeeded in raising RMB547 million (approximately US$75 million) in an IPO, with its stock price rising 44 percent on its opening day ("BGI Raises $81M in IPO" 2017; He 2017). Nevertheless, BGI's continued operation remains dependent on the central government's favor. In 2019, for example, BGI received a substantial fine for violating new regulations that restricted the sharing and publication of Chinese DNA samples and sequence data (Cyranowski 2018). Other national laws regulating the use of prenatal genetic testing also have significant impacts on BGI's business.

Whereas the downfall of its patron mayor might have temporarily postponed BGI's IPO, Weiguang's recent ownership restructure reflects the long-term constraints that biotech companies face in a transitional economy. In 2023, China National Pharmaceutical Group, also known as Sinopharm, became the major shareholder of Weiguang (Li 2023). Thereafter, Weiguang transformed from a local SOE under the Guangming District State-Owned Assets Supervision and Administration Commission to a central SOE supervised by the State Council. This change occurred within the broader context of Chinese President Xi Jinping's call for the revitalization of SOEs and a more prominent state presence in key sectors (Hao 2022). In the blood product sector, particularly, the core competitiveness of individual enterprises comes from their capacity for blood collection (Li 2022). In contrast to the heterogeneous collection system in the US, blood and plasma collection in China is highly centralized (National Academy of Sciences 1995). The top Chinese players in the field have consistently been the central SOEs. Despite outstanding R&D, Weiguang's inability to expand blood collection operations has limited its growth. The ownership structure change might help Weiguang scale up, but it will also undermine the decision-making power of Weiguang's management.

Scholarship on biotech in capitalist contexts has demonstrated that standardization and regulation has facilitated the marketization of biological products. Biocapital accumulation has depended on the globalization of bioethical practice (e.g., Institutional Review Boards), the increasing regulation of the exchange of genetic material and information (Parry 2004), and the management of the trade in tissues and organs (Waldby and Mitchell 2006). These institutional

and regulatory structures frame known risks for biotech companies operating in these spaces. Standing partially outside of these frameworks, Chinese biotech companies have been afforded greater scope to engage in high-risk behaviors and pursue profits. However, post-socialist biotech is associated with a different set of risks, including the risk of exclusion from international markets, condemnation by the domestic public, and falling afoul of local or national governments.

In a biocapitalist context, the early biotech "start-ups" sought angel and venture capital investment to fund the development of their processes and technologies. These quickly came to be protected by intellectual property regimes (Diamond v. Chakrabarty 1980) that allowed these processes and technologies (including living biomaterials) to be traded, licensed, and sold, like other technologies. Based on the speculative value of these materials, biotech companies came to be publicly traded on stock markets and acquired by multinational corporations (especially pharmaceutical companies). "Risks" associated with the various stages of this development could, in theory, be accounted for by markets and priced accordingly. The two Chinese companies we examine are themselves institutional experiments in an experimental city built on the political, social, and economic risks taken by its founders and leaders. In Shenzhen, a city of risk, biotechnological companies could capitalize on legal or institutional loopholes and irregular ethical guidelines in the bioscience field during the early reform era. At the same time, they also faced the unpredictable prospects of marketization and sometimes mercurial or predatory behaviors by the state.

Conclusion

China's incomplete and incremental reform has significantly shaped the forms and practices of Shenzhen-based "post-socialist biotech." First, the conditions for post-socialist biotech have involved significantly different kinds of human and non-human movement and labor, as well as distinct forms of labor governance. Second, they have entailed the production of different kinds of values, particularly symbolic and political values linked to Chinese nationalism. Third, post-socialist biotech engenders a divergent risk profile, with risk emerging particularly from the uncertainties of the state's capriciousness.

These cases suggest a model for conceptualizing the biotechnology industry that stands orthogonal to biocapitalism. Of course China (especially since 1979) does not stand entirely outside the global capitalist system; both Weiguang and BGI have, to some extent, participated in global biocapital markets. Nevertheless, post-socialist biotech does offer, to paraphrase Helmreich, an alternative account of the encounter between the biological and the economic. This alternative should not be conceptualized as an opposition between "Western" and "Eastern" forms of biotechnology. Nor should we view the development of Chinese biotechnology as a mere recapitulation of the Western story, played out several decades later. Instead, we have sought to illustrate the emergence of biotechnology shaped by the historical legacy of socialist political, social, and economic institutions, combined with a non-linear trajectory toward economic liberalization. Over the past decade, the resurgence of state control in resource allocation within the Chinese economy has disrupted the country's transition toward a more

market-oriented system (Lardy 2019). Since President Xi Jinping assumed office as General Secretary of the Chinese Communist Party in 2012, he has consistently emphasized the central role of state-owned enterprises in the national economy, particularly within strategic sectors. Biotech has been designated as one of these "strategic emerging industries" under the 2021–2025 Five-Year Plan (International Security Advisory Board 2024, 6).

Although the initial development of companies like Weiguang and BGI occurred during a period of market-driven growth in the Chinese economy, the re-emergence of a state-directed resource allocation strategy and the diminishing role of private enterprises cast uncertainty over their future. The tensions between the Chinese state and individual enterprises are particularly noteworthy here, highlighting the contrast between biocapitalist and post-socialist models of biotech development. BGI, in particular, has actively participated in global scientific initiatives such as the Human Genome Project and the HapMap Project, while expanding international markets for its products. Although these efforts have achieved notable success, they have also required delicate political and economic navigation, balancing the imperatives of global biocapital with the constraints and priorities of the post-socialist Chinese state. At the same time, companies such as BGI and Weiguang are vital contributors to the PRC state's ambition for global leadership in biotech innovation. Rather than merely passive instruments of state policy, enterprises like BGI exercise significant agency and autonomy, making strategic decisions to align with global scientific standards, forge international partnerships, and innovate beyond the direct control of the state. The agency of biotech firms such as BGI suggests that the Chinese state, too, must increasingly navigate between pursuing its post-socialist objectives on the one hand, and aligning more closely with global biocapital norms on the other.

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Notes

[1] Tinker refers to grassroots players in Shenzhen's technology sector who approaches innovation in a contingent, haphazard, and experimental fashion. See Lintner 2020 and Lean 2020.
[2] The observations in this paragraph are based on fieldwork conducted by one of the authors (Stevens) at BGI in Shenzhen between 2014 and 2017.
[3] Although "old" is a common honorific in China, its widespread usage at BGI can be taken to connote both paternalism and fictive kinship.
[4] On the unpredictable trajectory of China's reform in recent years, see, for example, Lardy 2019, and Economy, 2018.