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China Healthcare

Road to Re-opening 2023

Deep Dive

John Yung, CFA AC
David Shang
Eva Zhao, CFA
Zoe Bian

CITI'S TAKE

China will be ready to re-open in early 2023, we estimate – COVID prevalence in China over the next few months is difficult to predict. Less so the timing of China's re-opening to the world, in our view. While suppressing the virus and protecting the population (especially the most vulnerable groups) is likely the priority ahead of the 20th National Congress (in Oct/Nov 2022), we believe China should be ready to re-open in early 2023.

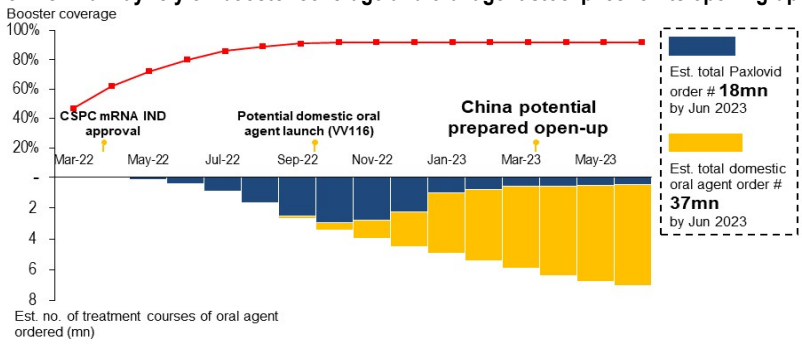
Zero COVID policy likely to remain in effect — A hasty opening up in China could overload the country's public healthcare system, leading to a spike in hospitalizations and especially serious consequences for the more vulnerable (the very young and the elderly). In our scenario analysis of an immediate opening-up – which, among other factors, assumes a booster vaccination rate of 47% and limited use of Pfizer's anti-COVID pill Paxlovid – we estimate a hospitalization rate of as high as 2.1% of the infected population.

Hong Kong may provide the template for a national solution — Hong Kong's strategy of "boosters + antigen testing + oral agents" could be the blueprint for how the mainland's COVID policies ultimately evolve. Under our measured opening-up scenario – which assumes a booster vaccination rate of 92% and broad use of Paxlovid and domestic oral drugs – we estimate a hospitalization rate of 0.6% of the infected population.

COVID-19 small molecules/vaccines — China will order 55mn courses of small molecules between Mar. 22 and Jun. 23, on our estimate, with 37mn of them produced domestically and the other 18mn imported. We project an incremental COVID-19 vaccine market of Rmb27.1bn (bear case: Rmb17.9bn; bull case: Rmb35.4bn).

Investment implications for our top sector picks — Junshi will benefit from potentially the first launch of a potent domestic COVID oral agent (VV116). CSPC's IND mRNA vaccine, if approved, could be a popular booster choice in 2023, on diminished hopes of importing foreign vaccines. Wuxi AppTec will continue to benefit from small molecule orders, such as for Paxlovid, in our view.

Figure 1. China may rely on booster coverage and oral agent stockpiles for its opening-up



Note: We assume govt. to purchase 1.5x and 3x no. of oral agents required in practice in 2022E/2023E for stockpile

Source: Citi Research, the State Council

See Appendix A-1 for Analyst Certification, Important Disclosures and Research Analyst Affiliations.

Contents

Predicting China's Future COVID-19 Policies

Since Apr 2020, China has emphasized its strategy of "Zero COVID". While the strategy allowed most people to lead relatively normal lives for the best part of two years, the wave of Omicron infections in major China cities has put this strategy to the test. Due to the dynamic pandemic situation and the prolonged closure of the country's borders to the rest of the world, we think China's COVID-19 policies are set to evolve.

COVID-19 policies explained

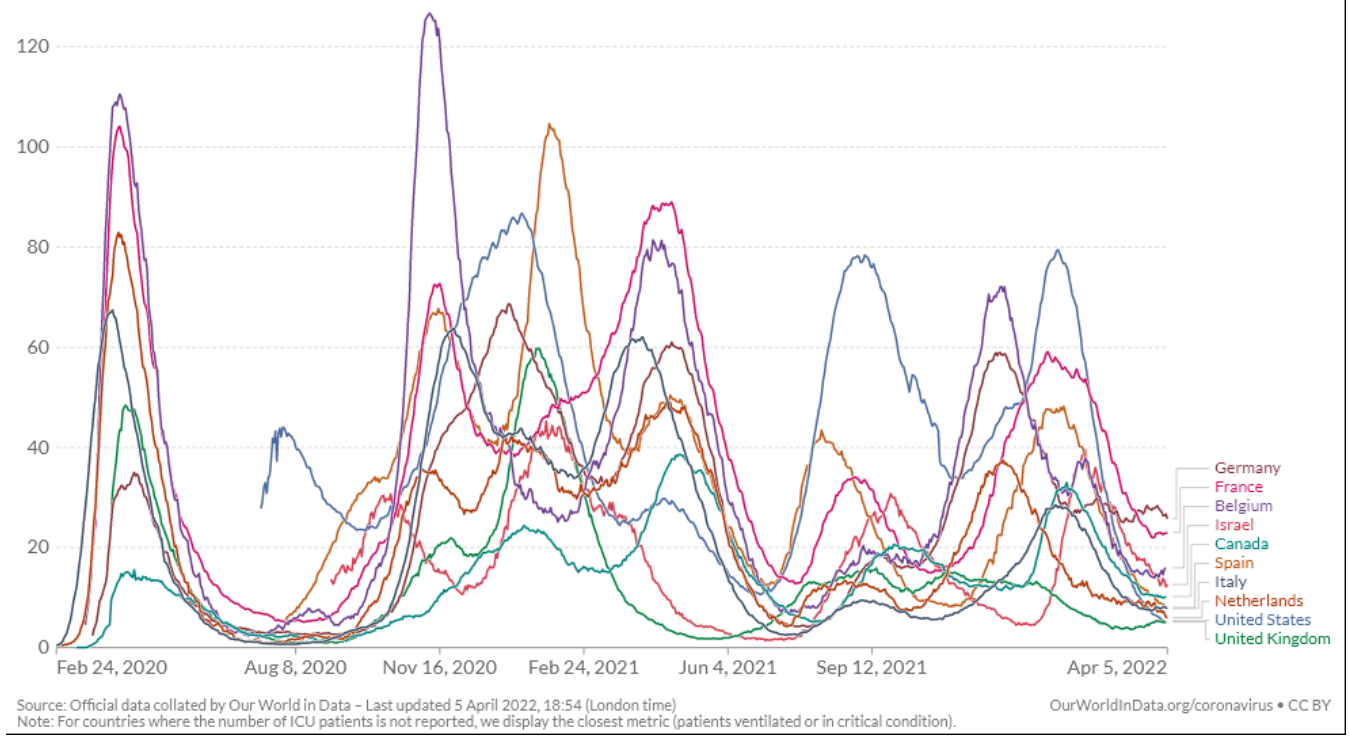
Reasons for China's zero tolerance

From our discussions with doctors who have been on the frontline in China's pandemic-hit cities, the key official concerns are: 1) a surge in severe cases that overloads local medical facilities and 2) the risk to the most vulnerable sections of the population. **The elderly:** As this group has a higher risk of hospitalization from COVID-19 infection, the China government has stated that treatment of the elderly should be a priority. **The very young:** Children below the age of three are not approved for vaccination in China. Thus, if China was over-hasty in opening up its economy, we believe the public healthcare system would be prone to overloading, while those in the most vulnerable categories would be at risk of severe health repercussions.

Upsurge in severe cases could overload local medical facilities

China has 44 ICU beds per 1 million residents, according to Chinese Health Resources. China's hospital resources would be overwhelmed if the country suffered the COVID peaks seen in western countries. At the peak of the pandemic, as shown in the figure below, patient demand for ICU beds in a number of countries reached >80 per million residents, significantly higher than China's equivalent ICU supply at 44 beds.

Figure 2. No. of COVID-19 patients in ICU per million residents



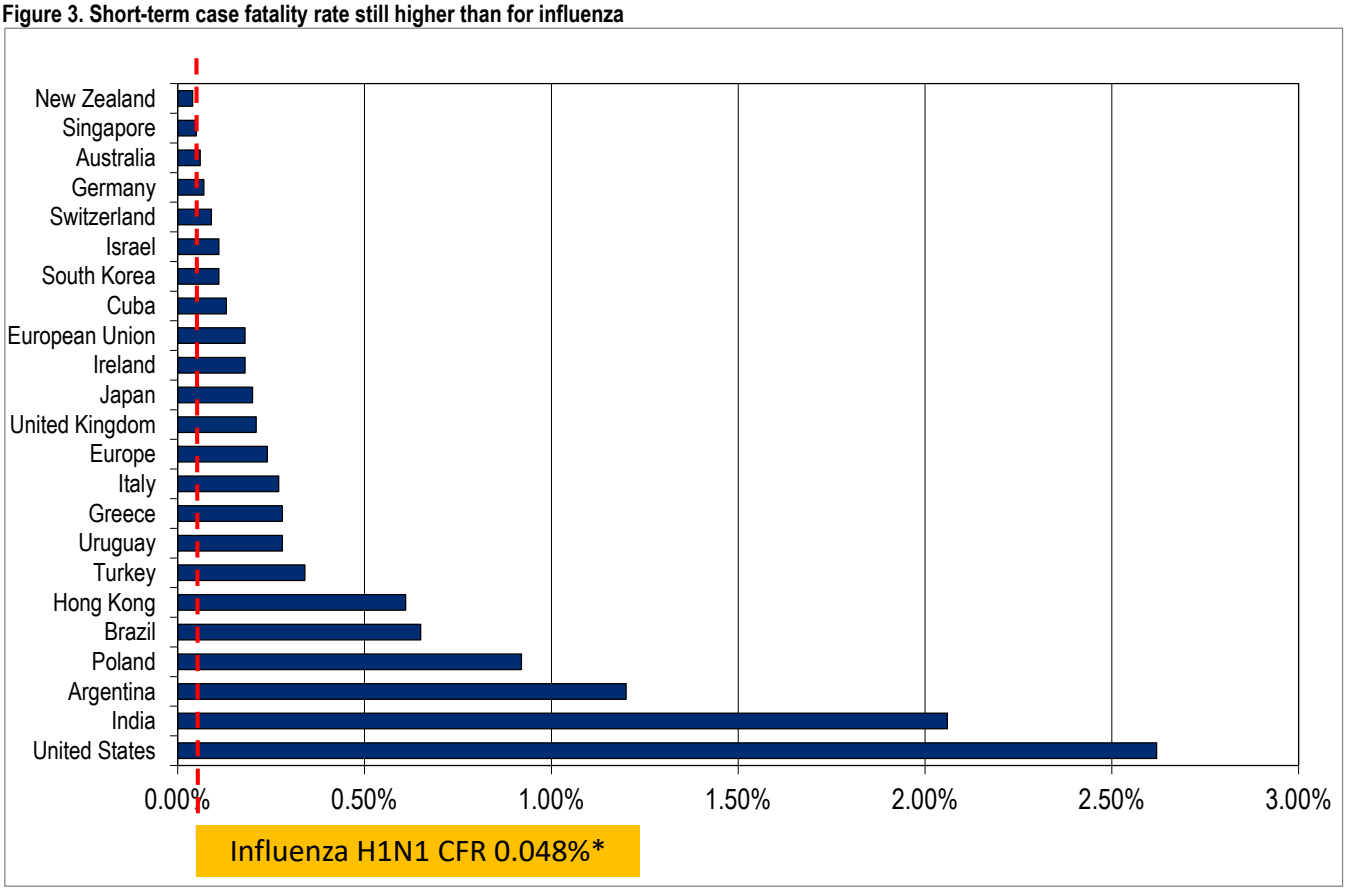
Source: Citi Research, Our World in Data, Johns Hopkins University

Vulnerable groups are a key concern

According to data from Johns Hopkins University, the case fatality rate (CFR) in most countries (mostly Omicron cases) is much higher than for influenza H1N1 with symptomatic CFR at 0.048%. Meanwhile, due to the high level of transmissibility of Omicron, mortality rates would still be likely to increase if the government removes COVID restriction policies. [1]

[1] Projecting COVID-19 Mortality as States Relax Nonpharmacologic Interventions, JAMA, Apr 2022

Figure 3. Short-term case fatality rate still higher than for influenza



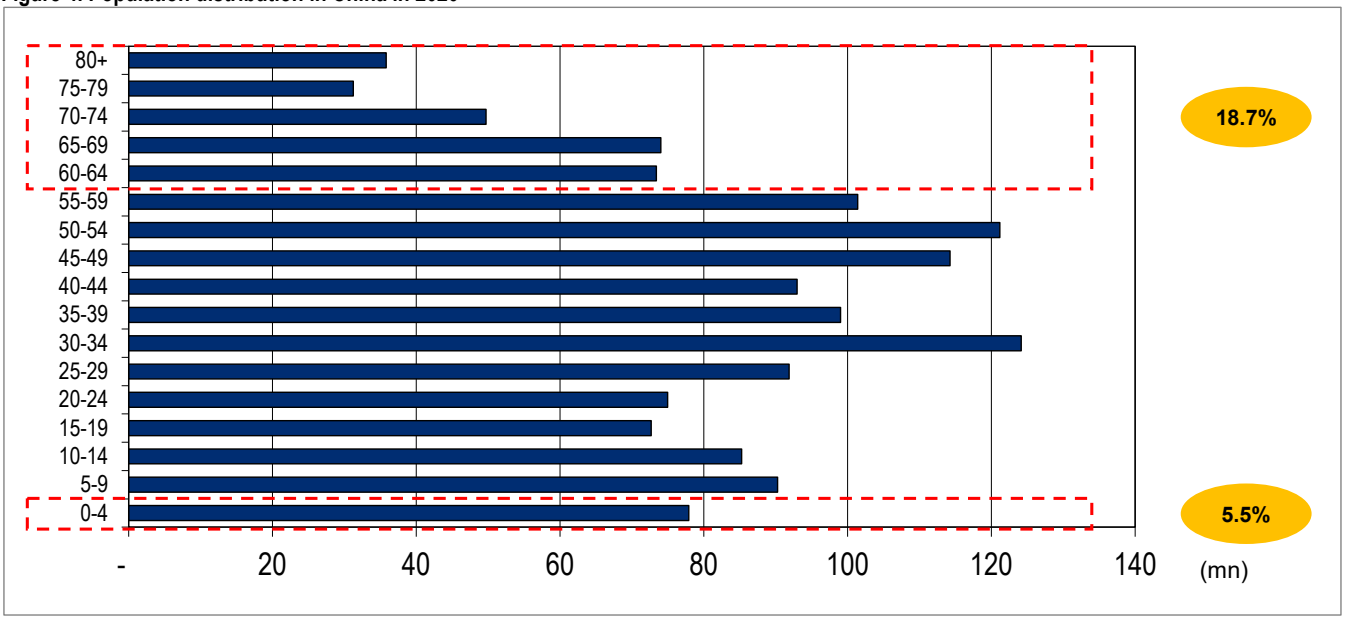
Note: Symptomatic CFR among all medically attended cases estimated per "Case fatality ratio of pandemic influenza", The Lancet.
The case fatality rate (CFR) is calculated as the ratio between the 7-day average number of deaths and the 7-day average number of infected cases 10 days earlier. Data as of Mar 25th 2022.

Source: Citi Research, The Lancet ("Case fatality ratio of pandemic influenza", July 2010), Our World in Data, Johns Hopkins University

The elderly and unvaccinated most at risk in pandemic

China had 78mn children aged below 4 (5.5% of total population) and 264mn elderly aged above 60 (18.7% of total population) in 2020, according to National Bureau of Statistics of China.

Figure 4. Population distribution in China in 2020



Source: Citi Research, National Bureau of Statistics of China

Vaccines in China

China has a total vaccination rate of 88%, with 48%/40% of the population having been vaccinated with three/two jabs respectively as of Mar 25th 2022. Since Oct 2021, The State Council had recommended booster shots for the general public due to waning vaccine effectiveness.

Figure 5. Vaccination status in China as of Mar 25th

	age<60	age>60	Overall
Vaccination status*			
Population (mn)	**1,148**	**264**	**1,412**
As % of total population	*81.3%*	*18.7%*	*100%*
Population-fully vaccinated (mn)	**1,029**	**212**	**1,241**
Full vaccination rate	*89.6%*	*80.4%*	*87.9%*
Population-with three doses (mn)	533	138	671
As % of each age group	*46.4%*	*52.4%*	*47.5%*
Population-with 2 doses (mn)	496	74	570
As % of each age group	*43.2%*	*28.0%*	*40.3%*
Population- not fully vaccinated (mn)	**119**	**52**	**171**
As % of each age group	*10.4%*	*19.6%*	*12.1%*
Population- with 1 dose vaccine (mn)	24.2	10.6	34.8
As % of each age group	*2.1%*	*4.0%*	*2.5%*
Population- unvaccinated (mn)	95.0	41.3	136.3
As % of each age group	*8.3%*	*15.6%*	*9.7%*

Source: Citi Research, the State Council

Currently, China has approved seven COVID-18 vaccines (incl. five inactivated, one adenovirus vector vaccine and one recombinant protein vaccine). Clinical results show relatively low protection rates for China-approved COVID-19 vaccines vs. overseas vaccines due to different technologies. Though not approved in China, mRNA vaccines demonstrate the highest protection against infection, recording

rates of 95.3% for the Pfizer/ BioNTech vaccine and 94.1% for the Moderna vaccine in clinical trials. We summarize key information in the table below.

Figure 6. Comparison of key approved COVID-19 vaccines in China and overseas

Company	Pfizer/ BioNTech	Moderna	AstraZeneca	J&J	Sinopharm (Beijing Institute)	Sinopharm (Wuhan Institute)	Sinovac	CanSinoBIO	Zhifei
Company type	MNC	MNC	MNC	MNC	China	China	China	China	China
Product	Comirnaty	mRNA-1273	Vaxzevria	JNJ-78436735	Sinopharm COVID-19 vaccine	Sinopharm COVID-19 vaccine	CoronaVac	Convidecia	ZF2001
Type	mRNA vaccine	mRNA vaccine	Viral vector vaccine	Adenovirus vector vaccine	Inactivated vaccine	Inactivated vaccine	Inactivated vaccine	Adenovirus vector vaccine	DNA vaccine
Protection against infection (dominant variant)	95.3% (Beta)	94.1% (NA)	64.3% (Incl. Alpha, Beta)	66.3% (Wuhan-H1 variant D614G, Beta, P.2 lineage)	79.34% (the wild-type strain)	72.51% (the wild-type strain)	50.4% (Brazil, NA); 83.5% (Turkey, NA); 65.9% (Chile, gamma and alpha)	63.7% (B.1.1.519, Alpha, the wild-type strain)	81.76% (Incl. Alpha, Delta)
Protection against severe illness (dominant variant)	97.2% (Beta)	~100% (NA)	94.2% (Incl. Alpha, Beta)	85% (Omicron)	~90% (NA)	~90% (NA)	83.7% (Brazil, NA); 100% (Turkey, NA); 87.5% (Chile, gamma and alpha)	96% (B.1.1.519, Alpha, the wild-type strain)	~100% (Incl. Alpha, Delta)

Source: Citi Research, NHC, US Centers for Disease Control and Prevention, The Lancet, NEJM

mRNA vaccines development in China

Among domestic mRNA COVID-19 vaccine players, Abogen/ Walvax, and StemiRNA were the first to initiate clinical trials in 2020/21. So far, no key clinical data has been provided from early developers. Both Abogen/Walvax and AIM Vaccine's Ph1 efficacy data showed the highest GMT for the mid-dose groups. Also, Abogen/Walvax's small-scale follow-up analysis of its Ph1 trial saw significant reduction in GMT against Omicron vs. the wild-type strain. StemiRNA has submitted IND for its 2nd-gen mRNA COVID-19 vaccine to The National Medical Products Administration (NMPA). In early Apr 2022, both CSPC and CanSinoBIO were granted IND approvals for their mRNA COVID-19 vaccines from NMPA. We expect more IND approvals to be granted to other domestic mRNA vaccines. Fosun/ BioNTech's mRNA COVID-19 vaccine is under regulatory review for market approval in China. We believe the government looks at mRNA vaccines as an innovative platform for long term development but not as a critical solution to the pandemic, due to availability of inactivated vaccines.

Figure 7. Comparison of mRNA COVID-19 vaccine candidates in China

Company	Product/ candidate	Status	Cohort	Efficacy results	Safety results
Abogen/ Walvax	ARCoV	Ph3 ongoing (China)	1-2 Doses of ARCoV in unvaccinated people	Ph1: GMT were 305/1293/2415/529/726 ELISA units in the 5/10/15/20/25 μg vaccine group 15 days after the second vaccination Follow-up analysis of Ph1: most samples (8/11, 72.7%) retained low but detectable neutralization activity against Omicron, with a 47-fold reduction in GMTs against Omicron compared to the WT strain (GMT 1440.87 to 30.67)	Ph1: Fever (5%/65%/85%/95%/100% in the 5/10/15/20/25 μg group), Grade 3 SAE (0%/15%/30%/35%/31% in the 5/10/15/20/25 μg group)
StemiRNA	mRNA COVID-19 vaccine	Ph1 completed (China)	In unvaccinated people	NA	Ph1: Good safety profile
	2nd-generation mRNA COVID-19 vaccine	IND submitted (China); Ph2 (Laos)	2-Dose of vaccines in unvaccinated people	NA	NA
AIM Vaccine	LVRNA009	Ph1 completed (China)	NA	Ph1 interim: the GMT on day 56 of the adult low-dose group, the adult medium-dose group and the adult high-dose group was 576.6, 1591.2 and 845.7 respectively	Ph1 interim: High safety and well toleration
CSPC	SYS6006	IND approved (China)	Booster shot after 2-dose of inactivated vaccine	Preliminary human data: >105 neutralizing antibody titer 14 days after vaccination of SYS6006 booster, vs. ~104 for inactivated vaccine booster	Preliminary human data: The AE after vaccination of SYS6006 is similar to BioNTech PhI in China; Grade 3 AE 8.6%
CanSinoBIO	COVID-19 Mrna vaccine	IND approved (China)	NA	Pre-clinical data: can induce high-titer neutralizing antibodies against multiple SARS-CoV-2 variants of concern identified by WHO	NA
Fosun/ BioNTech	BNT162b2	Under regulatory review (China)	Booster shot after 2-dose of BNT162b2	Global Ph3: A third dose of the BNT162b2 administered a median of 10.8 months after the second dose provided 95.3% efficacy against Covid-19 infection, vs. 2-dose BNT162b2 vaccine during a median follow-up of 2.5 months. (when the delta variant was the predominant)	Global Ph3: Pain at the injection site (12.9%), fatigue (7.2%), headache (5.0%), pyrexia (4.8%), myalgia (4.7%), chills (4.6%) No new safety signals were identified after dose 3.

Note: BNT162b2 highlighted in blue is imported. Others are developed by domestic players.
Source: Citi Research, Company data, The Lancet, Nature

Hong Kong may provide the template for a national solution

Boosters + Antigen tests + Oral agents, then open up…

The Omicron outbreak in HK provided valuable experience and data to China as a whole. Hong Kong could be the testing field with potential to scale up nationwide – use of boosters, antigen testing and small molecules (Paxlovid and molnupiravir) and a potential scenario of progressively reconnecting to the rest of the world.

Figure 8. Statistics on 5th Wave of COVID-19 in Hong Kong (from 31 Dec 2021 up till 25 Mar 2022 00:00)

6,749 / 0.6%
Cumulative No. / rate of death cases

1,098,998 / 14.9%
Cumulative No. / rate of reported cases

10,654
Current No. hospitalized cases

811,696 / 11.0%
Population covered by 1 vaccine/ coverage rate

3,065,562 / 41.5%
Population covered by 2 vaccine/ coverage rate

2,612,015 / 35.3%
Population covered by 3 vaccine/ coverage rate

4,000 paxlovid /12,000 molnupiravir
No. of oral chemical anti-COVID drugs prescribed

Rate of death cases is calculated by dividing the no. of cumulative death case by no. of cumulative reported cases

Source: Citi Research, Centre for Health Protection

Three doses of mRNA/inactivated vaccines prove highly effective against severe/fatal disease and mortality

A research on the vaccine effectiveness of two and three doses of BNT162b2 and CoronaVac against COVID-19 in Hong Kong was published by Hong Kong University recently (Link to the Research), which analyzed data from confirmed cases with mild/moderate (N=5,474), severe/fatal (N=5,294) and fatal (N=4,093) COVID-19 from Dec 31, 2021 to Mar 8, 2022. The research demonstrated that third doses of either BNT162b2 or CoronaVac provide substantial additional protection against severe COVID-19 and should be prioritized, particularly in elderly adults who received CoronaVac primary schedules.

Figure 9. COVID-19 vaccine effectiveness in Hong Kong

		VE [3] against mild/moderate disease		VE against severe/fatal disease		VE against mortality	
		20-60 years	≥60 years	20-60 years	≥60 years	20-60 years	≥60 years
Three doses	*BNT162b2*	*71.5*	71.6	98.5	98.0	99.4	98.1
	CoronaVac	*42.3*	50.7	98.5	97.9	n.a. [2]	98.3
2 doses	*BNT162b2*	*31.0*	n.a. [1]	95.2	89.6	96.4	92.3
	CoronaVac	*17.9*	n.a. [1]	91.7	72.2	94.0	77.4
1 dose	*BNT162b2*	37.4	n.a. [1]	85.0	65.6	93.7	73.0
	CoronaVac	*2.1*	n.a. [1]	60.9	40.4	65.4	51.2

(1) No evidence of protection based on a negative or very small positive point estimate and wide confidence intervals.
(2) Insufficient outcomes to estimate.
(3) Vaccine effectiveness was defined as (1-IRR)×100%. Incidence rate ratios (IRR) were estimated using a negative binomial rate model for the daily counts of cases adjusted for age group and calendar day including the logarithm of person-time as an offset term in the model to account for differing numbers at risk within each strata.

Source: Citi Research, medRxiv (Vaccine effectiveness of two and three doses of BNT162b2 1 and CoronaVac against COVID-19 in Hong Kong)

This result echoes recent studies that showed Omicron neutralization to be weak or undetectable after two doses of COVID-19 vaccines, either mRNA or inactivated vaccine. Per Nature Medicine, a booster is crucial for generating enough neutralizing antibody responses against the virus[2]. The research has meaningful implications to the current COVID situation in mainland China, in our view, as the population in both Hong Kong and China are predominantly infection-naïve and inactivated vaccines are widely available.

Figure 10. Baseline comparison: Mainland vs. HK

	China mainland			HK		
	age<60	**age>60**	**Overall**	**age<60**	**age>60**	**Overall**
% of unvaccinated	8%	16%	10%	10%	19%	12%
% of population with 1 doses	2%	4%	2%	11%	10%	11%
% of population with 2 doses	43%	28%	40%	44%	35%	41%
% of population with 3 doses	46%	52%	48%	35%	35%	35%
% of inactivated vaccine		>95%			~40%	

Note: Data as of Mar 25 2022, including population from all ages
Source: Citi Research, the State Council, Centre for Health Protection

China – future opening-up scenario

We refer to the results of the vaccine effectiveness study conducted by HKU and came up with the following scenario analysis to predict when China will open up. In our model, booster coverage and clinical use of effective anti-COVID-19 drugs are crucial in reducing the hospitalized and fatal cases. The "Prepared Open-up" scenario factors in optimistic booster coverage of 92% and broad usage of Pfizer's Paxlovid, assuming it can reduce hospitalization rate by 60%, which is broadly adopted in the "Immediate Open-up" scenario. Key assumptions and estimates are derived as follows:

[2] https://www.nature.com/articles/s41591-022-01727-0

Figure 11. China opening-up scenario analysis - key assumptions and estimates

Prepared Open-up – booster coverage at 92% and paxlovid widely used			
Key assumptions	**age<60**	**age>60**	**Total**
% of full vaccination	*92.0%*	*92.0%*	*92.0%*
% of booster coverage	*92.0%*	*92.0%*	*92.0%*
Infection rate of unvaccinated people	*30.0%*	*30.0%*	*30.0%*
Hospitalization rate of unvaccinated people (if infected)	*3.6%*	*5.0%*	*3.9%*
Fatality rate of unvaccinated people (if infected)	*0.2%*	*2.0%*	*0.5%*
Key estimates			
Est. total infection case (mn)	210.3	42.3	252.6
Infection rate as of total population	*18.3%*	*16.0%*	*17.9%*
Est. total severe/fatal case (mn)	1.1	0.4	1.5
Hospitalization rate as of total infected population	*0.5%*	*0.8%*	*0.6%*
Est. total fatal case (mn)	0.06	0.14	0.20
Fatality rate as of total infected population	*0.0%*	*0.3%*	*0.1%*

Immediate Open-up – booster coverage at 47% and paxlovid not widely used (current status)			
Key assumptions	**age<60**	**age>60**	**Total**
% of full vaccination	*89.6%*	*80.4%*	*87.9%*
% of booster coverage	*46.4%*	*52.4%*	*47.5%*
Infection rate of unvaccinated people	*30.0%*	*30.0%*	*30.0%*
Hospitalization rate of unvaccinated people (if infected)	*9.1%*	*12.6%*	*10.2%*
Fatality rate of unvaccinated people (if infected)	*0.5%*	*5.0%*	*1.9%*
Key estimates			
Est. total infection case (mn)	249.9	54.1	304.1
Infection rate as of total population	*21.8%*	*20.5%*	*21.5%*
Est. total severe/fatal case (mn)	3.9	2.5	6.4
Hospitalization rate as of total infected population	*1.6%*	*4.6%*	*2.1%*
Est. total fatal case (mn)	0.20	0.93	1.13
Fatality rate as of total infected population	*0.1%*	*1.7%*	*0.4%*

Source: Citi Research, NHC, the State Council, Vaccine effectiveness of two and three doses of BNT162b2 1 and CoronaVac against COVID-19 in Hong Kong

China scenario 1: Immediate Open-up – booster coverage at 47% and Paxlovid not widely used

Key assumptions for our base case are:

- Vaccine effectiveness of one, two and three doses is in-line with the vaccine effectiveness of CoronaVac demonstrated in the research conducted by HKU, e.g. infection rate for people aged <60 with two vaccines is (1-17.9%) of those unvaccinated.
- Infection rate of unvaccinated people at 30% for both group <60 and >60.
- Severe/Fatal rate (if infected) of unvaccinated people: 9.1% for group <60 and 12.6% for >60, an assumption based on placebo sub-group data in the ph3 clinical trial of molnupiravir in non-hospitalized patients[3]. According to the clinical

[3] Molnupiravir for Oral Treatment of COVID-19 in Nonhospitalized Patients, February 10, 2022, N Engl J Med 2022; 386:509-520, DOI: 10.1056/NEJMoa2116044

trial results, 9.1% and 12.6% of patients aged <60 / >60 in the placebo group were hospitalized or died.

- Fatality rate of unvaccinated people (if infected): 0.5% for group <60 and 5.0% for >60, vs. 0.1% and 3.8% in HK respectively for people not fully vaccinated as of Mar 25, 2022, incl. people unvaccinated or with one dose (vaccine effectiveness for people with one dose CoronaVac is 65.4% and 51.2% against mortality for group <60/>60 respectively).

Figure 12. China opening-up scenario analysis - Immediate Open-up

Key assumptions	age<60	age>60
Infection rate of unvaccinated people	*30.0%*	*30.0%*
Hospitalization rate of unvaccinated people (if infected)	*9.1%*	*12.6%*
Fatality rate of unvaccinated people (if infected)	*0.5%*	*5.0%*

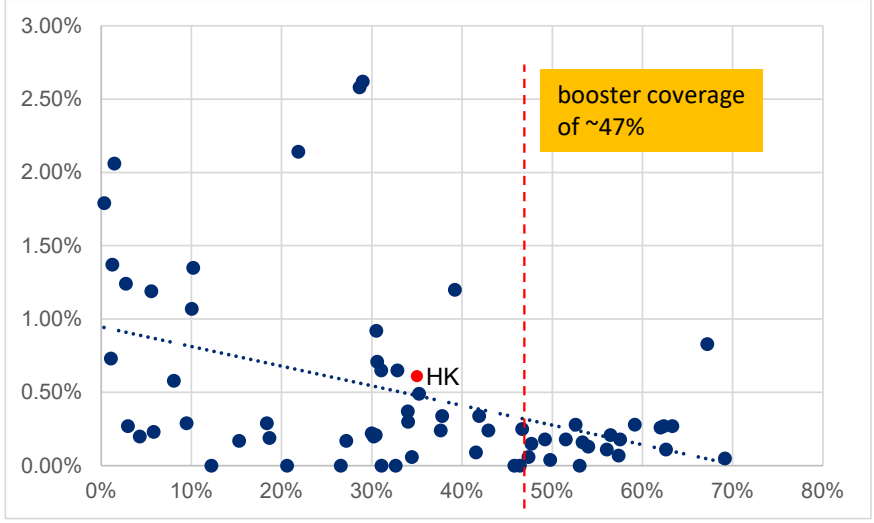
	age<60	age>60	Overall
Vaccination status*			
Population (mn)	**1,148**	**264**	**1,412**
As % of total population	*81.3%*	*18.7%*	*100%*
Population-fully vaccinated (mn)	**1,029**	**212**	**1,241**
Full vaccination rate	*89.6%*	*80.4%*	*87.9%*
Population-with three doses (mn)	533	138	671
As % of each age group	*46.4%*	*52.4%*	*47.5%*
Population-with 2 doses (mn)	496	74	570
As % of each age group	*43.2%*	*28.0%*	*40.3%*
Population- not fully vaccinated (mn)	**119**	**52**	**171**
As % of each age group	*10.4%*	*19.6%*	*12.1%*
Population- with 1 dose vaccine (mn)	24.2	10.6	34.8
As % of each age group	*2.1%*	*4.0%*	*2.5%*
Population- unvaccinated (mn)	95.0	41.3	136.3
As % of each age group	*8.3%*	*15.6%*	*9.7%*
Est. Infection			
Est. infection case- with three doses (mn)	92	20	113
Infection rate	*17.3%*	*14.8%*	*16.8%*
Est. infection case- with 2 doses (mn)	122	18	140
Infection rate	*24.6%*	*24.6%*	*24.6%*
Est. infection case- with 1 dose vaccine (mn)	7	3	10
Infection rate	*29.4%*	*29.4%*	*29.4%*
Est. infection case-unvaccinated (mn)	29	12	41
Infection rate	*30.0%*	*30.0%*	*30.0%*
Est. total infection case (mn)	**250**	**54**	**304**
Blended infection rate	*21.8%*	*20.5%*	*21.5%*
Est. Severe/Fatal			
Est. severe/fatal- with three doses (mn)	0	0	0
Hospitalization rate (if infected)	*0.1%*	*0.3%*	*0.2%*
Est. severe/fatal- with 2 doses (mn)	1	1	2
Hospitalization rate (if infected)	*0.8%*	*3.5%*	*1.1%*
Est. severe/fatal- with 1 dose vaccine (mn)	0	0	0
Hospitalization rate (if infected)	*3.6%*	*7.5%*	*4.8%*
Est. severe/fatal- unvaccinated (mn)	3	2	4
Hospitalization rate (if infected)	*9.1%*	*12.6%*	*10.2%*
Est. total severe/fatal case (mn)	**4**	**2**	**6**
Blended Hospitalization rate (if infected)	*1.6%*	*4.6%*	*2.1%*
Est. Fatal			
Est. fatal case-fully vaccinated with booster (mn)	0.01	0.02	0.03
Fatality rate (if infected)	*0.01%*	*0.09%*	*0.0%*
Est. fatal case- with 2 doses (mn)	0.04	0.21	0.24
Fatality rate (if infected)	*0.03%*	*1.14%*	*0.2%*
Est. fatal case- with 1 dose vaccine (mn)	0.01	0.08	0.09
Fatality rate (if infected)	*0.17%*	*2.46%*	*0.9%*
Est. fatal case- unvaccinated (mn)	0.14	0.62	0.77
Fatality rate (if infected)	*0.5%*	*5.0%*	*1.9%*
Est. total fatal case (mn)	**0.20**	**0.93**	**1.13**
Blended fatal rate (if infected)	*0.1%*	*1.7%*	*0.4%*

Note: Vaccination data as of Mar 25; For VE data not available, we assume same data as the other age group.

Source: Citi Research, the State Council, NHC, Vaccine effectiveness of two and three doses of BNT162b2 1 and CoronaVac against COVID-19 in Hong Kong

As the % of population with booster plays a key role in fatality rate estimate, we also conducted a correlation analysis between the % of population with booster and short-term case fatality rate (a ratio between confirmed deaths and confirmed cases, calculated as the ratio between the 7-day average number of deaths and the 7-day average number of cases 10 days earlier), which demonstrated a clear negative correlation between % of population with booster and short-term case fatality rate. Based on this chart, we see that a booster coverage of 47% also implies a fatality rate of ~0.4%.

Figure 13. Correlation between short-term case fatality rate and booster coverage



Note: CFR and booster coverage data from 66 countries are included. Data as of Mar 25. China data is not available.

Source: Citi Research, Our World in Data

China scenario 2: Prepared Open-up – booster coverage at 92% and Paxlovid widely used (assuming 60% reduction in hospitalization rate with Paxlovid in broad population)

We also conducted a scenario analysis for the case where: 1) booster coverage rises to 85% and 2) Paxlovid is widely used. It is worth noting that the assumption of our first scenario analysis reflects little impact from the clinical usage of Paxlovid as Hong Kong started to use Paxlovid from Mar 15. We assume 60% reduction in hospitalization rate of unvaccinated people with Paxlovid use in China to reflect a higher efficacy of Paxlovid in the broad population vs. current therapy.

Figure 14. China opening-up scenario analysis - Prepared Open-up (Booster coverage at 92% and Paxlovid widely used assuming 60% reduction in hospitalization rate with Paxlovid)

Key assumptions	age<60	age>60
% of full vaccination	*92.0%*	*92.0%*
% of booster coverage	*92.0%*	*92.0%*
% of population with 1 vaccine	*0.0%*	*0.0%*
Infection rate of unvaccinated people	*30.0%*	*30.0%*
Hospitalization rate of unvaccinated people (if infected)	*3.6%*	*5.0%*
Fatality rate of unvaccinated people (if infected)	*0.2%*	*2.0%*

	age<60	age>60	Overall
Vaccination status*			
Population (mn)	1,148	264	1,412
As % of total population	*81.3%*	*18.7%*	*100.0%*
Population-fully vaccinated (mn)	**1,056**	**243**	**1,299**
Full vaccination rate	*92.0%*	*92.0%*	*92.0%*
Population-with 3 doses (mn)	1,056	243	1,299
As % of each age group	*92.0%*	*92.0%*	*92.0%*
Population-with 2 doses (mn)	-	-	-
As % of each age group	*0.0%*	*0.0%*	*0.0%*
Population- not fully vaccinated (mn)	**92**	**21**	**113**
As % of each age group	*8.0%*	*8.0%*	*8.0%*
Population- with 1 dose vaccine (mn)	-	-	0.0
As % of each age group	*0.0%*	*0.0%*	*0.0%*
Population- unvaccinated (mn)	91.8	21.1	112.9
As % of each age group	*8.0%*	*8.0%*	*8.0%*
Est. Infection			
Est. infection case- with 3 doses (mn)	183	36	219
Infection rate	*17.3%*	*14.8%*	*16.8%*
Est. infection case- with 2 doses (mn)	-	-	-
Infection rate	*24.6%*	*24.6%*	*-*
Est. infection case- with 1 dose vaccine (mn)	-	-	-
Infection rate	*29.4%*	*29.4%*	*-*
Est. infection case-unvaccinated (mn)	28	6	34
Infection rate	*30.0%*	*30.0%*	*30.0%*
Est. total infection case (mn)	**210**	**42**	**253**
Blended infection rate	*18.3%*	*16.0%*	*17.9%*
Est. Severe/Fatal			
Est. severe/fatal- with 3 doses (mn)	0	0	0
Hospitalization rate (if infected)	*0.1%*	*0.1%*	*0.1%*
Est. severe/fatal- with 2 doses (mn)	-	-	-
Hospitalization rate (if infected)	*0.3%*	*1.4%*	*-*
Est. severe/fatal- with 1 dose vaccine (mn)	-	-	-
Hospitalization rate (if infected)	*1.4%*	*3.0%*	*-*
Est. severe/fatal- unvaccinated (mn)	1	0	1
Hospitalization rate (if infected)	*3.6%*	*5.0%*	*3.9%*
Est. total severe/fatal case (mn)	**1**	**0**	**1**
Blended Hospitalization rate (if infected)	0.5%	0.8%	0.6%
Est. Fatal			
Est. fatal case-fully vaccinated with booster (mn)	0.01	0.01	0.02
Fatality rate (if infected)	*0.00%*	*0.03%*	*0.0%*
Est. fatal case- with 2 doses (mn)	-	-	-
Fatality rate (if infected)	*0.01%*	*0.46%*	*-*
Est. fatal case- with 1 dose vaccine (mn)	-	-	-
Fatality rate (if infected)	*0.07%*	*0.98%*	*-*
Est. fatal case- unvaccinated (mn)	0.06	0.13	0.18
Fatality rate (if infected)	*0.2%*	*2.0%*	*0.5%*
Est. total fatal case (mn)	**0.06**	**0.14**	**0.20**
Blended fatal rate (if infected)	*0.0%*	*0.3%*	*0.1%*

Note: Vaccination data as of Mar 25; For VE data not available, we assume same data as the other age group.

Source: Citi Research, the State Council, NHC, Vaccine effectiveness of two and three doses of BNT162b2 1 and CoronaVac against COVID-19 in Hong Kong

Sensitivity analysis

We run a sensitivity analysis on the key assumptions of our model: infection rate and hospitalization rate of unvaccinated people aged >60 for three scenarios:

Scenario 1 (equivalent to Immediate Open-up of previous section): booster coverage at 47% and Paxlovid not widely used

Figure 15. Sensitivity analysis on infection rate and hospitalization rate of unvaccinated people

Est. total fatal case (mn)		Infection rate of unvaccinated people				
		10%	20%	30%	40%	50%
Hospitalization rate of unvaccincated people aged >60	2.0%	0.06	0.12	0.18	0.24	0.30
	5.0%	0.15	0.30	0.45	0.60	0.75
	12.6%	0.38	0.75	1.13	1.50	1.88
	15.0%	0.45	0.89	1.34	1.79	2.24
	20.0%	0.60	1.19	1.79	2.38	2.98

Assuming the relative ratio between fatality rate and hospitalization rate for group <60 and group >60 remains unchanged respectively

Source: Citi Research

Scenario 2: booster coverage at 47% and Paxlovid widely used (assuming 60% reduction in hospitalization rate with Paxlovid in broad population)

Figure 16. Sensitivity analysis on infection rate and hospitalization rate of unvaccinated people (with Paxlovid in clinical use)

Reduction in hospitalization rate with paxlovid in use		60%				
Est. total fatal case (mn)		Infection rate of unvaccinated people				
		10%	20%	30%	40%	50%
Hospitalization rate of unvaccincated people aged >60	0.8%	0.02	0.05	0.07	0.10	0.12
	2.0%	0.06	0.12	0.18	0.24	0.30
	5.0%	0.15	0.30	0.45	0.60	0.75
	6.0%	0.18	0.36	0.54	0.72	0.89
	8.0%	0.24	0.48	0.72	0.95	1.19

Assuming the relative ratio between fatality rate and hospitalization rate for group <60 and group >60 remains unchanged respectively.

Source: Citi Research

Scenario 3: (equivalent to Prepared Open-up of previous section): booster coverage at 92% and Paxlovid widely used (assuming 60% reduction in hospitalization rate with Paxlovid in broad population)

Figure 17. Sensitivity analysis on infection rate and hospitalization rate of unvaccinated people (with Paxlovid in clinical use and booster coverage up to 92%)

Reduction in hospitalization rate with paxlovid in use		60%				
Booster coverage		92%				
Est. total fatal case (mn)		Infection rate of unvaccinated people				
		10%	20%	30%	40%	50%
Hospitalization rate of unvaccincated people aged >60	0.8%	0.01	0.02	0.03	0.04	0.05
	2.0%	0.03	0.05	0.08	0.11	0.13
	5.0%	0.07	0.13	0.20	0.27	0.34
	6.0%	0.08	0.16	0.24	0.32	0.40
	8.0%	0.11	0.21	0.32	0.43	0.53

Assuming the relative ratio between fatality rate and hospitalization rate for group <60 and group >60 remains unchanged respectively.

Source: Citi Research

Note that many factors can affect the accuracy of our model/estimates, like:

- Overestimate of fatality rate on lack of testing capability
- Rising accumulative infection rate likely affecting infection rate
- Shortage of available medical resources
- Waning of booster effectiveness
- The level of population aging

Timing of China's Prepared Opening-up

China's opening-up to rest of the world

From our discussion with experts and personnel familiar with government policies, social stability likely remains the highest priority in China before the National Congress which is set to happen in October/November 2022. We predict early 2023 to be the earliest for China to start reconnecting more progressively to the rest of the world, with the following conditions: 1) that effective and low cost therapeutics are in stock sufficiently to tackle imported future waves and 2) prompt and low cost early screening mechanisms are implemented nationwide, at different levels of municipals. We believe the mass availability of oral agents (small molecule) drugs and Antigen testing kits to be the solution.

Small Molecules + Antigen Tests; Policy Evolutions

Due to the current unexpected wave of Omicron infections, the 9th version of the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (新型冠状病毒肺炎诊疗方案) updated in Mar 2022 had key adjustments on:

1) PCR test results are still the primary standard for positive confirmed cases, and antigen tests are used as a supplement

2) Paxlovid is recommended as the first small molecule for COVID-19 treatment

3) Mild cases no longer require treatment in hospitals but are required to undergo centralized quarantine

4) Lower RT-PCR tests use Ct (Cycle threshold) cutoffs of 35 cycles from previous 40 cycles.

Figure 18. Version 9 vs. Version 8: Amendment in Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia

Item	Key amendment in Version 9	Citi comment
Case confirmation	COVID-19 nucleic acid detection as the prior standard for case confirmation, while antigen detection as a supplementary tool.	Antigen test is supplement for confirmed cases
Hospitalization standards	Mild cases are no longer required for treatment in hospitals but required for centralized quarantine; Moderate and severe cases should be isolated and treated at designated hospitals	Adjustment on quarantine policy to deal with hundreds of mild cases and leaving hosptalization resources for moderate to severe cases
Treatment	Adding Paxlovid and amubarvimab/ romlusevimab to protocol; Adding acupuncture to protocol; TCM treatmemt is recommended	NAb and oral drugs for COVID-19 are firstly approved and recommended as treatment
Negative COVID-19 test standard after treatment	The threshold for producing a negative COVID-19 test drops the cycle threshold (Ct) value from 40 to 35	Lower cycle threshold (CT) value aims to shortern the hospitalization period based on previous clinical experience
Quarantine requirement after discharged from hospital	14-day centralized quarantine revised to 7-day home quarantine after discharged from hospital	More reasonable quarantine policy after discharging from hospital

Source: Citi Research, NHC

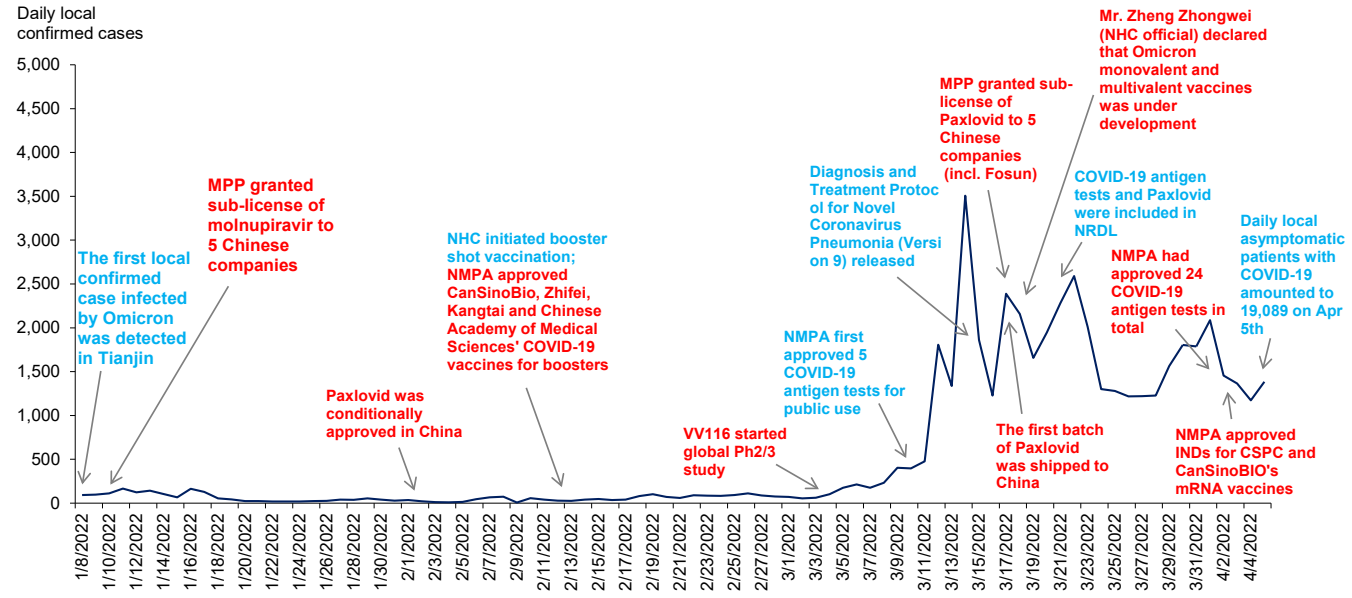
Outbreak/policy timeline

We summarize the following key timeline for regulatory break-through with regard to local pandemic outbreaks:

- On Jan 8th, the first local confirmed case infected by Omicron was detected in Tianjin. On the same day, mainland China reported 92 local confirmed cases.
- On Feb 11th, China NMPA granted conditional approval to Pfizer's oral COVID-19 drug Paxlovid (nirmatrelvir and ritonavir tablets) to treat adults with mild to moderate COVID-19 and with high risk of progressing to a severe condition.
- On Feb 19th, NHC initiated booster shot vaccination; NMPA approved CanSinoBio, Zhifei, Kangtai and Chinese Academy of Medical Sciences' COVID-19 vaccines for boosters.
- On Mar 11th, Changchun was locked down for compulsory universal testing after local pandemic outbreak in colleges.
- On Mar 12th, local confirmed cases amounted to 1,807, a peak during the past 2 years.
- On Mar 13th, affected by recent local cases that emerged from Hong Kong, Shenzhen announced to lock down for 7 days for compulsory universal testing.
- On Mar 14th, Jilin issued a notice to prohibit inter-region travel. On the same day, daily confirmed cases peaked at 3,507.
- On Mar 15th, Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Version 9) was released with a few major changes vs. Version 8.

- On Mar 19th, Mr. Zheng Zhongwei (NHC Scientific Development Center Director) declared that Omicron monovalent and multivalent vaccines was under development.
- On Mar 21th, COVID-19 antigen tests and Paxlovid were included in NRDL.
- On Mar 27th, due to significantly rising local confirmed cases, Shanghai decided to lock down the whole city separately by Pudong and Puxi for compulsory universal testing.
- On Mar 29th, Shanghai government issued the Notice on Several Policies and Measures for Shanghai to Fight against the Epidemic and Help Enterprises Promote Development (上海市全力抗疫情助企业促发展的若干政策措施) to encourage COVID-19 vaccine and innovative drug development.
- On Apr 3rd and Apr 4th respectively, CSPC and CanSinoBIO announced that their COVID-19 mRNA vaccines were granted IND approval by NMPA to start clinical trials.

Figure 19. Omicron wave evolution in Mainland China



Note: Key epidemic events or policy break-through are highlighted in blue; drug/vaccine/COVID-19 antigen tests progresses are highlighted in red.
Source: Citi Research, CEIC, NHC, NMPA, CDE, MPP, Company data

COVID-19 Therapeutics in China

China currently has 3 types of drugs for COVID-19 treatment: 1) small molecule, 2) TCM and 3) Neutralizing antibody. Even if China has approved NAb (Brii196/Brii198) and small molecule drug (Paxlovid) for COVID-19. They are not widely used in most clinical treatment cases. Based on our communication with frontline doctors for COVID-19 treatment, symptomatic and supportive treatment is essential and the main treatment for COVID-19 in China. We think more small molecule drugs will be used in COVID-19 treatment when they deliver good clinical results and prove effective against COVID-19.

Small molecule drugs

So far, Pfizer has only supplied 20K boxes of Paxlovid to China which does not appear enough for the wave of COVID-19 cases. We see many domestic candidates' anti-COVID small molecule drugs in the pipeline.

- We list key COVID-19 small molecule drugs/ candidates developed by Chinese companies in the table below. Junshi's VV116 and Geniune Biotech's Azvudine are at the later stage:

Figure 20. Key COVID-19 small molecule drugs/ candidates developed by Chinese companies

Mechanism	Company	Ticker	Drug/ candidate	Delivery	Status
RdRp	Chinese Academy of Sciences/ Junshi/ Vigonvita	1877 HK/ 688180 CH	VV116	Oral	EUA (Uzbekistan), Ph3 (Global)
	Geniune Biotech	-	Azvudine	Oral	Ph3 (Brazil)
	Ascletis	1672 HK	ASC10	Oral	Pre-IND
	Kexing Biopharm/ Antaiwei	688136 CH	SHEN26	Oral	Pre-IND
3CL	Frontier Biotech	688221 CH	FB2001	IV	Ph1 (US, CH)
	Ascletis	1672 HK	ASC11	Oral	Pre-IND
	Simcere	2096 HK	SIM0417	Oral	Pre-IND
	Zhongsheng Pharma	002317 CH	RAT003, RAT004	Oral	Pre-IND
	Singapore Experimental Drug Development Centre / Everest	1952 HK	EDDC-2214	Oral	Pre-IND
	Cosunter	300436 CH	GST-HG171	Oral	Pre-IND
	Chinese Academy of Sciences/ Junshi/ Vigonvita	1877 HK/ 688180 CH	VV993	Oral	Pre-IND
AR	Kintor	9939 HK	Proxalutamide	Oral	Ph3 (US) failed

Source: Citi Research, Company data, clinicaltrial.gov

- Paxlovid - the only approved small molecule drug in China

On Feb 11th, China NMPA granted conditional approval to Pfizer's small molecule drug Paxlovid (nirmatrelvir and ritonavir tablets) to treat adults with mild to moderate COVID-19 and with high risk of progressing to a severe condition. Paxlovid is priced at Rmb2,300/carton for a full 5-day treatment, and became reimbursable from Mar 21st.

Distribution of Paxlovid

On March 17th 2022, 22:30 China time, 21,200 cartons of Paxlovid (Nimatevir/Ritonavir) were inspected and released by the Shanghai Waigaoqiao Free Trade Zone Customs with import customs clearance, and then quickly shipped to medical institutions nationwide.

COVID-19 neutralizing antibody

On Dec 8th 2021, Brii Bio's Amubarvimab/Romlusevimab combination received NMPA approval as the first COVID-19 neutralizing antibody combination therapy in China to treat adults with mild to moderate COVID-19 and with high risk of progressing to a severe condition.

China conditionally approved Brii's Neutralizing antibody combo Brii196/Brii198 to treat adults with mild to moderate COVID-19 and with high risk of progressing to a severe condition in Dec 2021, before the Omicron outbreak in China. Separately, the U.S. Department of Health and Human Services has paused the distribution of COVID-19 antibody treatments from Regeneron's REGEN-COV (casirivimab and

imdevimab), Eli Lilly/ Junshi's bamlanivimab and etesevimab, as they are likely ineffective against the Omicron coronavirus variant, according to the US FDA.

We list key COVID-19 large molecule drugs/ candidates developed by Chinese companies in the table below. We noted a few clinical trials withdrawn due to the spread of Omicron.

Figure 21. Key COVID-19 large molecule drugs/ candidates developed by Chinese companies

Company	Ticker	Drug/ candidate	Status
Brii	2137 HK	BRII-196/BRII-198	EUA (CH)
Junshi	1877 HK/ 688180 CH	JS016	EUA with LY-CoV555 (EU, US, etc. 15+ countries), Ph3 (CH)
Junshi	1877 HK/ 688180 CH	JS026	Ph1 (CH)
BeiGene/ Singlomics/ Beijing University	BGNE US/ 688235 CH/ 6160 HK	BGB-DXP593	Ph2 (global) completed
BeiGene/ Singlomics/ Beijing University	BGNE US/ 688235 CH/ 6160 HK	BGB-DXP-604	Ph1 (AU) completed
Mabwell/ SinoCellTech	688062 CH/ 688520 CH	SCTA01	Ph2/3 (global)
Mabwell/ SinoCellTech	688062 CH/ 688520 CH	SCTA01 + SCTA01C	Ph1/2 withdrawn
Mabwell	-	MW33	Ph2 (CH)
CNBG/ Singlomics	-	DXP-604	Ph2 (CH)
Luye	2186 HK	LY-CovMab	Ph2 (CH, US) planned
Henlius	2696 HK	HLX70	Ph1 (US) withdrawn
Henlius	2696 HK	HLX71	Ph1 (US) completed
Jemincare	-	JMB2002	Ph1 (CH) completed
Chinese Academy of Sciences/ CNBG	-	2B11	Ph1 (CH)

Source: Citi Research, Company data, clinicaltrial.gov

TCM for COVID-19 treatment

According to the State Council, based on previous clinical experience, Traditional Chinese Medicines help to reduce clinical symptoms of COVID-19. The 9th version of Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia includes TCM treatment cover all disease types, from mild to critical. Recommended TCM interventions include 1) TCM formulas (e.g. Qingfei Paidu decoction and Xuanfei Baidu decoction), 2) Chinese patented medicine (e.g. Lianghua Qingwen capsules and Jinhua Qinggan granules), 3) renowned TCM (e.g. Angong Niuhuang pills and Suhexiang pills), and 4) TCM injections (e.g. Xuebijing injection and Shenmai injection).

Figure 22. TCM recommended for COVID-19 treatment in China

Disease type	Listed companies related	Ticker	Recommended TCM
Medical observation for close contacts	Taiji Group, Yiling Pharmaceutical	600129 CH, 002603 CH	Huoxiang Zhengqi granules/pills/shui/oral liquids, Jinhua Qinggan granules, Lianhua Qingwen capsules/ granules, Shufeng Jiedu granules
Mild, moderate, severe	CR999, Pianzaihuang	000999 CH, 600436 CH	Qingfei Paidu decoction/ granules
Mild	Yiling Pharmaceutical	002603 CH	Jinhua Qinggan granules, Lianhua Qingwen capsules/ granules
Moderate	Buchang, Yiling Pharmaceutical	603858 CH, 002603 CH	Xuanfei Baidu decoction/ granules, Jinhua Qinggan granules, Lianhua Qingwen capsules/ granules
Severe	CTCM, Chase Sun Pharma, Kangyuan, Shanghai Kaibao, Dali Pharma, Tasly	570 HK, 300026 CH, 600557 CH, 300039 CH, 603963 CH, 600535 CH	Huashi Baidu decoction/ granules, Xiyanping injection, Xuebijing injection, Reduning injection, Tanreqing injection, Xingnaojing injection
Critical	Beijing Tongrentang, Taiji Group, Guangyuyuan, Baiyunshan, Pianzaihuang, Chase Sun Pharma, Kangyuan, Shanghai Kaibao, Dali Pharma, Tasly, CR999, Shineway	600085 CH, 600129 CH, 600771 CH, 874 HK/600332 CH, 600436 CH, 300026 CH, 600557 CH, 300039 CH, 603963 CH, 600535 CH, 000999 CH, 2877 HK	Suhexiang pills, Angong Niuhuang pills, Xuebijing injection, Reduning injection, Tanreqing injection, Xingnaojing injection, Canfu injection, Shengmai injection, Shenmai injection

Source: Citi Research, NHC, Company data

China CDMO players potentially benefiting from increasing demand for Paxlovid

Notably, a few Chinese CDMO players (Wuxi AppTec, Asymchem and Porton) received substantial orders in the past few months, while most of them did not disclose which client or which product it was related to.

Figure 23. Recent CDMO orders

Ticker	China CDMO	Potential order size (Rmb bn)	Announcement date
603259.SS/2359.HK	**WuXi AppTec (STA)**	**n.a.**	
002821.SZ/6821.HK	**Asymchem**	**9.3**	
	Order 1	*2.7*	11/29/2021
	Order 2	*3.1*	11/17/2021
	Order 3	*3.5*	2/21/2022
300363.SZ	**Porton**	**5.7**	
	Order 1	*4.3*	2/11/2022
	Order 2	*1.4*	11/30/2021

Note: using USD|CNY=6.35
Source: Citi Research, Company data

China pharma manufacturers granted sub-licenses from MPP (Medicine Patent Pool)

MPP for Paxlovid

On Mar 17th, 35 generic manufacturers (spanning 12 countries) have been granted the sub-licenses from MPP to facilitate affordable access to Paxlovid in 95 low- and - middle-income countries (LMICs). Among these companies, 5 Chinese companies are granted the sub-licenses, including 1 focusing on producing raw ingredients and 4 on producing both raw ingredients and the finished drug of nirmatrelvir, co-packaged with ritonavir. Fosun Pharma obtained the sub-license to manufacture both raw ingredients and the finished drug.

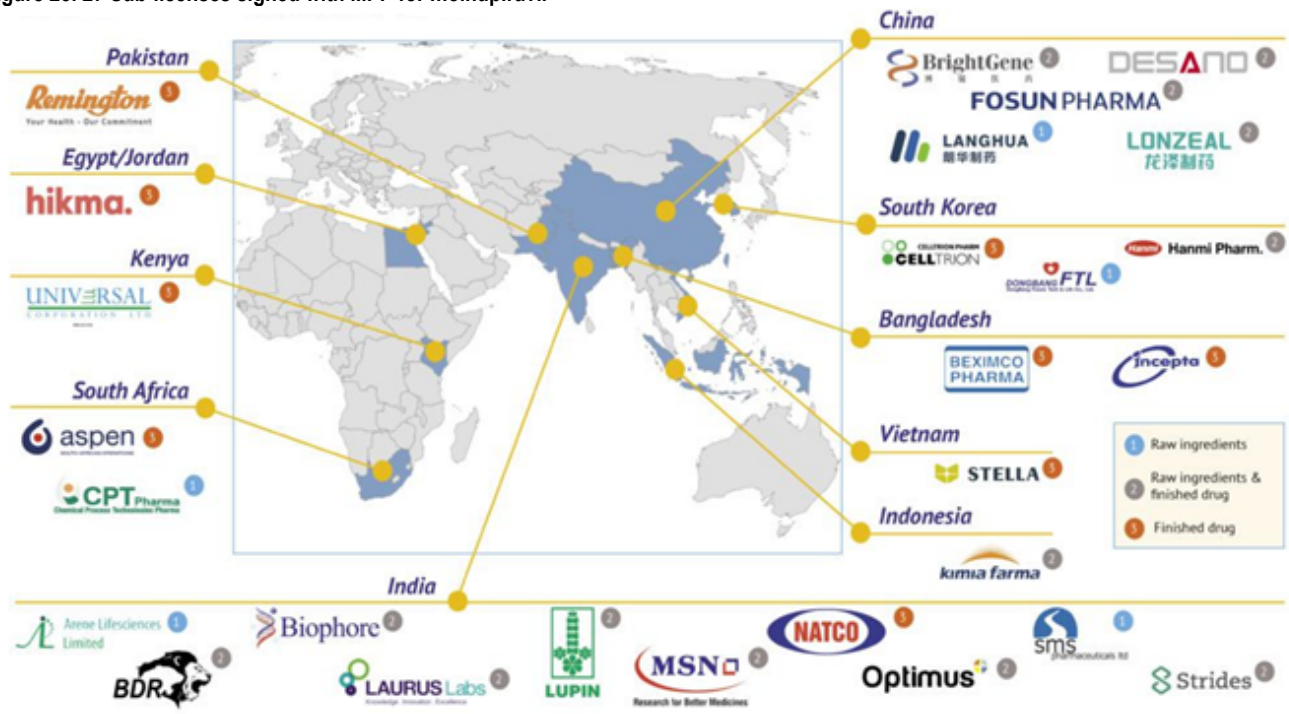
Figure 24. 35 Sub-licenses signed with MPP for nirmatrelvir

Source: MPP

MPP for Molnupiravir

On Jan 20th, 27 generic manufacturers (spanning 11 countries) have been granted the sub-licenses from MPP to facilitate affordable access to molnupiravir in 105 low- and - middle-income countries (LMICs). Among these companies, 5 Chinese companies are granted the sub-licenses, including 1 focusing on producing raw ingredients and 4 on producing both raw ingredients and the finished drug. Fosun Pharma obtained the sub-license to manufacture both raw ingredients and the finished drug.

Figure 25. 27 Sub-licenses signed with MPP for molnupiravir



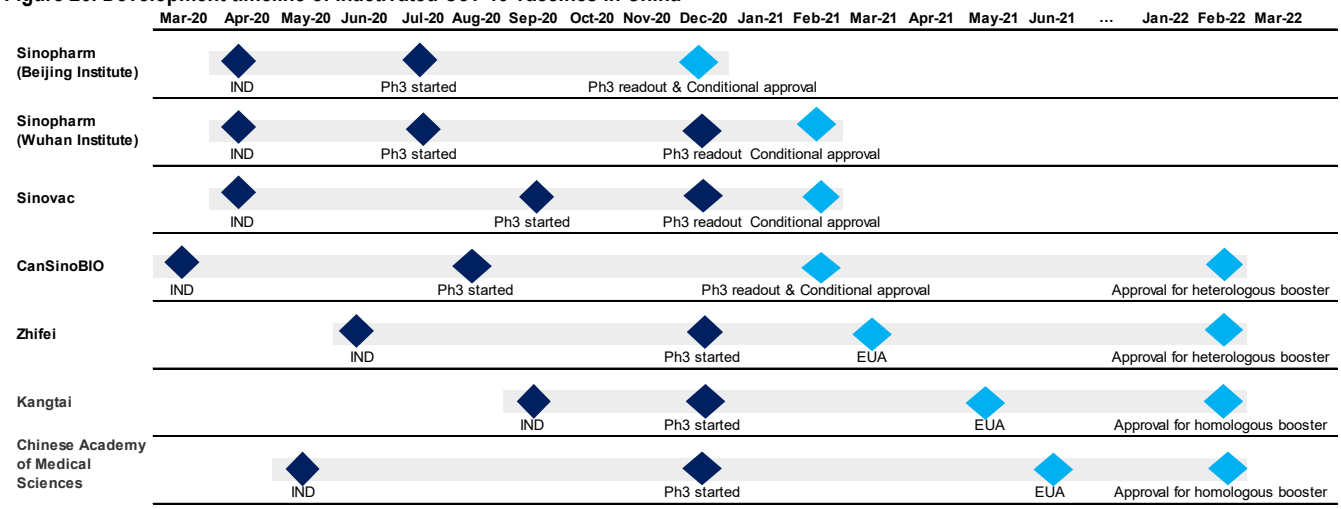
Source: MPP

COVID-19 vaccines

7 Approved domestic COVID-19 vaccines

As of Mar 2022, in total 7 domestic COVID-19 vaccines have been approved in China. Out of the first 4 launched vaccines, 3 are inactivated vaccines from Sinopharm (Beijing Institute), Sinopharm (Wuhan Institute), and Sinovac, and 1 adenovirus vector vaccine from CanSinoBIO. Most of them started IND in Mar/Apr 2020 as soon as the pandemic occurred, and it took them less than a year to gain market approvals in YE20/early 2021. Latecomers such as Zhifei (DNA vaccine), Kangtai (inactivated vaccine), and Chinese Academy of Medical Sciences (inactivated vaccine) filed for INDs after May 2020, and gradually obtained market approvals in Mar-Jun 2021. In Feb 2022, along with the formal booster shot vaccination program initiated by NHC, NMPA approved CanSinoBio, Zhifei, Kangtai and Chinese Academy of Medical Sciences' COVID-19 vaccines for boosters.

Figure 26. Development timeline of Inactivated Cov-19 vaccines in China



Source: Citi Research, NHC

mRNA COVID-19 vaccines under development/ regulatory review

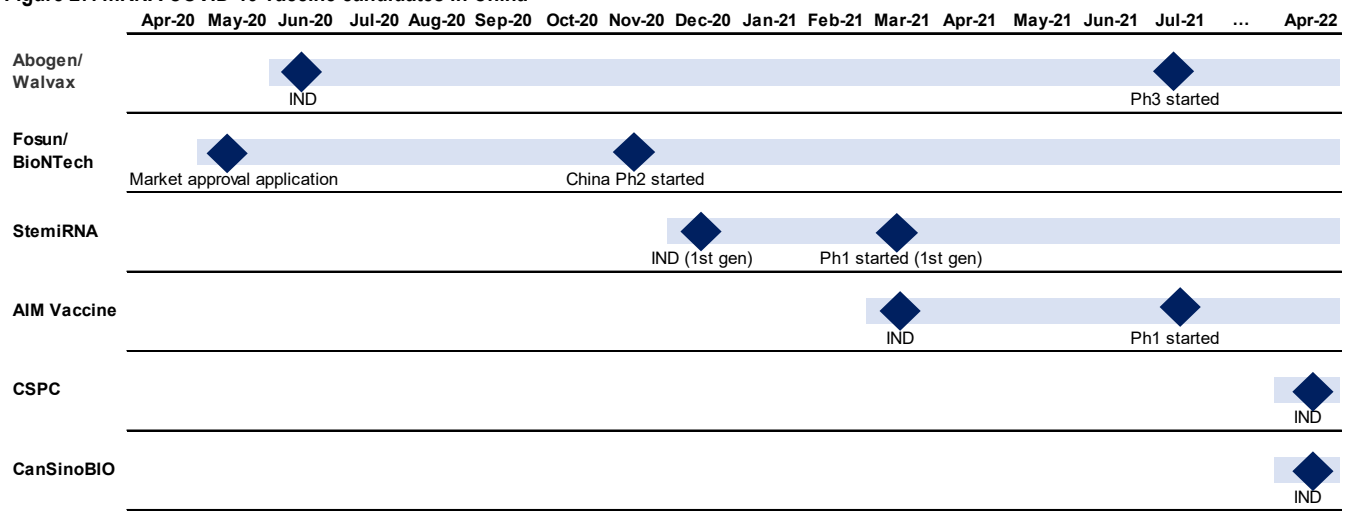
For mRNA COVID-19 vaccine candidates in China, Abogen/ Walvax's ARCoV started Ph3 trial in China in Jul 2021, and Fosun / BioNTech's Comirnaty started registrational Ph2 trial in China in Nov 2020. StemiRNA's 2nd-generation mRNA COVID-19 vaccine is undergoing Ph2 trial in Laos and IND application was submitted to China NMPA. AIM Vaccine also completed Ph1 in China.

In early Apr 2022, both CSPC and CanSinoBIO were granted IND approvals for their mRNA COVID-19 vaccines from NMPA. We expect more IND approvals to be granted to other domestic mRNA vaccines.

CSPC plans to conduct official Ph1/2 trial for its mRNA COVID-19 vaccine in unvaccinated people in selected provinces, then potentially booster trials in China and overseas. Preliminary human data showed >10^5 neutralizing antibody titer 14 days after vaccination of SYS6006 booster, vs. ~10^4 for inactivated vaccine booster; the AE after vaccination of SYS6006 is similar to BioNTech Ph1 in China. Pre-clinical animal data also showed SYS6006's protection against both Delta and Omicron.

Everest also licensed in PTX-COVID19-B from Providence Therapeutics, which is undergoing a global head-to-head Ph2 primary vaccine trial against Comirnaty. A Ph3 booster vaccine trial is to be initiated in multiple Asian regions jointly by Everest and Providence in mid-2022. Everest aims to further communicate with NMPA on boosting trial design in China.

Figure 27. mRNA COVID-19 vaccine candidates in China



Source: Citi Research, NHC

COVID-19 antigen test kits

Initially approved five in China in Mar 2022, but now the market is crowded with >20 players

As of Apr 2nd 2022, NMPA had approved 24 COVID-19 antigen tests. On Mar 11th and 12th, China NMPA approved the first 5 COVID-19 antigen tests for public use by removing previous restriction on use only by well-trained personnel under certain circumstances.

On Mar 11th, NHC announced the Notice on Application Plan of COVID-19 Antigen Tests (Trial Version). The Notice stipulates that COVID-19 antigen tests are suitable for 1) the first five days patients are developing COVID-19-like symptoms; 2) quarantined personnel; 3) residents with self-testing needs. In the face of rising local cases recently, the State Council COVID-19 Response Team decided on a new strategy of "screening by antigen tests, diagnosis by nucleic acid tests". Nucleic acid testing remains the basis for COVID-19 infection confirmation, and antigen testing would be a complementary tool. The antigen test kits are available at pharmacies and e-commerce platforms.

Figure 28. The first approved COVID-19 antigen tests in China

Ticker	Company	Approval date
NA	Beijing Savant Biotechnology	3/11/2022
300482.SZ	Guangzhou Wondfo Biotech	3/12/2022
NA	Beijing Jinwofu Bioengineering Technology	3/12/2022
300676.SZ	BGI	3/12/2022
688105.SS	Nanjing Vazyme Biotech	3/12/2022

Source: Citi Research, NMPA, Company data

Investment Read-through

- Stockpiling imported/domestic oral (small molecule) drugs is key to re-opening. We project China's total order of small molecules to be 55mn courses (March 2022 to June 2023), composed of 18mn/37mn imported/domestic products.
- We believe the government is looking at mRNA vaccines as the innovative platform for long-term development, not only as a solution during the pandemic, due to the availability of inactivated vaccines.
- We see China's COVID-19 vaccine market growing further, mainly driven by rising booster coverage (currently at 46.4% for those aged <60 and 52.4% for those aged >60).
- Among our top- picks: Junshi will benefit from potentially the first launch of a domestic potent COVID oral agent (VV116). CSPC's IND mRNA vaccine, if approved, could be a popular booster choice in 2023, on diminished hopes of importing foreign vaccines. Wuxi Apptec will continue to benefit from small molecule orders, such as for Paxlovid, in our view.

Shanghai Junshi Biosciences (1877.HK)

Eyes on oral anti-COVID drug – VV116

Mgmt plan to file NDA in June/July for VV116 for moderate-to-severe indication in China and launch in 2H22. Junshi is a front runner in oral-COVID drug development. Junshi's VV116 (JT001), an oral remdesivir derivative against COVID, is co-developed by Chinese Academy of Sciences/ Junshi/ Vigonvita. Currently VV116 is undergoing two global ph2/3 clinical trials for patients with 1) moderate-to-severe COVID-19 (~640 est. pts enrolment, placebo as comparator) and 2) mild-to-moderate COVID-19 (~2,000pts est. pts enrolment, Favipiravir as comparator) respectively. Both trials set % of the participants with progression to critical COVID-19 or death as primary endpoints. Besides, Junshi's VV993 (JT003), a pre-IND 3CLpro inhibitor candidate, targets to enter clinical trials in 3 months.

Figure 29. vv116 is undergoing two ph3 trials

Indication	Stage	Estimated enrollment	Age	COVID-19 vaccination	Comparator	Primary endpoint	Secondary endpoint	Region	Study start date	Filing plan
Moderate-to-severe COVID-19	Ph3	640	18+ Years	Excluded	Favipiravir	% of the participants who have progression to critical COVID-19 or death from any cause, through Day 29	1. AEs and SAEs 2. Progress to critical COVID-19; Death from any cause 3. Death from any cause 4. The change of Chest CT scan 5. SARS-CoV-2 clearance	Uzbekistan, China	8-Mar-2022	Jun/Jul 2022 in China
Mild-to-moderate COVID-19	Ph2/3	2,000	18+ Years	Partially excluded	Placebo	% of the participants who have progression to severe/critical COVID-19 or death from any cause, through Day 29	1. AEs and SAEs 2. Progress to critical COVID-19; Death from any cause 3. The change of WHO 11-point ordinal outcome scale 4. The change of Chest CT scan 5. SARS-CoV-2 viral load 6. SARS-CoV-2 clearance 7. The plasma concentration	Multiple regions incl. China, South East Asia, East Europe, South America	5-Mar-2022	-

Source: Citi Research, ClinicalTrials.gov

Small Molecules Analysis

The following is our analysis of COVID-19 small molecule drugs in China.

We estimate the small molecule market size at Rmb1.6bn/11.8bn in 2022/23E, based on the following assumptions:

- Only adult patients are eligible to take small molecule drugs, based on the approved indication of Paxlovid in China.
- ~15% of infected patients will take small molecule drugs (please refer to the following figures for detailed infected population estimate). The ratio is on par with the US data in 1Q22: ~4mn small molecule drugs (incl. Paxlovid and molnupiravir) were distributed in the US per CDC for ~28mn patients infected.
- Treatment rate of small molecule drugs is 55% in 2022E considering limited Paxlovid production in the near-term and 85% in 2023E on improving drug supply given ramp-up of production capacity and approval of domestic drugs.
- Market shares of domestic drugs at 23%/93% in 2022E/2023E.

- Price discounts at 75%/80% in 2022E/2023E vs. current Rmb 2,300 per course for Paxlovid in China.

Figure 30. Est. market size of domestic small molecule drugs in China in 2022E/2023E

	2022E	2023E
Est. total infected case for population aged >18, <60 (mn)	105	156
Infection rate	*12.62%*	*18.93%*
Est. total infected case for population aged >60 (mn)	32	50
Infection rate	*12.02%*	*18.04%*
Est. total infected case for population aged >18 (mn)	**137**	**206**
% of infected cases as of total population	*12.47%*	*18.70%*
Est. total eligible population aged >18, <60(mn)	13	19
% of patients with risk progressing to critical illness (if infected)	*12.43%*	*12.43%*
Est. total eligible population aged >60(mn)	9	13
% of patients with risk progressing to critical illness (if infected)	*26.50%*	*26.50%*
Est. total eligible population (mn)	**22**	**33**
% of patients with risk progressing to critical illness (if infected)	*15.74%*	*15.81%*
No. of patients using small molecule drugs (mn)	**12**	**28**
% of patients using small molecule drugs	*55.00%*	*85.00%*
No. of domestic small molecule drugs (mn)	**3**	**26**
% market share of domestic small molecule drugs	*23.00%*	*93.00%*
Price of Paxlovid: Rmb 2,300 per course		
Average price discount vs. proxy	*75.00%*	*80.00%*
Average price of small molecule drug (Rmb)	**575**	**460**
Market size of domestic small molecule drugs (Rmb mn)	**1,573**	**11,844**

Source: Citi Research

The following is our analysis of the eligible patient population for COVID-19 small molecule drugs in China.

Key assumptions include:

- Infection rate at 20%/30% of unvaccinated population in 2022E/2023E;
- % of unvaccinated patients with risk of progressing to critical illness (if infected): 85% for patients aged >18, <60; 95% for patients aged >60. These patients are eligible to take small molecule drugs.

Figure 31. Est. patient no. of domestic small molecule drugs in China in 2022E/2023E

	2022E		2023E	
	age >18, <60	aged > 60	age >18, <60	aged > 60
Population	**832**	**269**	**827**	**275**
% of total population	*58.93%*	*19.07%*	*58.55%*	*19.45%*
Population-fully vaccinated (mn)	**749**	**229**	**744**	**233**
Full vaccination rate of population aged >18, <60	*90.00%*	*85.00%*	*90.00%*	*85.00%*
Population-with three doses (mn)	707	202	703	206
As % of population aged >18, <60	*85.00%*	*75.00%*	*85.00%*	*75.00%*
Population-with two doses (mn)	42	27	41	27
As % of population aged >18, <60	*5.00%*	*10.00%*	*5.00%*	*10.00%*
Population- not fully vaccinated (mn)	**83**	**40**	**83**	**41**
Population- with one dose vaccine (mn)	25	8	25	8
As % of population aged >18, <60	*3.00%*	*3.00%*	*3.00%*	*3.00%*
Population- unvaccinated (mn)	58	32	58	33
As % of population aged >18, <60	*7.00%*	*12.00%*	*7.00%*	*12.00%*
Est. Infection				
Est. infection case- with three doses (mn)	82	20	122	30
Infection rate	*11.54%*	*9.86%*	*17.31%*	*14.79%*
Est. infection case- with two doses (mn)	7	4	10	7
Infection rate	*16.42%*	*16.42%*	*24.63%*	*24.63%*
Est. infection case- with one dose vaccine (mn)	5	2	7	2
Infection rate	*19.58%*	*19.58%*	*29.37%*	*29.37%*
Est. infection case-unvaccinated (mn)	12	6	17	10
Infection rate	*20.00%*	*20.00%*	*30.00%*	*30.00%*
Est. total infection case (mn)	**105**	**32**	**156**	**50**
Blended infection rate	*12.62%*	*12.02%*	*18.93%*	*18.04%*
Est. patients eligible for oral anti-COVID19 drugs				
Est. eligible population - with three doses (mn)	1	0	2	1
% of patients with risk progressing to critical illness (if infected)	*1.28%*	*2.00%*	*1.28%*	*2.00%*
Est. eligible population - with two doses (mn)	0	1	1	2
% of patients with risk progressing to critical illness (if infected)	*7.06%*	*25.94%*	*7.06%*	*25.94%*
Est. eligible population - with one doses (mn)	2	1	2	1
% of patients with risk progressing to critical illness (if infected)	*33.24%*	*56.62%*	*33.24%*	*56.62%*
Est. eligible population - unvaccinated (mn)	10	6	15	9
% of patients with risk progressing to critical illness (if infected)	*85.00%*	*95.00%*	*85.00%*	*95.00%*
Est. total eligible population (mn)	**13**	**8.6**	**19**	**13.1**
% of patients with risk progressing to critical illness (if infected)	*12.43%*	*26.50%*	*12.43%*	*26.50%*

Source: Citi Research, NHC, the State Council, Vaccine effectiveness of two and three doses of BNT162b2 1 and CoronaVac against COVID-19 in Hong Kong

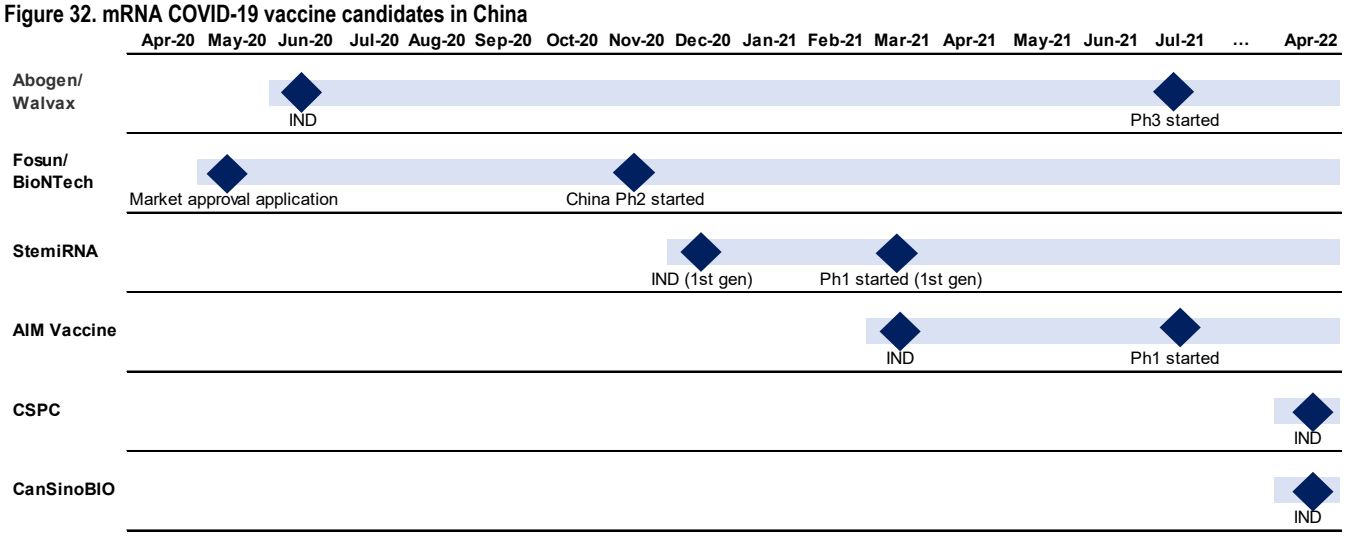
CSPC (1093.HK)

COVID-19 mRNA vaccine to start clinical trials

CSPC is one the leading domestic players developing mRNA COVID-19 vaccine. On Apr 3rd, CSPC announced that its COVID-19 mRNA vaccine (SYS6006) was granted IND approval by NMPA to start clinical trials. CSPC plans to conduct official Ph1/2 trials in unvaccinated people in selected provinces, then potentially booster trials in China and overseas. According to CSPC, SYS6006 adopts highly scalable production processes with assured batch-to-batch consistency, and key starting materials can by sourced in-house or domestically. SYS6006 also shows good stability and can be stored at 2-8℃.

Preliminary human data showed >10^5 neutralizing antibody titer 14 days after vaccination of SYS6006 booster, vs. ~10^4 for inactivated vaccine booster; the AE after vaccination of SYS6006 is similar to BioNTech Ph1 in China. Pre-clinical animal data also showed SYS6006's protection against both Delta and Omicron.

Figure 32. mRNA COVID-19 vaccine candidates in China



Source: Citi Research, NHC

COVID-19 Vaccine Analysis

The following are our scenarios for the incremental vaccine market in China.

Base case: Incremental COV-19 vaccine market size at Rmb27.1bn

We estimate the incremental vaccine market size at Rmb27.1bn by 2022E, based on the following assumptions:

- Full vaccination rate at 90% for those aged <60 by 2022E (vs. current 89.6%); 85% for those aged >60 (vs. current 80.4%);
- Booster coverage rate at 85% for those aged <60 by 2022E (vs. current 46.4%); 75% for those aged >60 (vs. current 52.4%)
- Price of each vaccine dose: Rmb50.

Figure 33. Est. vaccine market size in China: Base case - Full vaccination rate at 90% for group aged <60; 85% for group aged >60; Booster coverage rate at 85% for group aged <60 by 2022E; 75% for group aged >60

	age<60	age>60	Overall
Current vaccination status*			
Population-fully vaccinated (mn)	**1,029**	**212**	***1,241***
Full vaccination rate	*89.61%*	*80.35%*	*87.88%*
Population-with three doses (mn)	533	138	*671*
As % of each age group	*46.44%*	*52.36%*	*47.54%*
Population-with 2 doses (mn)	496	74	*570*
As % of each age group	*43.18%*	*28.00%*	*40.34%*
Population- not fully vaccinated (mn)	**119**	**52**	***171***
As % of each age group	*10.39%*	*19.65%*	*12.12%*
Population- with 1 dose vaccine (mn)	24	11	*35*
As % of each age group	*2.11%*	*4.00%*	*2.46%*
Population- unvaccinated (mn)	95	41	*136*
As % of each age group	*8.28%*	*15.64%*	*9.66%*
Current total doses adminitrated (mn)	**2,614**	**573**	**3,188**

	age<60	age>60	Overall
Base case			
Population-fully vaccinated (2 or 3 doses) (mn)	**1,033**	**224**	***1,257***
Full vaccination rate by YE22	*90.00%*	*85.00%*	*89.07%*
Population-with 3 doses (mn)	976	198	*1,174*
Target vaccination rate by YE22	*85.00%*	*75.00%*	*83.13%*
Population-with 2 doses (mn)	57	26	*84*
Target vaccination rate by YE22	*5.00%*	*10.00%*	*5.94%*
Population- not fully vaccinated (mn)	**115**	**40**	***154***
As % of each age group	*10.00%*	*15.00%*	*10.94%*
Population-with 1 doses (mn)	34	8	*42*
Target vaccination rate by YE22	*3.00%*	*3.00%*	*3.00%*
Population-with 0 doses (mn)	80	32	*112*
Target vaccination rate by YE22	*7.00%*	*12.00%*	*7.94%*
Est. total doses by YE 22 (mn)	**3,076**	**655**	**3,731**
Est. vaccine market size			
Δ Doses (mn)	**462**	**82**	**543**
Price per dose (Rmb)	**50**	**50**	**50**
Δvaccine market size (Rmb mn)	***23,088***	***4,083***	***27,171***

Note: Vaccination data as of Mar 25

Source: Citi Research, NHC, the State Council

Bull case: Incremental COV-19 vaccine market size at Rmb35.4bn

We also conducted Bull/Bear case studies on the China vaccine market size. In the Bull Case, we assume:

- Full vaccination rate at 92% for both age groups (aged <60 / >60);
- Booster coverage rate at 92% for both age groups (aged <60 / >60);
- Price of each vaccine dose: Rmb50 (same as base case).

Figure 34. Est. vaccine market size in China: Bull case - Full vaccination rate and booster coverage rate at 92% and 92% respectively

	age<60	age>60	Overall
Bull case			
Population-fully vaccinated (2 or 3 doses) (mn)	**1,056**	**243**	***1,299***
Full vaccination rate by YE22	*92.00%*	*92.00%*	*92.00%*
Population-with 3 doses (mn)	1,056	243	*1,299*
Target vaccination rate by YE22	*92.00%*	*92.00%*	*92.00%*
Population-with 2 doses (mn)	-	-	-
Target vaccination rate by YE22	*0.00%*	*0.00%*	*0.00%*
Population- not fully vaccinated (mn)	**92**	**21**	**113**
As % of each age group	*8.00%*	*8.00%*	*8.00%*
Population-with 1 doses (mn)	-	-	-
Target vaccination rate by YE22	*0.00%*	*0.00%*	*0.00%*
Population-with 0 doses (mn)	92	21	*113*
Target vaccination rate by YE22	*8.00%*	*8.00%*	*8.00%*
Est. total doses by YE 22 (mn)	**3,168**	**729**	**3,897**
Est. vaccine market size			
Δ Doses (mn)	**554**	**156**	**709**
Price per dose (Rmb)	**50**	**50**	**50**
Δvaccine market size (Rmb mn)	***27,680***	***7,779***	***35,459***

Note: Vaccination data as of Mar 25

Source: Citi Research, NHC, the State Council

Bear case: Incremental COV-19 vaccine market size at Rmb17.9bn

In the Bear Case, we assume

- Full vaccination rate at 90% for group aged <60; 85% for group aged >60;
- Booster coverage rate at 70% for both age groups (aged <60 / >60);
- Price of each vaccine dose: Rmb50 (same as base case).

Figure 35. Est. vaccine market size in China: Bear case - Full vaccination rate at 90% for group aged <60; 85% for group aged >60; Booster rate at 70% for both age group

	age<60	age>60	Overall
Bear case			
Population-fully vaccinated (2 or 3 doses) (mn)	**1,033**	**224**	***1,257***
Full vaccination rate by YE22	*90.00%*	*85.00%*	*89.07%*
Population-with 3 doses (mn)	803	185	*988*
Target vaccination rate by YE22	*70.00%*	*70.00%*	*70.00%*
Population-with 2 doses (mn)	230	40	*269*
Target vaccination rate by YE22	*20.00%*	*15.00%*	*19.07%*
Population- not fully vaccinated (mn)	**115**	**40**	**154**
As % of each age group	*10.00%*	*15.00%*	*10.94%*
Population-with 1 doses (mn)	34	8	*42*
Target vaccination rate by YE22	*3.00%*	*3.00%*	*3.00%*
Population-with 0 doses (mn)	80	32	*112*
Target vaccination rate by YE22	*7.00%*	*12.00%*	*7.94%*
Est. total doses by YE 22 (mn)	**2,904**	**642**	**3,546**
Est. Vaccine market size			
Δ Doses (mn)	**290**	**68**	**358**
Price per dose (Rmb)	**50**	**50**	**50**
Δvaccine market size (Rmb mn)	***14,479***	***3,423***	***17,902***

Note: Vaccination data as of Mar 25

Source: Citi Research, NHC, the State Council

WuXi AppTec (603259.SS/2359.HK)

Potential COVID-19 related project to fuel WuXi Chemistry growth

On Feb 11th, China NMPA granted conditional approval to Pfizer's oral COVID-19 drug Paxlovid (nirmatrelvir and ritonavir tablets) to treat adults with mild to moderate COVID-19 and with high risk of progressing to a severe condition. As a leading CDMO player in China, WuXi AppTec is one of the potential beneficiaries from the recent substantial Paxlovid-related orders. Though WuXi Apptec didn't disclose order size, we estimate WuXi Apptec's related order to be Rmb8bn. On the margin side, according to the company, potential COVID-19 related projects can achieve over 40% GM, similar to the WuXi Chemistry segment GM (39.5% in 2021).

Figure 36. Recent CDMO orders

Ticker	China CDMO	Potential order size (Rmb bn)	Announcement date
603259.SS/2359.HK	**WuXi AppTec (STA)**	**n.a.**	
002821.SZ/6821.HK	**Asymchem**	**9.3**	
	Order 1	*2.7*	11/29/2021
	Order 2	*3.1*	11/17/2021
	Order 3	*3.5*	2/21/2022
300363.SZ	**Porton**	**5.7**	
	Order 1	*4.3*	2/11/2022
	Order 2	*1.4*	11/30/2021

Note: using USD|CNY=6.35

Source: Citi Research, Company data

CSPC Pharma

(1093.HK; HK$8.76; 1; 08 Apr 22; 16:10)

Company description

CSPC Pharma is one of the leading Vitamin C and antibiotics API manufacturers in China and globally. The company is shifting its strategic focus from API to higher-margin drugs through assets injection. After the restructuring, key products of CSPC Pharma include NBP (stroke), Oulaining (Alzheimer's diseases and dementia) and Xuanning (hypertension).

Investment strategy

We assign a Buy rating to CSPC Pharma shares. Transitioning from a major name in the API business to drugs, which are more profitable with more sustainable growth potential, CSPC's growth should be driven by: 1) strong growth momentum in NBP injection post NDRL inclusion 2) ramp-up in oncology portfolio; and 3) a strong pipeline to capture long-term growth opportunities.

Valuation

Our target price for CSPC Pharma of HK$14.0 is based on a sum-of-the-parts analysis: 1) existing business HK$9.3; 2) net cash HK1.2; and 3) pipeline valuation HK$3.5. Our NPV analysis on the segments factors in our revenue and earnings forecasts up to 2031E and we use a terminal growth of 3% and WACC of 9.9% (cost of equity 11.3%, beta of 0.9).

Risks

Key downside risks that could impede the stock from reaching our target price include: 1) slower-than-expected NBP sales and new product launches; 2) price declines; and 3) a further pharma market slowdown.

Shanghai Junshi Biosciences

(1877.HK; HK$51.9; 1H; 08 Apr 22; 16:10)

Company description

Founded in 2012, Shanghai Junshi Biosciences is an innovative biopharmaceutical company dedicated to the discovery and development of innovative drugs and their clinical research and commercialization on a global scale. With extensive capabilities including innovative drug discovery, advanced biotechnological R&D, large-scale production capacity on the full industry chain, and a rapidly expanding drug candidate portfolio with significant market potential, the company has a competitive edge in China in the emerging field of immuno-oncology and for the treatment of autoimmune and metabolic diseases.

Investment strategy

We have a Buy / High Risk (1H) rating on Junshi shares. JS001 (Toripalimab) was launched in YE18, the first anti-PD-1 antibody developed by a PRC

company. The company features in 1) potentially the first launch of domestic potent small molecule anti-COVID drug; 2) Junshi's PD-1 has already received the breakthrough therapy certification, so potentially the first China PD-1 to be approved in the US.

Valuation

Our target price of HK$111.0 is derived from a price-to-sales (PS) based sum-of-the-parts (SOTP) valuation methodology, which is the sum of discounted values of 4x commercialization probability-weighted peak sales of each product / candidate (5x for covid-19 NAb). This breaks down on a per-shares basis as JS001 HK$6.3, VV116 HK$16.2, other pipeline candidates HK$69.7, HK$9.1 for net cash, and HK$9.7 for milestone income and government grants. We assign a discount rate of 8.5% with separate discount period for each product.

Risks

We rate Junshi shares as High Risk given the shares' short trading history as well as the risk factors cited below. Key risks that could prevent the shares from reaching our target price include: short operating history; drug commercialization delays or failures; challenges in commercial manufacturing or sales execution; competition on PD1/PD-L1 drugs including pricing pressures in the China market; R&D risks and uncertainties; off-label sales on NSCLC could be difficult if Opdivo / Keytruda included in NRDL; any failures to obtain needed regulatory approvals; lack of historical profitability; risk of losing key personnel.

WuXi AppTec

(2359.HK; HK$119.3; 1; 08 Apr 22; 16:10)

Company description

WuXi AppTec is China's No.1 CRO, CDMO leader established in 2000. In 2002, the company started manufacturing process development services. From 2004-2006, the company started manufacturing services for R&D, bio-analytical services and antibody discovery and process development services. In 2007, the company started toxicology and formulation services and listed on the New York Stock Exchange under ticker WX.US. From 2011 to 2014, the company acquired Medkey, expanding to clinical development and registration services. The R&D and manufacturing site in Wuxi was put into operation. In 2014, the company opened a new facility in Philadelphia, strengthening R&D and production services of CAR-T therapies and other immunotherapies. In 2018, WuXi AppTec became dual-listed on the Shanghai and Hong Kong Stock Exchanges. In 2019, the company acquired Pharmapace in San Diego to enhance biometrics services for clinical development.

Investment strategy

We rate WuXi AppTec H-shares Buy. It is the leading player in the CRO/CDMO industry in terms of talent, technology and capacity, helping it to attract more customers and further expand. WuXi AppTec provides comprehensive and tailored services to a growing group of diverse pharma/biotech start-ups, who have greater demand and higher reliance on

CRO/CDMO services. In addition, WuXi AppTec has a 100% retention rate of its Top 10 customers. We believe cell and gene therapy CDMO services, as well as PROTAC technology are key future growth drivers of WuXi AppTec that currently look underappreciated by the market. We expect strong growth visibility supported by increasing backlogs from home and abroad - we project China-based lab services to deliver 27.4% sales CAGR in 20-23E backed by its “long-tail” strategy and innovative platforms to provide differentiated services.

Valuation

Our target price of HK$215 for WuXi AppTec H-shares is derived from an NPV-based SOTP valuation using a WACC of 7.2%, a beta of 0.7, and a terminal growth of 3% on the growing trend of China CRO/CDMO sector. Our NPV analysis for the different segments factors in revenue and earnings forecasts up to 2030E. Our NPV breaks down as: 1) HK$136.0/sh for WuXi Chemistry; 2) HK$47.7/sh for WuXi Testing; 3) HK$10.5/sh for WuXi Biology; 4) HK$4.6/sh for WuXi ATU; 5) HK$2.4/sh WuXi DDSU; 6) HK$12.2/sh for investment income; and 7) HK$1.6/sh for other services and net cash.

Risks

Key downside risks that could mean the WuXi AppTec H-shares fail to achieve our target price include: 1) The risk of reduction on customers spending on and demand for outsourced discovery, testing development and manufacturing of pharmaceuticals, cell and gene therapies and medical devices. 2) If the company is not able to attract, train, motivate and retain highly skilled scientists and research technicians. 3) The risk on failure to comply with existing regulations and industry standards or any adverse actions by the drug approval authorities against the company could negatively impact its reputation and business, financial condition. 4) If the company is not able to successfully expand or operate in new geographic markets. 5) The company may not be able to continue to serve clients if it fails to meet customers’ standards in audits and inspections. 6) Increased labor cost may affect its profitability.

WuXi AppTec

(603259.SS; Rmb105.0; 1; 08 Apr 22; 15:00)

Company description

WuXi AppTec is China's No.1 CRO, CDMO leader established in 2000. In 2002, the company started manufacturing process development services. From 2004-2006, the company started manufacturing services for R&D, bio-analytical services and antibody discovery and process development services. In 2007, the company started toxicology and formulation services and listed on the New York Stock Exchange under ticker WX.US. From 2011 to 2014, the company acquired Medkey, expanding to clinical development and registration services. The R&D and manufacturing site in Wuxi was put into operation. In 2014, the company opened a new facility in Philadelphia, strengthening R&D and production services of CAR-T therapies and other immunotherapies. In 2018, WuXi AppTec became dual-listed on the Shanghai and Hong Kong

Stock Exchanges. In 2019, the company acquired Pharmapace in San Diego to enhance biometrics services for clinical development.

Investment strategy

We rate WuXi AppTec A-shares Buy. It is the leading player in the CRO/CDMO industry in terms of talent, technology and capacity, helping it to attract more customers and further expand. WuXi AppTec provides comprehensive and tailored services to a growing group of diverse pharma/biotech start-ups, who have greater demand and higher reliance on CRO/CDMO services. In addition, WuXi AppTec has a 100% retention rate of its Top 10 customers. We believe cell and gene therapy CDMO services, as well as PROTAC technology are key future growth drivers of WuXi AppTec that currently look underappreciated by the market. We expect strong growth visibility supported by increasing backlogs from home and abroad - we project China-based lab services to deliver 27.4% sales CAGR in 20-23E backed by its “long-tail” strategy and innovative platforms to provide differentiated services.

Valuation

Our target price of Rmb180 for WuXi AppTec A-shares is derived from an NPV-based SOTP valuation using a WACC of 7.2%, a beta of 0.7, and a terminal growth of 3% on the growing trend of China CRO/CDMO sector. Our NPV analysis for the different segments factors in revenue and earnings forecasts up to 2031E. Our NPV breaks down as: 1) 1) Rmb113.9/sh for WuXi Chemistry; 2) Rmb39.9/sh for WuXi Testing; 3) Rmb8.8/sh for WuXi Biology; 4) Rmb3.8/sh for WuXi ATU; 5) Rmb2.0/sh WuXi DDSU; 6) Rmb10.2/sh for investment income; and 7) Rmb1.4/sh for other services and net cash.

Risks

Key downside risks that could mean the WuXi AppTec A-shares fail to achieve our target price include: 1) The risk of reduction on customers spending on and demand for outsourced discovery, testing development and manufacturing of pharmaceuticals, cell and gene therapies and medical devices. 2) If the company is not able to attract, train, motivate and retain highly skilled scientists and research technicians. 3) The risk on failure to comply with existing regulations and industry standards or any adverse actions by the drug approval authorities against the company could negatively impact its reputation and business, financial condition. 4) If the company is not able to successfully expand or operate in new geographic markets. 5) The company may not be able to continue to serve clients if it fails to meet customers’ standards in audits and inspections. 6) Increased labor cost may affect its profitability.

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Appendix A-1

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Ratings and Target Price History
Fundamental Research

Analyst: John Yung, CFA

	Date	Rating	Target Price	Closing Price
1	19-Jan-21 05:06:12	*1	*196.67	141.83
2	15-Aug-21 20:03:30	1	*200.00	160.20
3	24-Mar-22 14:02:39	1	*215.00	130.10

*Indicates Change

Rating/target price changes above reflect Eastern Time

WuXi AppTec (603259.SS)

Ratings and Target Price History
Fundamental Research

Analyst: John Yung, CFA

	Date	Rating	Target Price	Closing Price
1	19-Jan-21 04:21:26	*1	*166.67	119.48
2	15-Aug-21 20:03:30	1	*170.00	138.74
3	24-Mar-22 14:02:39	1	*180.00	117.00

*Indicates Change

Rating/target price changes above reflect Eastern Time

Shanghai Junshi Biosciences (1877.HK)

Ratings and Target Price History
Fundamental Research

Analyst: David Shang

	Date	Rating	Target Price	Closing Price
1	29-Mar-20 22:21:28	1H	*40.00	31.40
2	04-May-20 03:43:45	1H	*50.00	40.60
3	01-Sep-20 11:05:45	1H	*80.00	48.30
4	28-Jan-21 07:02:29	1H	*111.00	72.10

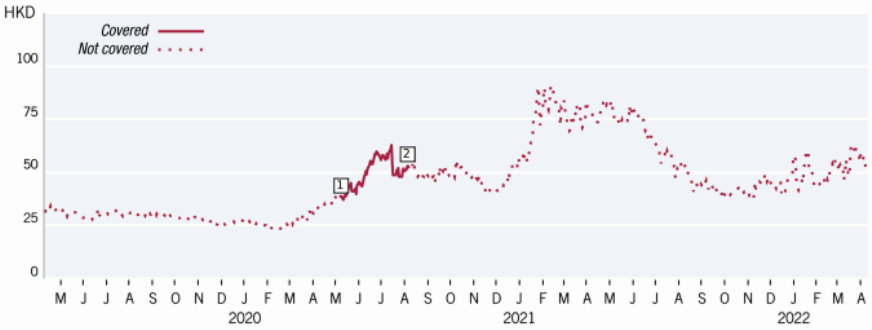
*Indicates Change

Rating/target price changes above reflect Eastern Time

Shanghai Junshi Biosciences (1877.HK)

Catalyst Watch Research

Analyst: David Shang



	Date	Expected Direction	Duration	Action	Closing Price
1	07-May-20 05:56:22	Upside	90 Days	Open	38.65
2	05-Aug-20 04:14:28	Upside	90 Days	Close	53.05

Rating/target price changes above reflect Eastern Time

CSPC Pharma (1093.HK)

Ratings and Target Price History
Fundamental Research

Analyst: John Yung, CFA

	Date	Rating	Target Price	Closing Price
1	06-Dec-19 05:39:37	*1	*10.52	9.34
2	26-Aug-20 04:14:34	1	*11.38	10.40
3	28-Jan-21 07:02:29	1	*10.20	8.17
4	18-Mar-21 06:52:57	1	*12.00	9.59
5	24-May-21 16:53:36	1	*14.00	11.56

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Data current as of 31 Mar 2022	**Buy**	**Hold**	**Sell**	**Buy**	**Hold**	**Sell**
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% of companies in each rating category that are investment banking clients	62%	66%	54%	69%	60%	68%

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