INTERNATIONAL MONETARY FUND

IMF Country Report No. 24/276

PEOPLE'S REPUBLIC OF CHINA

SELECTED ISSUES

August 2024

This paper on the People's Republic of China was prepared by a staff team of the International Monetary Fund as background documentation for the periodic consultation with the member country. It is based on the information available at the time it was completed on July 3, 2024.

Copies of this report are available to the public from

International Monetary Fund • Publication Services
PO Box 92780 • Washington, D.C. 20090
Telephone: (202) 623-7430 • Fax: (202) 623-7201
E-mail: publications@imf.org Web: http://www.imf.org
Price: $18.00 per printed copy

International Monetary Fund
Washington, D.C.

INTERNATIONAL MONETARY FUND

PEOPLE'S REPUBLIC OF CHINA

SELECTED ISSUES

July 1, 2024

Approved By
Asia and Pacific Department

Prepared by a team led by Sonali Jain-Chandra, with individual chapters authored by Natalija Novta; Yizhi Xu; Ashique Habib (all APD), Simon Black, Anthony Liu, James Roaf and Karlygash Zhunussova (all FAD), Andrea Presbitero and Robert Zymek (RES), Dmitry Plotnikov (SPR) and Phakawa Jeasakul (Resident Representative in Hong Kong SAR).

CONTENTS

ANNEX

ANNEX

FIGURE

TABLE

FIGURES

APPENDIX

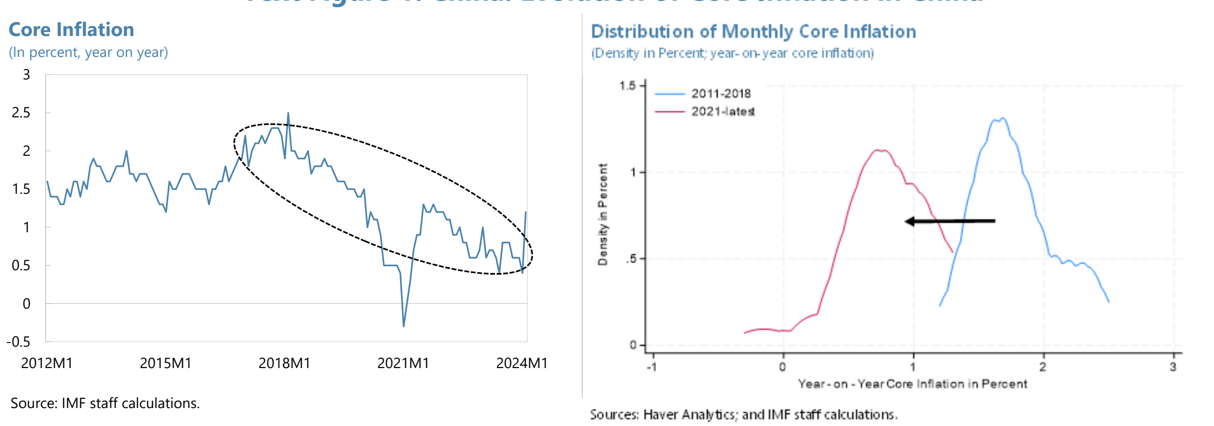
DEFLATION VULNERABILITY AND INFLATION-AT-RISK[1]

Recent economic shocks in China, including the ongoing property sector adjustment, have resulted in disinflationary pressures and low inflation. This paper assesses the downside risks to inflation around the baseline. Specifically, we develop a deflation vulnerability index (DVI), which combines data from many factors that may contribute to deflationary pressures. The inflation-at-risk analysis suggests that output gaps and inflation expectations are the key components of DVI affecting the tail risk of core deflation in China. The probability of deflation in China is currently estimated to be around 7 percent in the baseline but could be as large as 27 (54) percent 9 months after a one (two) standard deviation shock to DVI.

A. Introduction

1. **In recent years, China has been beset by low inflation.** The downward trend in core inflation started before the pandemic, at the end of the credit boom of the late 2010s (Chen and Kang 2018), and has continued through the ongoing property market correction and the accompanying debt overhang. Specifically, the multi-year adjustment in the property market, together with the pandemic, has contributed to an increase in household precautionary savings, further suppressing inflation. In addition, high levels of local government debt and reduced revenue from land sales have constrained local government spending, and also contributed to the downward pressure on prices. Since the pandemic, the entire distribution of monthly core inflation outcomes has shifted to the left as monthly core inflation prints have ranged between 0.4 and 1.3 percent, with a fatter left tail, compared to a range of 1 to 2.5 percent pre pandemic. Meanwhile, weak commodity prices also contributed to a decline in the producer price index, headline consumer prices, and the GDP deflator.

Text Figure 1. China: Evolution of Core Inflation in China



[1] Prepared by Natalija Novta and Yizhi Xu.

2. We focus on downside risks to inflation given the concern that some negative shocks may have a larger or more persistent impact on the left tail of the inflation distribution than on the median. COVID lockdown shocks in 2020 and 2022 and the property sector downturn since 2021 have resulted in large and persistent negative output gaps, and they have coincided with lower inflation expectations. Some of these factors may also have contributed to a fatter left tail of China's inflation distribution. This paper aims to analyze factors that are key to predicting downside risks to China's inflation and quantify the probability of core inflation slipping into negative territory in the near future.

3. To assess downside risks to inflation we develop a deflation vulnerability index (DVI) (Section B). The index is based on five categories of variables that predict deflation vulnerabilities across countries, including commodity prices, output gaps, financial asset prices, exchange rates, and inflation expectations, similar to Kumar and others (2003). Based on the DVI, China is currently experiencing the longest period of disinflationary pressures, initially driven by falling asset prices—particularly the correction in the property market—and increasingly by negative output gaps.

4. We use the DVI in quantile regressions to predict downside risks to inflation (i.e., inflation-at-risk, IaR) and to quantify the probability of future deflation in China (Section C). Typical econometric approaches focus on the determinants of average inflation (IMF 2024a, Box 1). However, downside risks involve changes at the bottom end of the distribution. A negative shock to DVI is associated with a larger decline at the 10^{th} than at the 50^{th} percentile of the core inflation distribution, underscoring downside risks to inflation. Output gaps and inflation expectations are the key components of DVI that affect the tail risk of future core deflation in China. While the risk of entering deflation is limited in the baseline, IaR estimates suggest a significant increase in future deflation probability in case of large negative shocks. Section D concludes with policy implications.

B. Deflation Vulnerability Index: Methodology and Data

5. Past literature identified several key determinants of deflation risks. Kumar and others (2003) proposed five categories of deflation risk indicators, including commodity prices, output gaps, financial asset prices, exchange rates, and money supply. To reduce dimensionality, they derived fixed thresholds for each indicator based on a sample of 35 economies, and then constructed an index of deflation vulnerability based on how many indicators were above or below the threshold. Decressin and Laxton (2009) extended this approach to include housing prices and inflation expectations.

6. This paper refines the list of deflation risk indicators to better reflect China' deflation pressures. Starting with the same 5 categories of variables as in Kumar and others (2023), we add pork prices to the commodity price group, underscoring the importance of the pork cycle in driving China's food inflation. We also include China's secondary market house price based on 70 cities and household survey inflation expectations. Finally, the money supply indicator is excluded because it is highly endogenous. Except for output gaps and inflation expectations—which are monitored by single indicators—each of the other three groups contains several indicators, as in prior literature. The detailed indicator definitions and sources are described in Text Table 1 and in Appendix I.

7. **A new deflation vulnerability index (DVI) is constructed based on a modified dimensionality reduction approach.** Pre-determined, country-invariant, and time-invariant thresholds as in Kumar and others (2003) can become dated over time or be ill suited when applied to a country outside of the original sample, such as China. Instead, we leverage on the principal component analysis (PCA) to extract the common factors within each group of deflation risk indicators. First, PCA is conducted within each group of indicators, transformed to standard normal distributions, to derive the deflation vulnerability factors (DVF) based on the first two principal components. In the second step, all five DVFs are used in PCA again to obtain the DVI that summarizes all data information into one index. Table 1 summarizes the aggregating weights from the two-step PCA. [2]

Text Table 1. China: Underlying Variables of DVI

(year-on-year change in percent)

Variable	Number of Obs.	Mean	Std Dev.	Weight in Group	Group Weight in DVI
1. Commodity prices					
Rice price	290	3.56	6.92	0.5	
Pork price	230	7.89	31.66	0.28	0.16
Fuel price	290	5.31	11.51	0.22	
2. Output gaps*	288	0.15	1.75	1	0.2
3. Financial asset prices					
Stock price	290	14.76	31.73	0.5	0.35
House price	146	-0.41	4.53	0.5	
4. Exchange rates					
FX	290	-0.55	4.14	0.5	0.01
(Negative) REER**	290	-1.03	5.34	0.5	
6. Inflation Expectations†	264	-0.02	17.08	1	0.28

*In percent of potential GDP

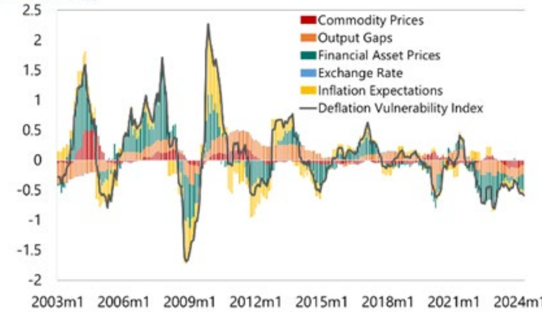
†In negative values of REER, so that lower value means real appreciation and higher deflationary pressure

8. **Based on the DVI, China is currently experiencing its longest recorded period of downward pressure on inflation**. Since 2003, China has experienced multiple periods of deflationary pressures, with DVI below zero. However, in past episodes, deflationary pressures were relatively temporary, largely driven by weak financial asset prices and inflation expectations. In the most recent episode, which began in 2020, deflationary pressure was initially driven by falling asset prices in 2021-22, and then increasingly by negative output gaps. In 2023, falling food prices and inflation expectations further contributed to the prolonged downward pressure on inflation.

[2] As vegetable prices are also important in China's CPI basket, as a robustness check we included vegetable price inflation in the commodity price category. The resulting DVI is almost unchanged compared to that used in the analysis.

C. Inflation-at-Risk

Deflation Vulnerability Index and Contributions
(In standard deviations from historical average; lower = more vulnerable to deflation risks)



Source: IMF staff calculations.

9. The inflation-at-risk (IaR) framework is developed to assess the relationship between current deflation vulnerabilities and distributions of future core inflation in China. Building on the growth-at-risk analysis in Adrian and others (2019) and Adrian and others (2022), we rely on the following local projection estimation of quantile regressions to estimate the impact of DVI on future core inflation distribution in China:

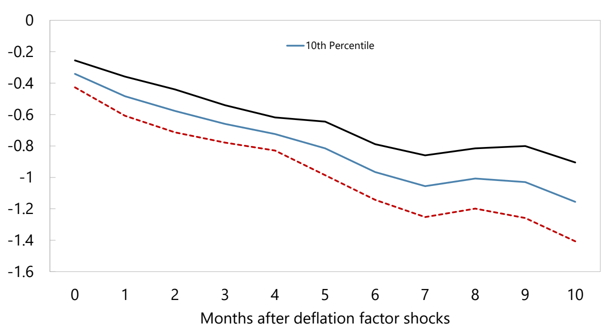
$$\pi^{\tau}_{t+h} = \beta^{\tau}_{h} DVI_t + \gamma^{\tau}_{h} X_{t-1} + \varepsilon_t$$

where π^{τ}_{t+h} indicates τ-th percentile of h-month ahead future core inflation distribution, DVI_t is the deflation vulnerability index as described in Section B, and X_{t-1} includes lagged controls such as past 12 months average core inflation and year-on-year growth in money supply M2. As our focus is the downside risk to inflation, we put most emphasis on the quantile regression with $\tau = 10$, which is typical in the Growth-at-Risk (GaR) literature.[3]

10. The DVI has a statistically significant impact on downside risk to core inflation in the months following a negative shock to DVI (Figure 2). A one-unit increase in DVI is associated with around 1.1 percentage point decline in core inflation at the 10th percentile of the 9-month ahead distribution. Such an impact on the left-tail, as indicated by $\beta^{10}_{h=9}$, significantly exceeds the impact at the median ($\beta^{50}_{h=9}$) and the 90th percentile ($\beta^{90}_{h=9}$) of the future core inflation distribution (Figure 2 Panel 2). The disproportionate change across different percentiles of the future inflation distribution demonstrates DVI's importance in predicting downside risks.

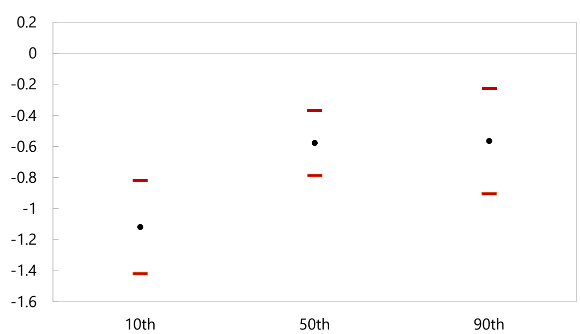
Text Figure 2. China: Impact of Negative DVI Shock on Future Core Inflation

Impact of Deflation Vulnerability Index on Core Inflation
(In percent)



Source: IMF staff calculations.
Note: dashed lines indicate 90 percent confidence intervals.

Impact of Deflation Vulnerability Index on Core Inflation
(In percent; 9 months after the shock)



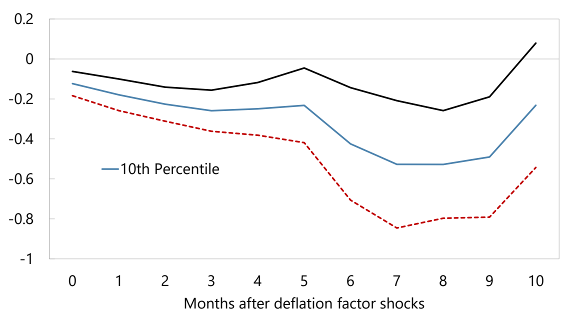
Source: IMF staff calculations.

[3] Such inflation-at-risk analysis is similar to López-Salido and Loria (2024), for the case of the U.S. and EU.

11. Output gaps and inflation expectations are the two variables within DVI with the highest predictive power for future deflation risks. To evaluate the predictive power of individual factors, we run quantile regressions with all five deflation vulnerability factors—commodity prices, output gaps, financial asset prices, exchange rates, and inflation expectations—included, instead of the DVI.[4] Negative output gaps and declines in inflation have the largest and most persistent impact on downside risk to future inflation (Figure 3, panel 1 and panel 3). With a one-standard-deviation negative shock to output gaps and inflation expectations—equivalent to the shock experience during the onset of the pandemic—the 10th percentile left-tail of 9-month ahead core inflation distribution is reduced by around 0.6 and 0.4 percentage points respectively. In addition, negative shocks to inflation expectations predict future downside risk of inflation (10th percentile) but are irrelevant at the median and 90th percentile of the future distribution (Figure 3, panel 4).

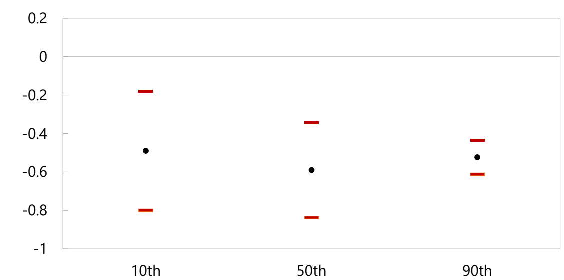
Text Figure 3. China: Impact of Negative Output Gaps and Inflation Expectations on Future Core Inflation

Impact of Output Gaps on Core Inflation
(In percent)



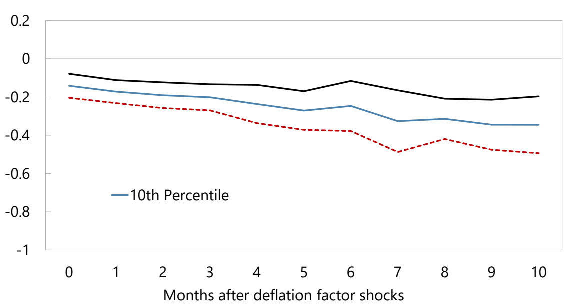
Source: IMF staff calculations
Note: Dashed lines indicate 90 percent confidence intervals.

Impact of Output Gaps on Core Inflation
(In percent; 9 months after the shock)



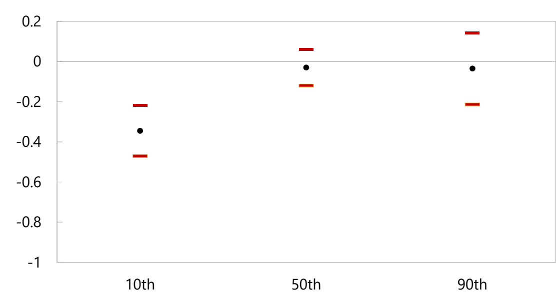
Source: IMF staff calculations.
Note: Red bars indicate 90 percent confidence intervals.

Impact of Inflation Expectations on Core Inflation
(In percent)



Source: IMF staff calculations.
Note: Dashed lines indicate 90 percent confidence intervals.

Impact of Inflation Expectations on Core Inflation
(In percent; 9 months after the shock)



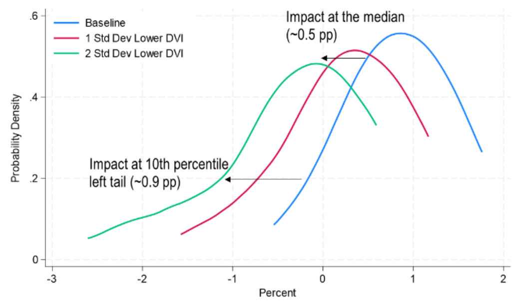
Source: IMF staff calculations.
Note: Red bars indicate 90 percent confidence intervals.

[4] This exercise is a horse race between the 5 deflation vulnerability factors (DVF) with the following specification: $\pi_{t+h}^{\tau} = \sum_{k=1}^{5} \beta_{k,h}^{\tau} DVF_{k,t} + \gamma_h^{\tau} X_{t-1} + \varepsilon_t$.

12. Finally, the probability of future core inflation slipping below zero is quantified using estimates from the inflation-at-risk analysis. When quantile regressions are estimated at many different percentiles, it is possible to non-parametrically estimate how the entire distribution of core inflation outcomes shifts after a negative shock to DVI. As depicted in the text figure, the whole distribution of future inflation shifts leftward after a negative shock to DVI, with a fattening of the left tail of the distribution. Under the current baseline projection, the probability of 9-month ahead core deflation is limited, with only around 7 percent chance that China's core inflation would turn negative. However, with a 1-standard deviation (2-standard deviations) shock to DVI, the chance of deflation in the next 9 months increases to 27 (54) percent.

Conditional Distribution of China's Core Inflation

(Probability density; 9-month ahead; year-on-year inflation)



Source: IMF staff calculations.

D. Policies and Conclusion

13. The risk of deflation in China has threatened the strength of its post-pandemic recovery. A scenario with prolonged deflation in China would imply subdued growth and worsening debt dynamics in China and could have significant global spillovers (IMF 2024b, Box 2). Nominal GDP growth has been below real GDP growth for 4 quarters starting in 2023Q2, which is unprecedented for China. This has implications for overall debt dynamics, household's interest income, and firm profitability. Although China's core inflation remains firmly in positive territory, the deflation vulnerability index (DVI) suggests persistent downward pressures on China's core inflation, primarily driven by negative output gaps and financial asset prices.

14. At this juncture, macroeconomic policies should be geared toward further supporting domestic demand and reducing deflation risks. To mitigate a deflation risks, the priority is to contain the macroeconomic impact of the ongoing property market adjustment, which has contributed to large negative output gaps and weak inflation expectations. A stabilization in the property market, with completion of unfinished pre-sold housing and restructuring of distressed developers, would restore consumer confidence and revive aggregate demand. Fiscal policy support for lower-income households, who have the highest marginal propensity to consume, could also help boost aggregate demand. Attention is also needed to avoid excessive reliance on supply side measures to expand productive capacity, amid weak demand, which could exacerbate deflationary pressures. Meanwhile, the PBoC should further ease the monetary policy stance and enhance its monitoring of deflation risks, with a focus on keeping inflation expectations anchored at a higher level and closing the negative output gap.

15. Enhanced monitoring of downside risks to inflation is needed. The inflation-at-risk analysis provides a useful tool to monitor downside risks to China's inflation. As the analysis suggests, the left tail of the distribution of core inflation 9 months ahead is particularly sensitive to negative output gaps and lower inflation expectations. Hence, in addition to supporting domestic demand, the focus should be on measuring and monitoring inflation expectations. Strengthening central bank communication could also help guide market inflation expectations over a longer horizon.

References

Adrian, Tobias, Nina Boyarchenko, and Domenico Giannone, 2019. "*Vulnerable Growth*." American Economic Review. 109(4): pp. 1263-89.

Adrian, Tobias, Federico Grinberg, Nellie Liang, Sheheryar Malik, and Jie Yu, 2022. "*The Term Structure of Growth-at-Risk*." American Economic Journal: Macroeconomics. 14(3): PP. 283-323.

Chen, Sally, and Joong Shik Kang, 2018. "*Credit Booms—Is China Different?*" IMF Working Paper 2018/002.

Decressin, Jörg, and Douglas Laxton, 2009. "*Gauging Risks for Deflation*." IMF Staff Position Note. 2009.

Kumar, Manmohan, Taimur Baig, Jörg Decressin, Chris Faulkner-MacDonagh, and Tarhan Feyzioglu, 2003. "*Deflation: Determinants, Risks, and Policy Options*." IMF Occasional Paper 221.

López-Salido, David, Francesca Loria, 2024. "*Inflation at risk*," Journal of Monetary Economics. In press.

International Monetary Fund, 2024a. People's Republic of China: 2023 Article IV Conclusion Staff Report.

International Monetary Fund, 2024b. People's Republic of China: 2024 Article IV Conclusion Staff Report.

Annex I. Data Sources and Sample Description

1. Underlying data for China's Deflation Vulnerability Index.

Monthly Variables	**Description**	**Source**
Rice price inflation	Grain price y/y percent change. Jan 2000-Feb 2024	NBS, Haver
Pork price inflation	Pork price y/y percent change. Feb 2005-Feb 2024	NBS, Haver
Fuel price inflation	Fuel and power price y/y percent change. Jan 2000-Feb 2024	NBS, Haver
Stock price returns	Market total return index y/y percent change. Jan 2000-Feb 2024.	Datastream
House price returns	Secondary market residential price across 70 cities, y/y percent change. Jan 2011-Feb 2024	CEIC
Exchange rate (vs. USD)	Nominal exchange rate per USD, y/y percent change. Jan 2000-Feb 2024.	Haver
Real Effective Exchange Rate	Narrow REER: CPI-based. Jan 2000-Feb 2024.	Bruegel, Haver
Quarterly Variables	**Description**	**Source**
Output gaps	Output gap to GDP ratio in percent. 2000Q1-2023Q4.	IMF staff estimation
Inflation expectations	Consumer Price Expectation for the Next Quarter (50+ = positive view), y/y percent change. 2000Q1-Feb 2023Q4.	NBS, Haver

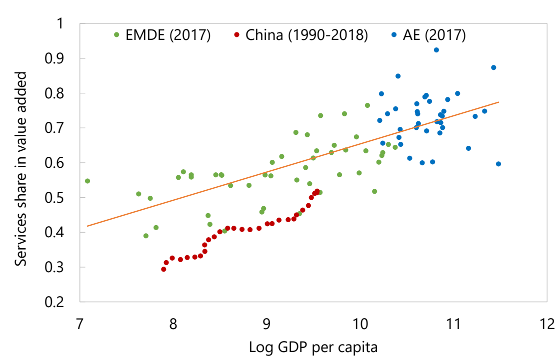
SERVICE SECTOR PRODUCTIVITY, ALLOCATIVE EFFICIENCY AND INNOVATION[1]

This paper examines the role of the service sector in driving productivity growth in the past and the extent to which service sector reforms can support productivity and growth in future. It finds that structural transformation has positively contributed to economy-wide total factor productivity (TFP) growth and innovation in the last 20 years in China. Partly, this is because the decline in value added share of the secondary sector was led by low TFP subsectors, such as oil and gas. Partly it is because, TFP growth of market services exceeded that of the secondary sector. However, despite the relatively strong TFP growth in market services, there is a substantial and growing misallocation of capital and labor in the sector, which has been masked by high innovation. Sector- and firm-level analysis suggests that further opening up to trade, greater labor mobility, and state-owned enterprise (SOE) reforms could improve allocative efficiency, unleashing higher TFP growth overall, and particularly in the service sector.

A. Introduction

1. **After decades of high growth, China's real GDP growth is expected to slow, and the search for new engines of growth has become a priority.** Growth driven by the property sector has become unsustainable, with the fundamental demand for housing expected to decline significantly (IMF, 2024). For years after China joined the WTO, the manufacturing sector had been a key driver of growth, including due to strong gains from trade. Going forward, however, growing fragmentation pressures may dampen external demand for Chinese manufacturing goods. Promoting sustainable growth, which is also greener and safer (IMF, 2022, 2023), requires rebalancing the economy towards consumption, and undertaking structural reforms to boost falling productivity growth and mitigate the drag from a declining labor force. This paper demonstrates that China's growing market services sectors have positively contributed to innovation and productivity growth and can be a source of sustainable growth going forward.

Service Sector Share



Source: IMF staff calculations.

2. **Green and high-tech manufacturing sectors are being prioritized as the new "quality productive forces" in China, while the service sector remains an underexploited growth driver.** The green manufacturing sectors, including EVs, batteries and solar panels, are still relatively small and analysis suggests they are unlikely to fully replace the drag from the property sector (Box 5, 2024 Article IV Staff Report). Meanwhile, the service sector—although it grew substantially—is still

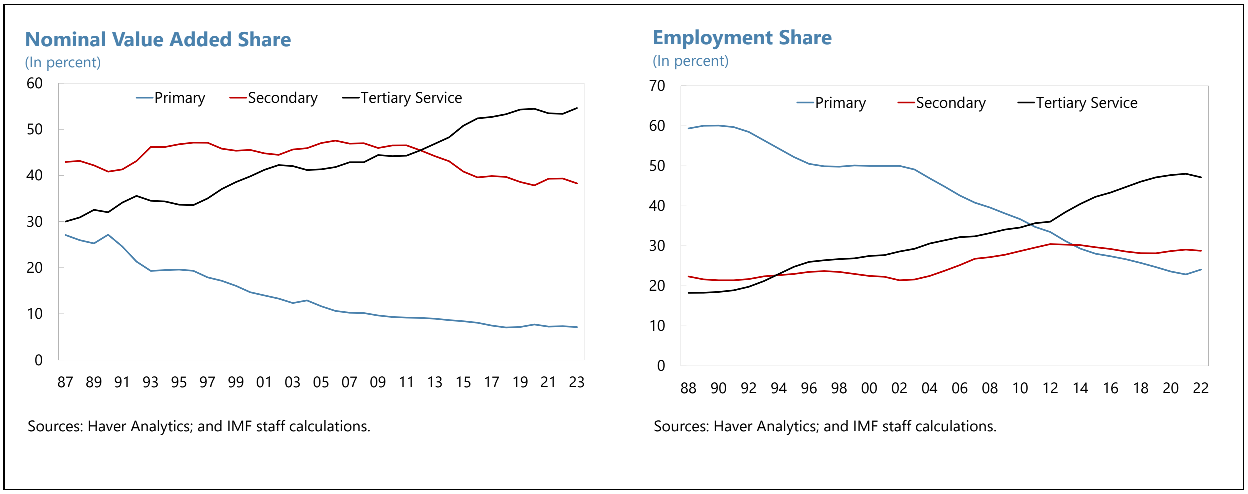
[1] Prepared by Natalija Novta, Robert Zymek and Yizhi Xu.

small for China's per capita income. The services sector has significant scope for expansion, with the value-added share of services in advanced economies about 20 percentage points above that in China.

3. This Selected Issues Paper presents stylized facts and answers three key questions. First, how has rebalancing towards services affected aggregate TFP growth in China (Section C)? Second, how are innovation and allocative (in)efficiency contributing to TFP growth in China (Section D)? Allocative (in)efficiency refers to the extent to which capital and labor flow to firms where they are most productive, while innovation refers to the technological and process innovation within firms that raises firm TFP. Third, which policies could help improve service sector allocative efficiency and boost growth (Section E)? To answer these questions, we use detailed sector-level data from the last three decades, comparing service subsectors to other sectors of the Chinese economy, and other countries. We also use firm-level data from Orbis to calculate allocative efficiency at the firm-, sector- and country level, and analyze differences in allocative efficiency, innovation, and policies that could help boost productivity.

B. Stylized Facts

4. China's service sector exhibited substantial growth in recent decades but has room to grow further. In the last four decades, the service sector—including trade and accommodation, transport and communications, financial and business services—grew from under 30 percent to over 50 percent of China's nominal value added, nearly surpassing the share of the secondary sector.[2] Throughout this period the agriculture sector declined in both employment and value-added terms.



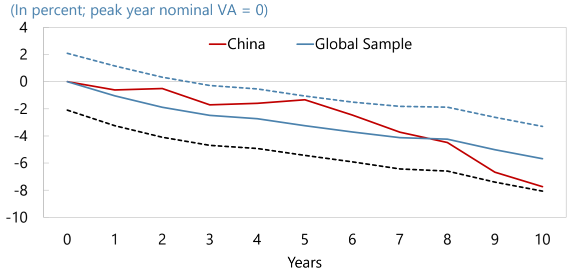
5. The secondary sector started gradually declining after 2011 in nominal value-added share term coupled with relatively stable employment. The pace of deindustrialization in China, has been in line with other countries, both in terms of the decline in nominal value-added

[2] Annex I provides sectoral classification of primary, secondary, market service, and non-market service sectors. Zhu, Zhang and Peng (2019) offer an excellent overview of sectoral productivity trends in China.

share of the secondary sector and the increase in the nominal value-added share of the service sector (chart). Still, the service sector in China is relatively small, both relative to countries at similar levels of income per capita, and compared with advanced economies.

China: Secondary Sector Nominal Value Added Share Since 2011

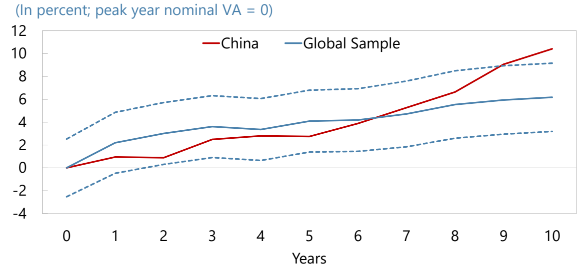
(In percent; peak year nominal VA = 0)



Source: IMF staff calculations.
Notes: Dashed lines indicate 90 percent confidence interval. T = 0 is 2011 for China or the year when the secondary sector nominal value added share reached the peak for countries in the global sample.

China: Tertiary Sector Nominal Value Added Share Since 2011

(In percent; peak year nominal VA = 0)

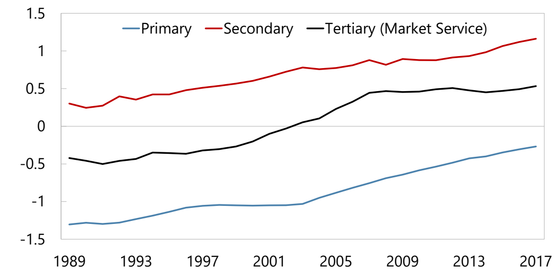


Source: IMF staff calculations.
Notes: Dashed lines indicate 90 percent confidence interval. T = 0 is 2011 for China or the year when the secondary sector nominal value added share reached the peak for countries in the global sample.

6. There is substantial heterogeneity in TFP growth and levels across subsectors within the secondary and tertiary sectors. The service sector is particularly diverse, with a divergence between non-market and market services. Non-market service sectors, such as healthcare and education, tend to have low or negative TFP growth rates and levels. In contrast, market service subsectors tend to have positive TFP growth rates and levels, except for real estate services (see chart). Within the secondary sector, manufacturing subsectors generally have positive TFP levels and growth rates. However, some secondary sector industries with significant presence of state ownership (e.g., oil & gas, petroleum) have had negative TFP levels and growth rates in China during 2003-2019.

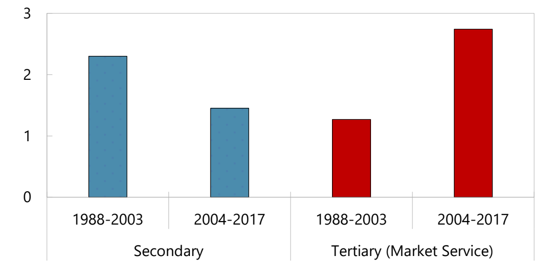
7. While the average *level* of TFP is still lower for market services compared to in the secondary sector, the *growth* of TFP in the market services sector was higher. The growth rate of service sector TFP has been substantial since the early 2000s and has exceeded TFP growth in the secondary sector. This means that, if TFP continues to grow for market services as their value added expands over time, market services can drive aggregate productivity growth in China. IMF (2018) also presents evidence of unconditional convergence towards the global frontier within major market services subsectors. This includes financial and business services, trade and accommodation, and transport and communications. Unconditional convergence within market service subsectors is crucial to support overall convergence towards advanced economy per capita income levels.

Logarithm of TFP



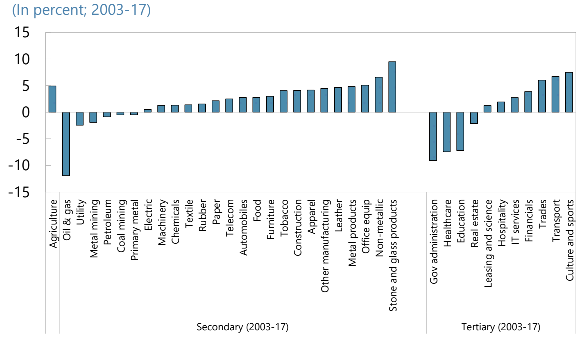
Source: World KLEMS; and IMF staff calculations.
Notes: Sector classifications follow Chen et al. (2023). TFP is defined as $NVA/(P \times L^{\alpha} \times K^{1-\alpha})$ where NVA is nominal value added, P is sectoral deflator, L is employment multiplied labor quality index, K is capital stock, and α is labor income share.

Sectoral Weighted TFP Growth
(In percent)



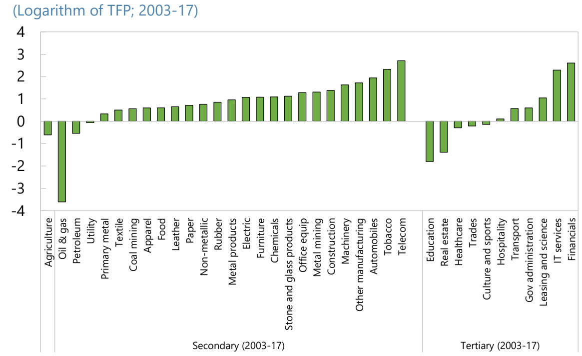
Sources: World KLEMS; and IMF staff calculations
Notes: TFP growth is defined as $\Delta \ln(NVA) - \Delta \ln(P) - \alpha\Delta \ln(L) - (1-\alpha)\Delta\ln(K)$ where NVA is nominal value added, P is sectoral deflator, L is employment multiplied labor quality index, K is capital stock, and α is labor income share.

Average TFP Growth by Sectors
(In percent; 2003-17)



Sources: World KLEMS; and IMF staff calculations.

Average TFP Level by Sectors
(Logarithm of TFP; 2003-17)



Sources: World KLEMS; and IMF staff calculations.

C. Rebalancing Towards Services Impact on Aggregate Productivity

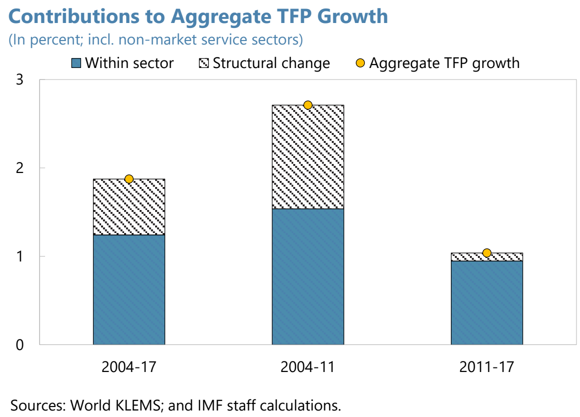
8. **To gauge the impact of the shift towards the service sector on aggregate productivity growth, we use a shift-share analysis, as in the literature.**[3] Aggregate productivity growth can be achieved in two ways: 1) through increases in productivity within sectors, and 2) through the reallocation of labor and capital towards more productive sectors, i.e. structural change. Because non-market service subsectors—such as health, education, and public administration—tend to have very low TFP levels, their expansion typically does not contribute to aggregate TFP growth (Baumol, 1967). However, *market* services—such as information technology and financial services—have both high TFP growth and TFP levels, and their expansion positively contributes to TFP growth. Even expansion into market services with relatively higher TFP growth but a lower level of TFP—such as

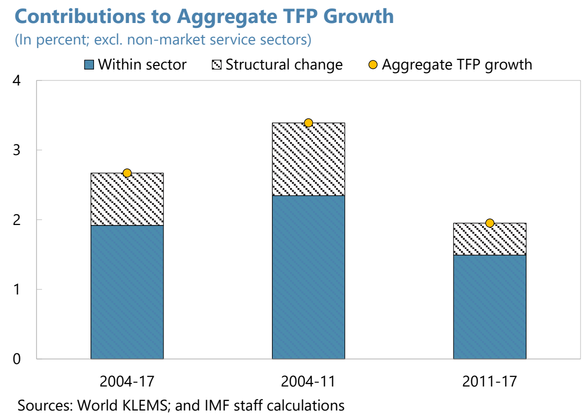
[3] The following formula illustrates the decomposition of TFP growth using the shift-share analysis approach (also used in McMillan and Rodrik (2011), Diao and others (2017) and IMF (2018).

$$\Delta \ln TFP_t = \sum_{s=1}^{S} \theta_{st-1}(\Delta \ln TFP_{st}) + \sum_{s=1}^{S}(\Delta\theta_{st}) \ln TFP_{st}$$

where θ_{st-1} indicates the value-added share of sector *s* in year *t-1*, the first summation represents "within-sector" contribution to TFP growth, as it is the weighted average of within-sector TFP growth $\Delta \ln TFP_{st}$. The second summation represents the contribution of "structural change" to TFP growth, as changes in sectoral shares $\Delta\theta_{st-1}$ are weighted by their sector-specific TFP levels.

trade, transport or culture and sport—can contribute positively to aggregate TFP growth as long as the level of TFP is higher than that in the sector which is shrinking.





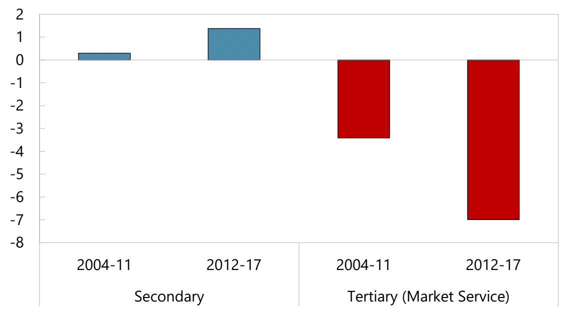
9. Structural change has positively contributed to aggregate TFP growth in China throughout the last two decades. The positive contribution to TFP growth from shifting to market services was particularly strong in the 2000s. In the 2010s, it remained positive but faded somewhat because of the expansion of real estate services, which contributed negatively to overall TFP growth of market services. Importantly, even when low-productivity non-market services are included in the shift-share analysis, the rebalancing towards services overall has not impacted China's aggregate TFP adversely (text chart). Consistent with this finding, structural transformation towards the service sector has positively contributed to growth across emerging economies (IMF, 2018).

D. Allocative Efficiency and Innovation

10. TFP growth is driven by technological innovation within firms and by how well capital and labor are allocated across firms, i.e. allocative efficiency. In a perfectly competitive market economy, in the absence of frictions, the most innovative firms would quickly attract capital and labor away from less productive firms. When the additional revenue generated by one more unit of inputs (capital and labor) is equal across firms, then the economy is considered perfectly "allocatively efficient" (IMF, 2024a). This is the basis of the revenue productivity approach to measuring allocative efficiency developed by Hsieh and Klenow (2009) and Bils et al. (2021). A large dispersion in revenue productivity across firms indicates low allocative efficiency, which must be reducing TFP growth relative to a higher TFP growth that would have resulted with perfect allocative efficiency. We calculate allocative inefficiency in China using Orbis data on the value added, workforce and capital stock for around 40,000 firms.[4] TFP growth net of change in allocative efficiency is thus a measure of the underlying technological innovation in China. In world of perfect allocative efficiency, innovation is the only driver of TFP growth.

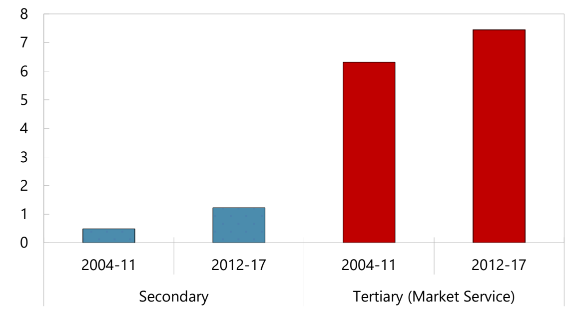
[4] Allocative efficiency is measured indirectly, based on the dispersion in the revenue productivity of capital and labor across firms. For details on data sources, cleaning and calculations, see Online Annex 3.3 for Chapter 3 of the April 2024 *World Economic Outlook*.

Allocative Efficiency Growth
(In percent)



Sources: World KLEMS; Orbis; and IMF staff calculations.

Innovation Growth
(In percent)

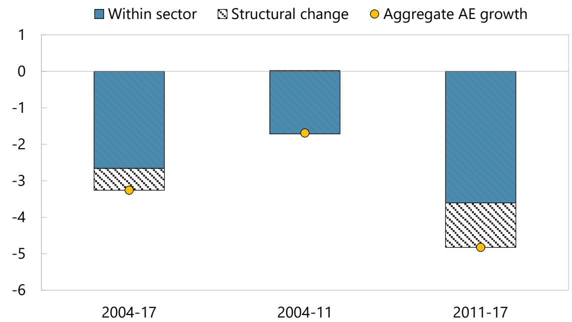


Sources: World KLEMS; Orbis; and IMF staff calculations.

11. Despite their relatively strong TFP growth, market services in China have had growing misallocation of capital and labor which masks the high underlying technological innovation. Declining allocative efficiency means that capital and labor are increasingly concentrated in relatively unproductive firms, likely due to a variety of frictions. Some frictions, such as the time needed for a young firm to attract talent and expand, only temporarily reduce allocative efficiency. Other frictions, such as policies favoring state-owned or otherwise politically connected firms with preferential credit and subsidies, or regulatory barriers that prevent market entry of new firms or their nationwide operation can reduce allocative efficiency more structurally. Better allocation of capital and labor across market services firms would lift TFP growth even higher than what it has been in recent decades in China.

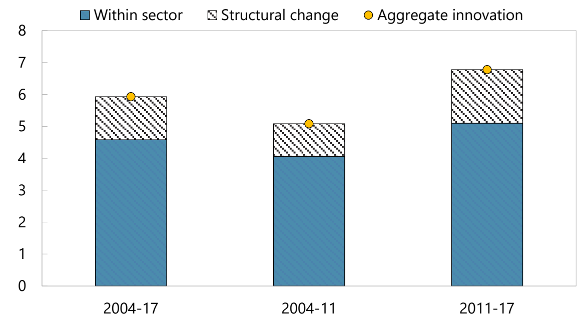
12. Innovation refers to the technological and process innovation that enhances productivity within firms. Innovation determines what ideal TFP growth would be with perfect allocative efficiency. In China, innovation took off across all sectors around 2015, but most prominently in the market service sector. The 2015 introduction of mobile-payment apps and their rapid adoption in China, along with other IT advances, is likely an important engine that spurred innovation in services (Dychtwald, 2021). In new, highly dynamic sectors with many new firms, it is possible to have both high innovation and high allocative inefficiency. Young firms with rapidly increasing productivity—even if they grow fast—may attract human and physical capital too slowly relative to their productivity growth. This can result in a temporary increase in allocative inefficiency, until capital and labor reallocate to the most productive firms (IMF, 2024a).

Contributions to Aggregate Allocative Efficiency Growth
(In percent; excl. non-market service sectors)



Sources: World KLEMS; Orbis; and IMF staff calculations.

Contributions to Aggregate Innovation
(In percent; excl. non-market service sectors)

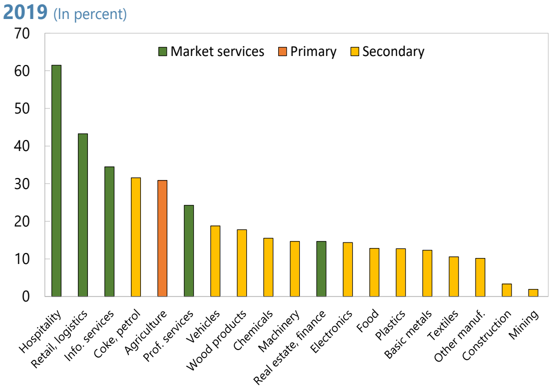


Sourced: World KLEMS; Orbis; and IMF staff calculations.

13. Structural transformation in China has positively contributed to TFP growth because innovation in market services offset the allocative inefficiency. The market services sector has had negative growth in allocative efficiency in China since 2003. This could be due to a greater presence of SOEs in services vs. manufacturing sector and generally high regulatory barriers in the service sector. As such, structural change towards service sectors has further contributed to the decrease in aggregate allocative efficiency. However, despite the decreased allocative efficiency, structural change has also been accompanied by rising innovation, led by the market services sector. This may be because of highly productive, young service sector firms, for example in IT or finance, that are innovating but also struggle to initially attract labor and capital fast enough, which results in temporarily increasing allocative inefficiency. Restrictions in labor mobility due to the household registration system or excessive market regulations may have further constrained young productive firms in China's market services as they attempt to grow towards their optimal size.

14. While China's allocative efficiency is low compared with major advanced economies in all sectors, the gap is the largest in some market services (Text Figure). The allocative efficiency gap can be interpreted as the productivity loss experienced by China, relative to five benchmark economies, due to greater resource misallocation between firms. This loss is smallest in industries such as construction and mining, suggesting that China's allocative efficiency is similar to that of advanced economies in these sectors. The loss is largest in market services, particularly hospitality, retail and information services. Several studies have documented that, across different countries, allocative efficiency tends to be lower in services than in goods-producing sectors, though misallocation in China's market services is

Allocative Efficiency Gap: China Relative to Major AEs, 2019 (In percent)



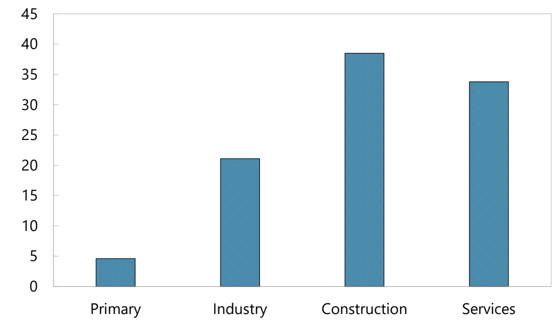
Sources: Bureau van Dijk Orbis; and IMF staff calculations. The allocative efficiency gap represents China's implied TFP loss from greater measured resource allocation relative to an average of five major AEs (DEU, FRA, JPN, ITA, USA; weighted by PPP GDP).

especially pronounced.[5] This implies that there are potentially sizeable gains in productivity and income from structural reforms aimed at improving resource allocation in China's market services.

E. Policies to Lift Allocative Efficiency and Productivity

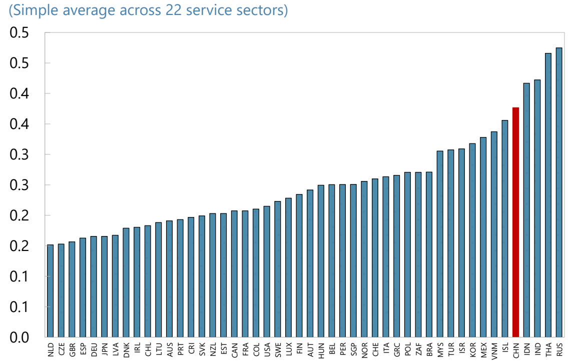
15. We show that policies—such as trade openness and less SOE presence—are associated with greater allocative efficiency at the country-, sector- and firm-level.[6] SOEs, while they are present in all sectors, have a particularly high share of sectoral value added in the service sector (34 percent), compared to 21 percent in industry (Zhang, 2019). While SOEs can help address certain market failures, they may contribute to misallocation of capital and labor. The service sector in China is also less open to trade than in other countries, as indicated by the OECD Service Trade Restrictiveness Index. Subcomponents of the index show that China imposes more restrictive measures on service sector activity than the global average. This is reflected in higher restrictions on foreign entry, less regulatory transparency, and more barriers to competition.

Share of SOEs in Sectoral Value Added, 2017



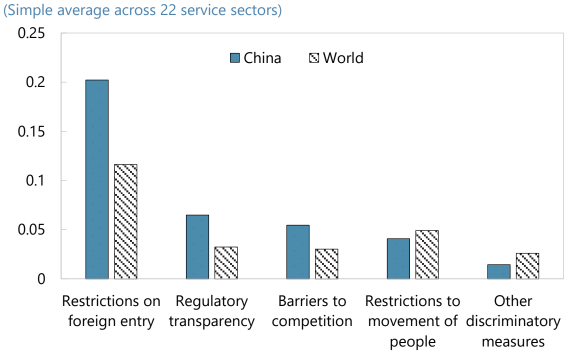
Sources: Zhang (2019); Chinese National Bureau of Statistics; and IMF staff calculations.
Note: Primary includes farming, forest, animal hubandry, fishing.

Service Trade Restrictiveness Index, 2022
(Simple average across 22 service sectors)



Sources: OECD; and IMF Staff calculations.

Service Sector Trade Restrictiveness Index, 2022
(Simple average across 22 service sectors)



Sources: OECD; and IMF staff calculations.

16. At the country level, higher allocative efficiency is generally associated with more competitive and open markets. For 20 major economies, the text figure correlates a measure of long-run allocative efficiency with their score on two structural policy indices.[7] First, an index

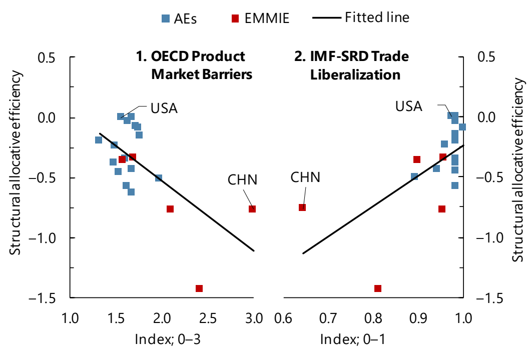
[5] For example, see Busso, Fazio, and Algazi (2012), De Vries (2014), Dias, Marques, and Richmond (2016), Chapter 2 of the April 2017 *Fiscal Monitor*, and Chapter 3 of the April 2024 *World Economic Outlook*.

[6] Allocative efficiency is first calculated at the firm level, and is then aggregated at country-sector, or country level.

[7] "Structural allocative efficiency" aims to capture allocative efficiency net of transitory misallocation caused by economic shocks, and is inferred from a decomposition of sector-level allocative efficiency using dynamic panel regressions. See Online Annex 3.3 for Chapter 3 of the April 2024 *World Economic Outlook* for details.

reflecting the extent of barriers to competition in product markets (left-hand-side panel). Second, an index reflecting the extent of barriers to international trade (right-hand-side panel). Consistent with this country-level evidence, case studies have demonstrated that specific interventions to reduce market frictions and improve trade openness improve allocative efficiency. For example, Chen and Irarrazabel (2015) find that removing credit market distortions during the 1980s bolstered TFP growth in Chile by reducing misallocation. Ha and Kiyota (2016) find that trade liberalization helped raise allocative efficiency in Vietnam during the 2000s.

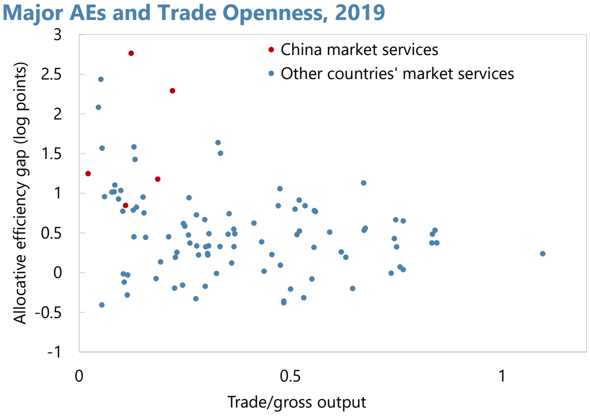
Structural Allocative Efficiency and Policies Across Countries



Sources: Bureau van Dijk Orbis; OECD; EU-KLEMS; and IMF staff calculations.
Note: Allocative efficiency is computed based on Hsieh and Klenow (2009) and Bils and others (2021). The country-specific structural component of allocative efficiency is obtained from a dynamic panel regression. Sample comprises 20 economies. AEs = advanced economies; EMMIEs = emerging market and middle-income economies.

17. At the sector level as well, low trade openness is associated with low allocative efficiency. For 6 market-services sectors across 20 major economies, the text chart plots the allocative efficiency gap relative to major AEs against the share of exports and imports in the sector's gross output, as of 2019. Observations pertaining to China's market services are highlighted in dark green. The chart illustrates that there is a negative correlation between service-sector openness and misallocation, and that China's services are characterized by both relatively high misallocation and low openness. This suggests that one avenue to address service-sector misallocation may be to facilitate more cross-border trade in Chinese market services, which would expose them to greater competition and market discipline. In a large country such

Market Service Sectors: Allocative Efficiency Gap with Major AEs and Trade Openness, 2019

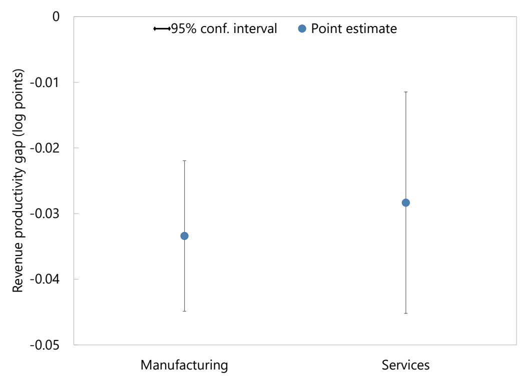


Sources: Bureau van Dijk Orbis; OECD; and IMF staff calculations. Each dot represents a country-sector observation, with the figure covering 5 market services and 20 major economies. The allocative efficiency gap is a sector's implied TFP loss from greater measured resource allocation relative to an average of five major AEs (DEU, FRA, JPN, ITA, USA; weighted by PPP GDP). Trade/gross output is the sum of a sector's exports and imports divided by the sector's gross output.

as China, reducing barriers to cross-provincial trade could also play a large role in improving allocative efficiency.

18. Firm-level regressions further indicate that SOEs tend to have lower allocative efficiency. Service-sector SOEs tend to overemploy capital and labor to a similar extent as their manufacturing counterparts. However, several service sectors—particularly finance, transport, storage, post and communications—tend to have a much higher presence of SOEs than the industrial sector and push up the average share of SOEs in services sectoral value added (Zhang, 2019). Based on firm-level regressions, the text chart shows that, as of 2018, the average SOE's revenue productivity in both manufacturing and services was about 3 percent below the average of private owned companies (POEs). This implies that in both manufacturing and services, more economic value added could be created if some capital and labor "stuck" in SOEs were freed up to move to POEs instead.

SOE Revenue Productivity Gaps, 2018



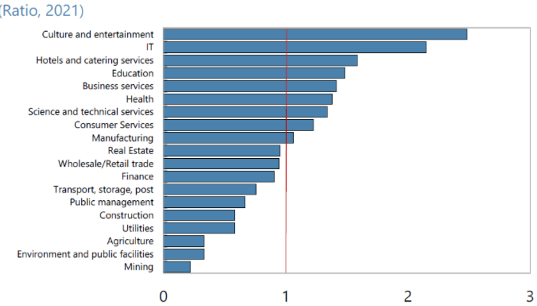
Sources: Bureau van Dijk Orbis; Wind; and IMF staff calculations. Point estimates and confidence intervals from a regression of (the log of) firm revenue productivity on sector fixed effects and an SOE fixed effect for the cross section of Chinese firms in 2018. Revenue productivity is computed as value added per capital and labor input, as in Hsieh and Klenow (2009).

19. Overall, we demonstrate that two specific factors—high trade restrictions and the presence of SOEs—contribute to low allocative efficiency in Chinese market service sectors. This analysis reaffirms earlier findings that greater trade openness and SOE reform would help raise productivity in China (Jiang 2011, Cerdeiro and Ruane, 2022, Jurzyk and Ruane 2021). We demonstrate that these policies, which have generally been based on analyses of the manufacturing sector, would also be beneficial in the service sector. As China continues to converge to advanced economy income levels, and the service sector expands in line with domestic consumer preferences, addressing these policy gaps will be critical for growth.

F. Conclusion and Policy Recommendations

20. Rebalancing toward market services has contributed positively to growth in recent years, but market services are still an underexploited driver of growth and small for China's level of development. Given high innovation among firms in market services, reducing impediments to the development and expansion of the market services sector could be higher up on the authorities' policy agenda. Given that the service sector is also the preferred sector

Sectoral Employment Share of Age Group 16-24 to Age Group 25+
(Ratio, 2021)



Sources: MOHRSS; and IMF staff calculations.
Notes: A ratio of >1 implies a large employment share in a sector for the 16-24 age group compared to the 25+ age group, a ratio of <1 a smaller share.

of employment for many young workers, further opportunities in the service sector would help reduce youth unemployment. High innovation in market services amid low allocative efficiency indicates continued prospects for productivity growth, making it a relatively underexploited driver of growth. Expansion of market services can help China converges to advanced economy per capita income levels.

21. China's service sector has had low allocative efficiency, which has so far been largely offset by high innovation. Low and declining allocative efficiency indicates that increasingly too much capital and labor is concentrated in relatively unproductive firms. Policies should be adjusted to allow greater market-based reallocation of capital and labor to the most productive firms, which would lift allocative efficiency both in the service sector and in the aggregate. While China has made some progress in reducing regulatory barriers across different services sectors, including paring back various FDI restrictions, and shareholding restrictions in banking, insurance, securities, and other financial services, as well as piloting greater trade in services through free trade zones,[8] there is still room for further reforms (OECD, 2024).

22. Greater opening up to trade and SOE reforms could help improve allocative efficiency and unleash higher TFP growth, particularly in the service sector. In addition to further reducing restrictions to trade in services, as well as interprovincial barriers to trade, allowing greater business dynamism would help. Allowing greater firm entry and exit across a unified national market would help allocate labor and capital to the most productive firms more promptly. Scaling back industrial policies, which implicitly or explicitly give preference to specific companies (e.g., SOEs) or sectors, could also help improve allocative efficiency and thereby lift productivity growth both in the service sector, and in the aggregate. Further reform in China's household registration system (Hukou), which the authorities are gradually planning to relax, would help. With continued innovation in the market services sector and future improvements in allocative efficiency, market services can be a sustainable source of growth.

[8] Since the end of 2023, foreign investors have been allowed to hold 100 percent of the shares in financial services institutions in China, as part of China's efforts to open its financial services industry to foreign institutions (see announcement here). In addition, China rolled out national and pilot free trade zone (FTZ) versions of list specifying service sectors accessible to foreign entities, with the aim of enhancing cross-border trade in services (see announcement here).

References

Baumol, William J. 1967. "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis." American Economic Review 57 (3): 415–26.

Bils, M., Klenow, P.J. and Ruane, C., 2021. "Misallocation or mismeasurement?" Journal of Monetary Economics, 124, pp.S39-S56.

Busso, M., Fazio, M. and Algazi, S., 2012. "(In) formal and (un) productive: The productivity costs of excessive informality in Mexico," IDB Working Paper 341, Inter-American Development Bank, Washington, DC.

Cerdeiro, D.A. and Ruane, C., 2022. "China's Declining Business Dynamism," International Monetary Fund Working Paper.

Chen, Kaiji and Alfonso Irarrazabel, 2015. "The Role of Allocative Efficiency in a Decade of Recovery," Review of Economic Dynamics, 18(3): 523-550

Chen, Xilu, Guangyu Pei, Zheng Song, and Fabrizio Zilibotti, 2023. "Tertiarization Like China," Annual Review of Economics, 15: 485-512.

De Vries, Gaaitzen J., 2014. "Productivity in a Distorted Market: the Case of Brazil's Retail Sector," Review of Income and Wealth 60, no. 3: 499-524.

Diao, X., McMillan, M. and Rodrik, D. 2017. "The Recent Growth Boom in Developing Economies: A Structural Change Perspective." NBER Working Paper 23132, National Bureau of Economic Research, Cambridge, MA.

Dias, Daniel A., Carlos Robalo Marques, and Christine Richmond, 2016. "Misallocation and Productivity in the Lead-Up to the Eurozone Crisis," Journal of Macroeconomics 49: 46-70.

Dychtwald, Z. 2021. "China's New Innovation Advantage," Harvard Business Review. Cambridge MA.

Hsieh, C.T. and Klenow, P.J., 2009. "Misallocation and manufacturing TFP in China and India," The Quarterly journal of economics, 124(4), pp.1403-1448.

IMF, 2018. World economic outlook, April 2018 "Manufacturing Jobs: Implications for productivity and inequality," International Monetary Fund, Chapter 3.

IMF, 2017. Fiscal monitor, April 2017. "Upgrading the Tax System to Boost Productivity," Chapter 2.

International Monetary Fund, 2022. People's Republic of China: 2021 Article IV Conclusion Staff Report.

International Monetary Fund, 2023. People's Republic of China: 2022 Article IV Conclusion Staff Report.

International Monetary Fund, 2024. People's Republic of China: 2023 Article IV Conclusion Staff Report.

IMF, 2024a. World economic outlook, April 2024. "Slowdown in Global Medium-Term Growth: What Will it Take to Turn to the Tide?" International Monetary Fund, Chapter 3.

Jiang, Yanqing. 2011 "Understanding openness and productivity growth in China: An empirical study of the Chinese provinces." China Economic Review 22, no. 3: 290-298.

Jurzyk, E. and Ruane, M.C., 2021. "Resource misallocation among listed firms in China: The evolving role of state-owned enterprises," International Monetary Fund Working Paper.

McMillan, M, and Rodrik, D. 2011. "Globalization, Structural Change, and Productivity Growth." NBER Working Paper 17143, National Bureau of Economic Research, Cambridge, MA.

Organisation for Economic Co-operation and Development, 2024. "OECD Services Trade Restrictive Index (STRI): China – 2023," OECD STRI Country Note.

Zhang, C., 2019. "How much do state-owned enterprises contribute to China's GDP and employment?"

Zhu, M., Zhang, M.L. and Peng, D., 2019. "China's Productivity Convergence and Growth Potential—A Stocktaking and Sectoral Approach," International Monetary Fund.

Annex I. Sectoral Classification

Broad sector	Subsectors	Industry description
Primary		Agriculture, forestry, animal husbandry & fishery
Secondary		Coal mining
		Oil & gas excavation
		Metal mining
		Non-metallic minerals mining
		Food and kindred products
		Tobacco products
		Textile mill products
		Apparel and other textile products
		Leather and leather products
		Saw mill products, furniture, fixtures
		Paper products, printing & publishing
		Petroleum and coal products
		Chemicals and allied products
		Rubber and plastics products
		Stone, clay, and glass products
		Primary & fabricated metal industries
		Metal products (excluding rolling products)
		Industrial machinery and equipment
		Electric equipment
		Electronic and telecommunication equipment
		Instruments and office equipment
		Motor vehicles & other transportation equipment
		Miscellaneous manufacturing industries
		Power, steam, gas and tap water supply
		Construction
Tertiary	Market services	Wholesale and retail trades
		Hotels and restaurants
		Financial intermediation (partial)
		Real estate
		Cultural, sports, entertainment services; residential and other services
		Transport, storage & post services
		Information & computer services
		Leasing, technical, science & business services
	Non-market services	Financial intermediation (partial)
		Healthcare and social security services
		Education
		Government, public administration, and political and social organizations, etc.

Note: As in Chen et al. (2023), 84 percent of financial intermediation sector's nominal value-added is allocated to the market services sector and the remaining is allocated to the non-market services sector.

REFORM OF THE EMISSIONS TRADING SYSTEM (ETS) IN CHINA[1]

China's Emissions Trading System is a key pillar of its climate policy. Its further optimization and reform could make China's green transition more cost-effective. In this Selected Issues Paper, we model China's current intensity-based Emissions Trading System (IB-ETS) along with three proposed reform options: 1) introducing partial auctioning of emissions permits, 2) switching to a quantity-based ETS (QB-ETS) with a cap on total emissions, and 3) extending the ETS to the industrial sector. We evaluate the benefits and drawbacks of different reforms, focusing on electricity prices, fiscal revenue, and changes in welfare.

A. Introduction and Details about China's ETS and Renewables Policy

1. Recent extreme weather in China and elsewhere, including record-breaking temperatures and severe storms, underscore the urgency of combating climate change. China is committed to its goals of peaking carbon emissions before 2030, reducing carbon intensity by 65 percent from 2005 levels by 2030, and achieving carbon neutrality by 2060. China's ETS system, currently the single largest climate policy instrument in the world, is an integral part of reaching these goals and setting an example for other emerging market economies. However, given that China currently emits almost a third of global annual greenhouse gas emissions, faster emissions reductions than those in China's current Nationally Determined Contributions (NDCs) for 2030 are necessary for the world to limit global warming to below 2°C. Reform of China's ETS could help it exceed its climate goals and pave the way for future emerging markets' mitigation efforts.

2. China's current intensity-based ETS allocates free allowances based on four fuel- and technology-specific benchmarks for coal and gas power plants (Table 1). Every year, each fossil fuel power plant receives carbon emissions allowances equal to the product of the benchmark for their technology class and their production in that period. Coal-fired power generators have higher benchmarks and are given more allowances. Power plants with emissions intensity higher than their benchmark must reduce their emissions intensity or purchase allowances from fossil fuel power plants with emissions intensity lower than their benchmark. The IB-ETS incentivizes coal and gas power plants to improve emission intensity via retrofits, shifting power generation to the most efficient plants, and use of carbon capture, utilization and storage (CCUS) technology (IEA 2022). But if aggregate production rises, the total number of carbon emissions permits in the system increases. In this respect, China's IB-ETS is very different from a quantity-based ETS (QB-ETS), in which there is an economy-wide cap on total emissions.[2]

---

[1] Prepared by Simon Black, Anthony Liu, Natalija Novta, James Roaf and Karlygash Zhunussova.

[2] For a review of different Emissions Trading Systems across countries see Parry and others (2022). In the QB-ETS in European countries, also called cap-and-trade, there is a cap on total emissions from all covered sectors; covered firms must surrender allowances each trading period in the amount of their emissions.

3. The national intensity-based ETS was introduced in 2021, and further reform and adjustments are planned. China has announced a long-term goal to extend the ETS to the industrial sector and to introduce auctioning of allowances, but specific details or timeline have not yet been confirmed. Reacceleration of ongoing power sector reforms, including more market-based electricity pricing and greater price flexibility, would further improve the sectors' responsiveness to market signals and increase the benefits of the ETS.

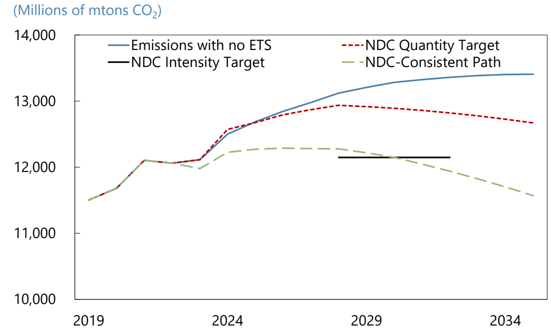
4. China's renewables policy is integral to its decarbonization efforts and supports the existing ETS. The renewables policy, outlined in its Five-Year Plans (FYPs), initially focused on installed capacity targets, which are set to be achieved ahead of time, with recent emphasis on renewables integration and consumption targets.[3] Because the IB-ETS does not directly incentivize the development of renewables, China's renewables policies have been crucial in directing the development of its renewable energy industry. Construction of the China Certified Emission Reduction Trading System (CCER), a voluntary carbon market to supplement the ETS, further supports this effort. The goal is to provide sufficient and stable electricity generation from renewables, so that fossil-fuel electricity generation can decline while the growing total electricity demand is still met. China is already the largest deployer of renewable energy in the world, accounting for about half of all new renewable capacity worldwide (IEA 2023).

5. Our analysis has three main conclusions. First, China will benefit from extending the IB-ETS to industrial firms as planned, and this reform should be implemented as soon as possible. Extending the coverage of the existing ETS from 44 percent to almost 80 percent of China's total CO2 emissions would help China reach its climate goals with lower overall cost. Second, China should utilize its ETS to raise revenue, perhaps through the partial auctioning of permits, and use the funds to provide transfers to low-income households, reversing the regressivity of its mitigation policy. Finally, a gradual transition to a quantity-based ETS (QB-ETS), one which includes a cap over economy-wide emissions, would maximize the gain in social welfare.

B. Reform Scenarios

6. To facilitate comparison across scenarios, we maintain the same future emissions path—consistent with China's stated NDC goals—across all scenarios. China set two relevant NDCs for 2030: to peak carbon emissions before 2030, and to cut the carbon intensity of GDP by 65 percent from 2005 levels by 2030. The "NDC-Consistent" emissions path used in this paper assumes that both of China's NDCs

Economy-Wide Emissions
(Millions of mtons CO_2)



Source: IMF staff calculations.

[3] By 2025, China aims for non-fossil electricity generation to reach 39% and renewable electricity consumption to account for 33% of total electricity consumption. China targets 30 GW of new energy storage capacity by 2025, primarily through battery systems, and 120 GW of total pumped hydro storage by 2030. Renewable Portfolio Standards (RPS) were introduced in 2019, setting targets for shares of total renewables and non-hydro renewables in electricity consumption by province.

goals are met, and that equal contributions to emissions reduction from each sector contribute to the economy-wide emissions path. In the power sector, this implies achieving emissions of 4.9 billion metric tons by 2030 emissions, a reduction of 15 percent. All scenarios are calibrated to achieve this 2030 target, with emissions tapering at the same rate beyond 2030.

7. We consider the following scenarios:

- **Baseline IB-ETS** (no reforms). The baseline includes 4 benchmarks, which we project will cumulatively tighten by 34 percent between 2023 and 2030 to achieve NDC goals (Table 1).[4]
- **Scenario 1: Partial auctioning** assumes that a share of allowances—growing linearly from 1 to 25 percent in 2030—is auctioned rather than allocated for free.
- **Scenario 2: Quantity-based ETS** introduces a cap on total quantity of emissions rather than emissions intensity benchmarks.
- **Scenario 3: Expand IB-ETS' coverage to industry** assumes that the current IB-ETS will be extended to include cement, aluminum, and iron and steel sectors (Phase 1), and pulp and paper, other non-metal products, other non-ferrous metals, chemicals, and petroleum refining (Phase 2).

Text Table 1. China: Projected Benchmark Standards for Intensity-Based ETS

Fuel Benchmark Category	Technology Type	2022	2025	2030	2035	% Reduction by 2030
Conventional coal-fired units >400MW	Subcritical > 400MW Supercritical > 400 MW Ultrasupercritical; Coal + CCS	0.8177	0.6549	0.5420	0.6476	-33.7%
Conventional coal-fired units ≤400MW	High-pressure Subcritical <= 400MW Supercritical <= 400MW	0.8729	0.6991	0.5785	0.6914	-33.7%
Unconventional coal-fired units	Circulating fluidized bed (CFB)	0.9303	0.7451	0.6166	0.7368	-33.7%
Gas-fired units	Gas; Gas + CCS	0.3901	0.3124	0.2586	0.3090	-33.7%

Source. 2022 Implementation Program for the Setting and Allocation of National ETS Allowances; IMF staff modeling (CPAT).
Note: Benchmark units are tons of CO2 per megawatt-hour. CCS refers to carbon capture and storage.

8. The scenarios are modeled by adding an ETS power plants module to the Climate Policy Assessment Tool (CPAT), including key features tailored to the Chinese economy. First, it models all Chinese fossil fuel plants at the province-technology class level. Second, it assumes that plants respond to the ETS with profit-maximizing decisions on their quantity and fuel efficiency, as measured by the heat rate. Third, it includes the existence of administrative pricing arrangements, contracts between power plants and other state-owned entities where a fixed amount of power is sold at a fixed price. Fourth, firms shut down if they produce unprofitably for three consecutive

[4] We assume that China would continue to taper emissions after 2030 at the same rate as before. Because maintaining benchmarks at the same level after 2030 would result in overly restrictive emissions cuts, we allow benchmarks to loosen up to 2035.

years. Fifth, it includes partial pass-through of costs to the price of electricity on the logic that losses cannot be sustained in the long run.[5] Sixth, it makes the price of coal endogenous to Chinese demand.[6] Overall, the ETS power plants module integrates a microeconomic model of the power sector from Goulder and others (2022) into CPAT's existing modeling of the power sector (see Annex for more technical details and IMF 2023).

9. **The CPAT model assumes rapid growth of electricity generation from renewable sources, based on declining costs for generation.** Investment in each source of electricity generation is based on levelized total cost, including fixed costs such as capital cost, variable costs including the price of fuel, as well as indirect costs such as transmission and storage of renewable energy. In our model, the share of renewable energy in 2030 rises from 37 percent to 44 percent when China's IB-ETS is considered.

C. Results

10. **Table 2 summarizes the key results of the three scenarios, including the change in electricity price, the welfare gain, and the amount of government revenues generated.** Each scenario targets the same NDC-consistent total emissions reduction but achieves it in different ways. When the IB-ETS is extended to the industrial sector, emissions reductions from the power sector do not have to be as deep. Relative to the IB-ETS, the QB-ETS reduces the quantity of electricity produced more, while not cutting emissions intensity as deeply. Electricity price increases are larger

Text Table 2. China: Summary Comparison Table for Policies, 2030

Fuel	No Policy	Baseline: Intensity-based ETS	Auction Permits	Quantity-based ETS	Include Industry, Phase 1	Include Industry, Phase 2
Change in Electricity Price from 2019	28%	38%	41%	45%	35%	34%
Government Revenues, % of GDP	0%	0.23%	0.33%	0.25%	0.20%	0.20%
Welfare Gain, Relative to No Policy, % of GDP	0.0%	0.43%	0.44%	0.49%	0.56%	0.56%
Other variables						
Power Sector Emissions Reduction	0%	-15%	-15%	-15%	-10%	-8%
Production from Fossil Fuel Power Plants (millions of GJ)	19,648	17,271	17,268	17,173	18,274	18,586
Firm Profits, Relative to No Policy	0.0%	-26.3%	-34.1%	-18.2%	-6.0%	-3.7%
Emissions Intensity (mtons CO2/GJ)	0.291	0.283	0.283	0.284	0.282	0.282
Needed Change in Benchmark	N/A	-35%	-35%	N/A	-12%	-8%

Source: IMF staff modeling using CPAT. All figures represent annual amounts or percentage changes for the year 2030 only.

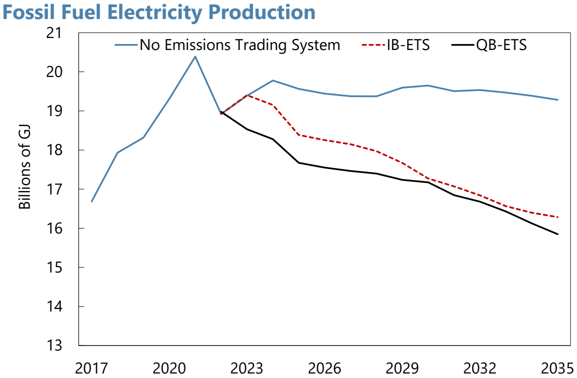
[5] China has historically kept electricity prices very stable, even as the price of coal and natural gas has fluctuated. The model assumes that this policy cannot be kept in place indefinitely if power producers are unprofitable.

[6] China consumes approximately 55 percent of the world's coal each year. As a result, substantial drops in demand for coal by China could plausibly lower world prices.

with auctioning and QB-ETS than in the baseline IB-ETS, but welfare is still higher in these two scenarios than with IB-ETS. This is because auctioning and QB-ETS internalize some of the negative externalities of prices below the full social cost of electricity.[7]

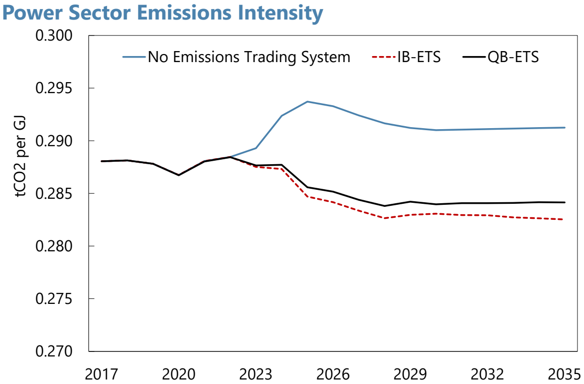
11. In Scenario 1, auctioning permits can raise significant fiscal revenues but raises costs for firms. Revenues raised by auctioning IB-ETS permits are around $40 billion, or 0.2 percent of GDP, by 2030. They could be used for general budget purposes, or as transfers to low-income households to compensate them for higher electricity prices, or to alleviate competitiveness issues in energy-intensive and trade-exposed industries. Because in this scenario each power plant receives less emissions permits, their cost of complying with the IB-ETS rises. This causes a moderate rise in total production cost per unit and a decrease in profitability, causing some marginally profitable power producers to shut down.

Fossil Fuel Electricity Production



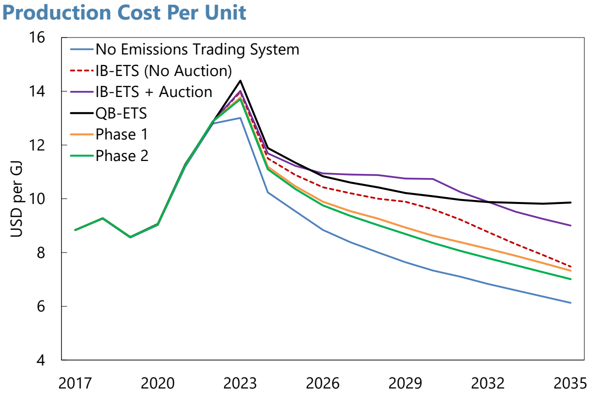
Source: IMF staff calculations.

Power Sector Emissions Intensity



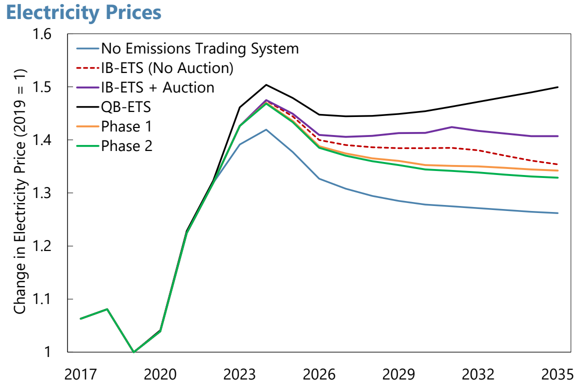
Source: IMF staff calculations.

Production Cost Per Unit



Source: IMF staff calculations.

Electricity Prices



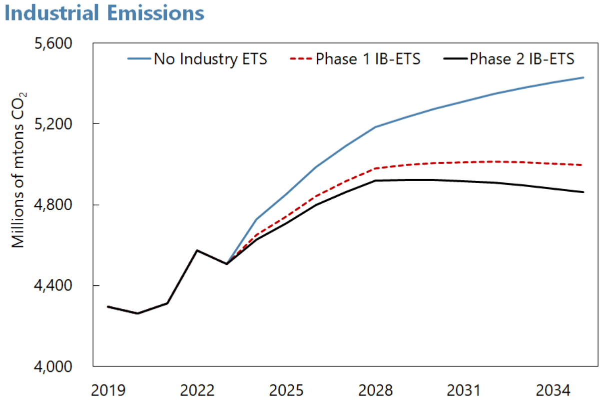
Source: IMF staff calculations.

[7] Low-income households have the highest marginal propensity to consume (IMF, 2022). Making targeted transfers to low-income households using revenues from ETS would support aggregate demand during the green transition.

12. In Scenario 2, China shifts to a quantity-based Emissions Trading System (QB-ETS), similar to the European Union's system.[8] Under a QB-ETS, fossil fuel power plants must surrender permits for every unit of electricity produced, creating the incentive for plants to cut both emissions intensity and electricity production from fossil fuels.[9] Because production is lower under the QB-ETS than the IB-ETS while the demand curve is the same, electricity prices are higher. Higher electricity prices are the largest cost of the QB-ETS because they raise prices for households and firms.

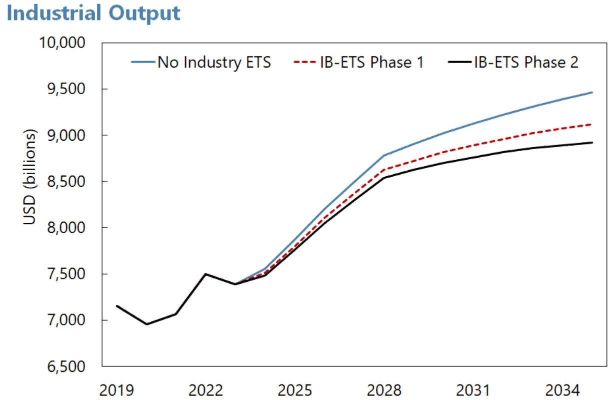
13. In Scenario 3, China extends the IB-ETS to include the industrial sector in Phase 1 and Phase 2. Expanding the IB-ETS to the industrial sector decreases the burden of emissions reductions on the power sector. As a result, fossil fuel power plants' unit costs, and hence electricity prices, increase by less than in Scenarios 1 and 2. Extending the IB-ETS to industrial sectors increases fossil fuel electricity production and emissions relative to the baseline. When the IB-ETS is extended to the industrial sector, the cost of burning fossil fuels rises for this sector. Higher costs can result in higher prices, lower quantity demanded, and a possible loss of competitiveness in international markets. Extending the IB-ETS to industry raises revenues from both the power sector and the industrial sector.

Industrial Emissions



Source: IMF staff calculations.

Industrial Output



Source: IMF staff calculations.

Welfare Analysis

14. We calculate the change in total welfare as the sum of the changes in consumer surplus, producer surplus, and governments revenues. We calculate consumer surplus using the changes in prices and quantities of residential electricity. We add the value of environmental benefits assuming that the difference between the social cost and the supply cost is $0.06 per kWh for coal-fired electricity and $0.12 per kWh for gas-fired electricity, as estimated in Black and others,

[8] In the early years of the European Union's QB-ETS, initial allocations of emissions permits were based on historical emissions levels. Gradually, the free allocation of permits has tapered down so that all permits in the power sector are now auctioned.

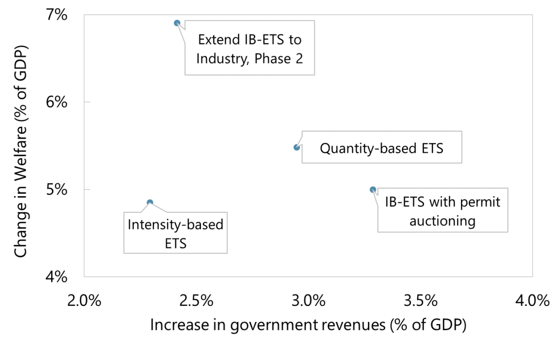
[9] An IB-ETS provides a strong incentive for each plant to reduce emissions intensity, but it has a mixed effect on production. This is because fossil fuel power plants that have an emissions intensity lower than the benchmark have an incentive to increase production.

(2023).[10] Both producer surplus, based on firm profits, and government revenues are direct outputs from our model.

15. While all scenarios considered raise welfare, extending the IB-ETS to industry raises total welfare the most thanks to increased coverage of the ETS (see Table 2). Welfare gains in all scenarios exceed that of the baseline IB-ETS. Although a QB-ETS raises electricity prices the most, negatively impacting consumers, these losses are more than offset by lower costs to power plants than in the IB-ETS. An extension of the IB-ETS to industry lowers profits for industrial firms but leads to smaller costs for power companies and a least negative effect on consumers, given less increase in electricity prices. The IB-ETS with permit auctioning raises most revenue but brings least improvement in consumer and producer surplus relative to the baseline. If annual changes in consumer and producer surplus are added up through 2035 and plotted against the sum of changes in government revenues, it is clear that all three scenarios are superior to the baseline. Some scenarios raise welfare more through changes in producer and consumer surplus (e.g. extension to industry), and other rely more on changes in government revenues which can be used to compensate households (e.g. permit auctioning).

China's ETS Reform Options: Effect through 2035

How to reach China's NDCs while maximizing welfare and protecting vulnerable households?



Distributional Consequences

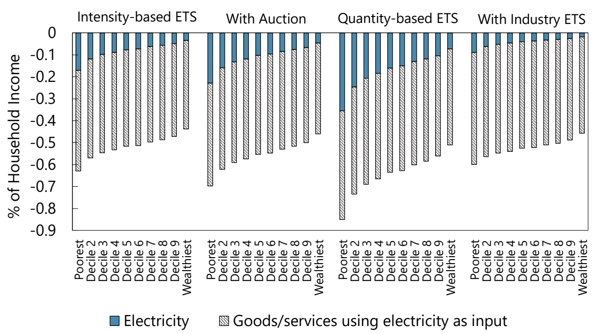
16. Increases in electricity price are important outcome because they increase costs for households and firms. The CPAT allows us to examine the effects of changes in electricity prices on households. In each of the panels in the chart below, the ten bars represent one decile of households. Because poorer households spend higher fractions of their wealth on electricity and goods and services using electricity, the impact on their incomes is higher than the impact on the incomes for wealthier households. Overall, since the price of electricity rises most under the QB-ETS scenario, decreases in household income for all households are highest in this scenario.

17. Distributional impacts on households can be offset with targeted transfers. Because each of the scenarios analyzed raise additional government revenues, we can examine the effect of directing a portion of those revenues as transfers to households. In the below graph, we direct 10 percent of new government revenues as lump sum transfers to the households in the lowest 3

[10] Because burning coal creates more air pollution and greenhouse gas emissions than burning gas, environmental externalities for coal are $0.06 per kWh, higher than the $0.038 per kWh for gas. However, the cost of purchasing natural gas for plants is much higher than the equivalent cost of coal for China. At the same time, coal-fired electricity and gas-fired electricity are sold at the same price. Because the social cost includes the cost of purchasing fuel, the difference between the social cost and the supply cost is higher for natural gas than coal.

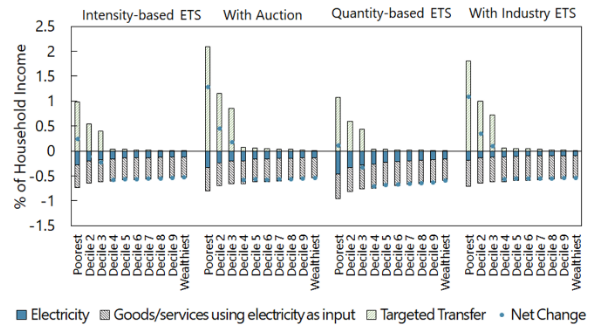
deciles. The regressivity of each system is reversed; lump sum transfers offset higher energy costs so that the poorest households now benefit from the IB-ETS and the three scenarios.

Relative Mean Per-capita Consumption Effect in 2030



Source: IMF staff calculations.

Relative mean per-capita consumption effect in 2030
(After transfers)



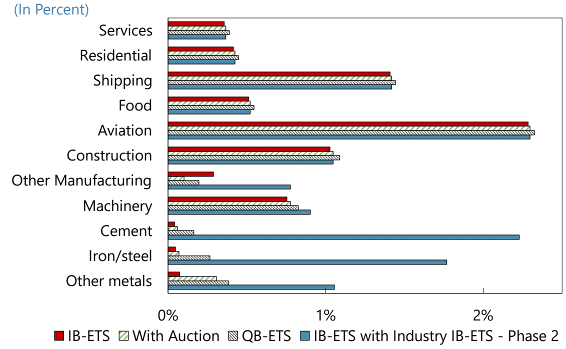
Source: IMF staff calculations.

18. Input costs also increase for major industries in all scenarios, with most cost increases between 0.5 and 2.5 percent. Because this simulation assumes equal effort by all sectors of the economy apart from industry, costs of fuels like gasoline and diesel increase for all sectors. As a result, overall input costs increase for most firms. As illustrated in the accompanying figure, input costs increase broadly across China, with the largest increases in those industries which are more energy-intensive, such as aviation. Cost increases are limited in the cement, iron and steel, and other metals industries until they are included in the industry IB-ETS in Scenario 3.[11]

D. Conclusion and Policy Recommendations

19. Reform of the existing intensity-based ETS would help China achieve its climate mitigation goals in a more cost-effective and welfare-maximizing manner. China is committed to reaching its climate goals. Early climate mitigation action—before 2035—is critical in reducing the overall costs of reaching China's ambitious 2060 carbon neutrality goal (Chateau and others, 2022, IMF, 2021). Early reforms would also be critical in helping reach the global goal of limiting warming to 1.5-2^{0}C. China's ETS is a key pillar of its climate policy and its continued

Change in Input Costs
(In Percent)



Source: IMF staff calculations.

[11] Firm input costs increase across the economy but are generally manageable, at 0.5 to 2.5 percent. For those firms that are projected to shut down (e.g., some coal power plants), temporary support could be provided to the affected localities and workers to assist with the reallocation of labor and capital. However, direct transfers to low-income households are generally better targeted and, along with a strengthening of the social safety net including unemployment insurance, would be the best way to address distributional concerns.

optimization will help China balance the trade-offs by improving the cost-effectiveness of the green transition.

20. China's existing plans to extend the intensity-based ETS to industrial firms should be accelerated (Scenario 3). Public finance theory recommends broad-based taxes with lower rates. Spreading emissions reductions from the power sector (44 percent of total emissions) to include the industrial sector (an additional 34 percent) would spread the burden of reducing a given amount of emissions. The gains from a smaller emissions reduction in the power sector outweigh losses from emissions reduction in the industrial sector, thus improving welfare. Scenario 3 indicates that electricity price increase would be lower when the IB-ETS extends fully to the industrial sector than under the baseline of existing IB-ETS.

21. China should use the ETS to raise fiscal revenue and use it to provide transfers to low-income households. In all scenarios considered, China experiences higher electricity prices as it reduces fossil fuel emissions in the energy sector. These higher electricity prices reduce real incomes in poor households more than those in rich households. Targeted transfers toward the lowest income deciles would reverse the regressivity of each policy. Gradually introducing permit auctioning and reducing the share of free permits is one way to raise revenue.

22. Finally, over the medium-term China should consider switching to a quantity-based ETS (Scenario 2) with a clear cap on total emissions.[12] This is consistent with environmental economics theory and prior modeling from Goulder and others (2022). Although the QB-ETS would increase energy prices for households and costs for firms, it would generate new government revenues that can be used to mitigate the harmful effects of these costs. As the renewable energy generation capacity and electricity storage options improve, moving to a QB-ETS, while also extending coverage, would maximize welfare while preserving China's energy security.

[12] Switching to a QB-ETS is equivalent to either auctioning all permits or dropping emissions intensity benchmarks to zero in the IB-ETS. See Annex for details.

References

Black, Simon, Antung Liu, Ian Parry, and Nate Vernon, 2023, "IMF Fossil Fuel Subsidies Data: 2023 Update," IMF Working Paper No. 2023/169.

Chateau, Jean, Wenjie Chen, Florence Jaumotte, and Karlygash Zhunussova, 2022, "A Comprehensive Package of Macroeconomic Policy Measures for Implementing China's Climate Mitigation Strategy," IMF Working Paper No. 2022/142.

Goulder, Lawrence, Xianling Long, Jieyi Lu, Richard D. Morgenstern. 2022. "China's Unconventional Nationwide CO_2 Emissions Trading System: Cost-Effectiveness and Distributional Impacts". *Journal of Environmental Economics and Management*, 111, 102561.

IEA, 2022. "Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector". (Paris: IEA 2022)

IEA, 2023. "Renewable Energy Market Update – June 2023". (Paris: IEA 2023)

IMF, 2021, People's Republic of China: Staff Report for the 2021 Article IV Consultation," IMF Country Report No. 2022/021.

IMF, 2022, People's Republic of China: Selected Issues," IMF Country Report No. 2023/081

IMF 2023, "The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate", IMF Working Paper No. 2023/128

Parry, Ian, Simon Black, and Karlygash Zhunussova, 2022, "Carbon Taxes or Emissions Trading Systems?: Instrument Choice and Design", Staff Climate Note No. 2022/006.

WRI, 2023 "These Countries are Adopting Electric Vehicles the Fastest."

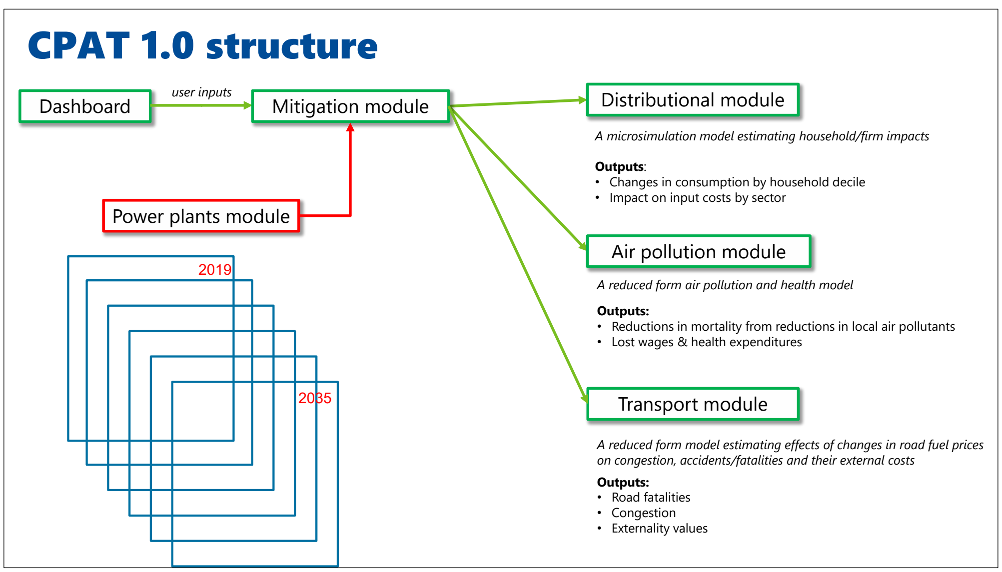
Zhang H., Zhang, D., Guo S., Zhang X. 2024 "Impact of benchmark tightening design under output-based ETS on China's power sector," *Energy*.

Annex I. Technical Details on CPAT and the Power Plants Module

1. The paper uses extensive quantitative analysis. Most of this analysis is based on a flexible and transparent spreadsheet model—the Climate Policy Assessment Tool (CPAT)—developed by IMF and World Bank staff. This model provides consistent cross-country projections for 200 countries of fuel use and CO_2 emissions by major energy sectors and the emissions, fiscal, economic, and distributional impacts of carbon pricing and other mitigation instruments. Although CPAT is based on central case parameter values, any modelling exercise involves inherent uncertainties over emissions projections and policy impacts. CPAT covers the period between 2020 and 2035.

2. The model of China's power plants is built and integrated into CPAT. The green boxes in the diagram below represent the main components of CPAT. The Dashboard receives user inputs and feeds them to the Mitigation module. The Mitigation module calculates how a policy would impact prices of energy, demand for it, and its first-order effects on the economy. The Mitigation module then feeds these results into the other three modules, which examine the broader effects of policy.

3. We built and added a model of China's power sector to CPAT. The power plants module that was constructed for this SIP augments the model of power plants in the Mitigation module. It models China's fossil fuel power plants at the province and technology class level. This models how the production and emissions of plants are likely to be affected by each policy environment.



4. Under an IB-ETS, fossil fuel plants optimize profits under the following profitability equation.

$$\pi = \underbrace{\left(\bar{p}\bar{q} + p(q-\bar{q})\right)}_{Revenue} - \underbrace{\left(\phi_0 + \phi_1 q^{\phi_2} + p_f \frac{h}{\xi} q\right)}_{Cost\ of\ Production} - \underbrace{\left(t[h\psi - \beta]q\right)}_{Cost\ of\ Compliance} - \underbrace{\left(\gamma \frac{\alpha}{1+\alpha}\left(h_0^{\frac{1+\alpha}{\alpha}} - h^{\frac{1+\alpha}{\alpha}}\right)q\right)}_{Cost\ of\ Adjustment}$$

In this equation:

- The first term in parentheses represents revenue received by the plant. $\bar{p}$ and $\bar{q}$ represent the price and quantity specified in any administrative contract the plant may have. p and q represent the market price and quantity sold by the plant.

- The second term in parentheses represents the cost of producing electricity. ϕ_0, ϕ_1, and ϕ_2 are parameters governing the operating and maintenance costs of production. p_f is the cost of fuel, h is the heat rate, and ξ is the energy associated with a unit of fuel input. The product $p_f \frac{h}{\xi} q$ represents the cost of fuel for the plant.

- The third term in parentheses represents the cost of complying with the IB-ETS, if one is present. The variable t is the cost of emissions permits. The variable ψ represents the carbon content of fuel, so $h\psi$ represents the carbon emissions intensity of the plant. The variable β is the government-set emissions benchmark for the technology class of the plant.

- The fourth term in parentheses represents the cost of adjusting the heat rate. The variable h_0 represents the initial heat rate of the plant. The parameters γ and α govern the cost of adjusting the heat rate.

5. The firm optimizes with respect to the quantity of power produced q and the heat rate h. This produces two equations governing the behavior of the plant with respect to changes in the price of electricity, the price of fuel, and government policy.

$$p = \phi_1 \phi_2 q^{\phi_2 - 1} + p_f \frac{h}{\xi} + t[h\psi - \beta] + \gamma \frac{\alpha}{1+\alpha}\left(h_0^{\frac{1+\alpha}{\alpha}} - h^{\frac{1+\alpha}{\alpha}}\right)$$

$$p\gamma h^{\frac{1}{\alpha}} = p_f \frac{1}{\xi} + t\psi$$

6. Under a QB-ETS, fossil fuel plants optimize profits under the following profitability equation.

$$\pi = \underbrace{\left(\bar{p}\bar{q} + p(q - \bar{q})\right)}_{Revenue} - \underbrace{\left(\phi_0 + \phi_1 q^{\phi_2} + p_f \frac{h}{\xi} q\right)}_{Cost\ of\ Production} - \underbrace{(th\psi q)}_{Cost\ of\ Compliance} - \underbrace{\left(\gamma \frac{\alpha}{1+\alpha}\left(h_0^{\frac{1+\alpha}{\alpha}} - h^{\frac{1+\alpha}{\alpha}}\right) q\right)}_{Cost\ of\ Adjustment}$$

A power plant under an IB-ETS has the same profits function as it would have under the QB-ETS if the emissions benchmark β in the IB-ETS were set to zero. This illustrates how China might transition from an IB-ETS to a QB-ETS.

Firms under a QB-ETS also optimize with respect to the quantity of power produced q and the heat rate h, with the following optimization equations:

$$p = \phi_1 \phi_2 q^{\phi_2 - 1} + p_f \frac{h}{\xi} + th\psi + \gamma \frac{\alpha}{1+\alpha}\left(h_0^{\frac{1+\alpha}{\alpha}} - h^{\frac{1+\alpha}{\alpha}}\right)$$

$$p\gamma h^{\frac{1}{\alpha}} = p_f \frac{1}{\xi} + t\psi$$

7. Our data include power plants at the province and technology class level. Using these data, we calibrate a baseline for Chinese fossil fuel plant production in 2019.

8. We calibrate the model baseline using projections for the Chinese power sector in CPAT. CPAT uses international data sources to project the price of electricity, coal, and natural gas in future years. Using the equations of behavior above, we can then calculate how existing power plants would produce power and emit carbon with this projection. Using CPAT's projections of investment in power plants, we then calculate new capacity that is built in future years. The result is the no ETS scenario that becomes the baseline of the model.

9. **We calibrate the QB-ETS scenario using CPAT's projection for a QB-ETS in China.** CPAT was built to model the effects of carbon pricing instruments such as a QB-ETS. We calibrate our QB-ETS policy scenario using this counterfactual policy scenario.

10. **We calculate the IB-ETS scenario.** We calculate a price for emissions permits and a path for emissions intensity benchmarks so that emissions from fossil fuel plants meet an NDC-consistent level in 2030 while production from plants matches projected production under IB-ETS power prices in CPAT.

11. **If permit prices are allowed to float, prices become unrealistically high in the baseline scenario.** There are two ways that the Intensity-Based ETS (IB-ETS) could be implemented as emission reductions become more significant. In the first method, emissions permit prices are allowed to float, balancing supply and demand. All emissions permits are allocated for free, based on the power plants' production levels and their technology class benchmarks. Under this method, prices for permits become unrealistically high, crossing a level of $800 per ton of CO2 in 2030 and almost $2,000 per ton of CO2 in 2035. Overall costs for power firms would increase by a factor of 3 to 5, necessitating massive increases in the price of electricity to avoid bankrupting fossil fuel firms.

12. **As a result, we cap permit prices, while relaxing the constraint on the number of permits sold in the market.** By design, the overall number of permits is the same in both modelling approaches, determined by the same NDC-consistent emissions path for the power sector. However, modelling the IB-ETS in this second approach implies that fewer permits are allocated for free, and the remainder of the permits are sold by the government in the market at capped prices. Fewer permits allocated for free implies that tighter benchmarks are deployed than those in the approach with the flexible price of permits, and a greater portion of the reduction in emissions comes from cuts in the quantity of power rather than reductions in emissions intensity. Because the government introduces new permits into the market at the capped prices, another feature of this implementation approach is that there is some fiscal revenue even without permit auctioning.

13. **The share of each fuel type in electricity generation is calculated by CPAT.** Growth of renewable energy is a crucial input in each scenario. CPAT calculates the growth in renewable power utilized by starting with existing capacity in historical years in China. It then estimates generation through historical utilization factors, dispatching electricity from carbon-free sources of energy like nuclear and renewables first. The remainder of electricity demanded is filled by fossil fuel sources of energy. This is primarily coal in the case of China. Costs for each fuel type is calculated, and investment in future periods is determined by comparing the total cost for electricity generation for each fuel. This investment then becomes the basis for renewable energy capacity in the following year.

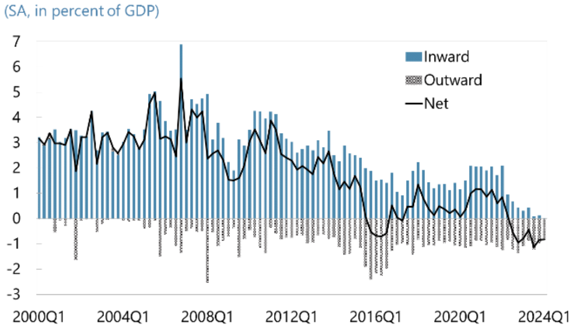
CHINA'S FOREIGN DIRECT INVESTMENT: INWARD AND OUTWARD[1]

This paper explores the potential drivers of China's foreign direct investment (FDI) flows in recent years, including by looking at sectoral trends. The analysis suggests that the downward trend in FDI inflows in recent years primarily reflects higher economic policy uncertainty, geopolitical risk, and weak future growth prospects. At the same time, the stability in total outward FDI masks an ongoing geographical diversification of Chinese FDI, higher flows to geopolitically aligned countries, and a shift away of investment from larger economies, consistent with the emergence of "connector" countries. Domestic policy uncertainty also appears to incentivize outward FDI. Reversing the decline in inward FDI will require steps to reduce policy uncertainty, work with other countries to mitigate geopolitical risks, advance structural reforms to boost potential growth, and relax inward FDI restrictions. The most attractive avenue for emerging markets to capture China's outward FDI is to implement structural reforms to increase capacity to absorb large investments, improve export diversification, and increase trade linkages with China, including by establishing free-trade agreements.

A. Introduction

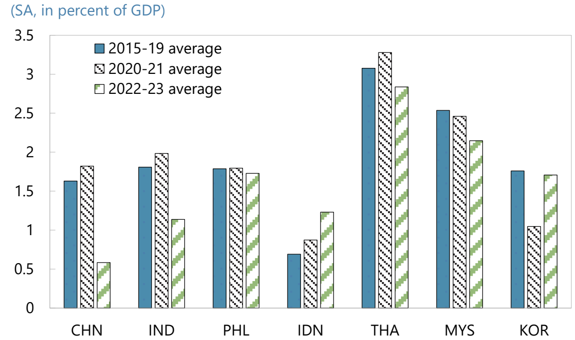
1. **Net FDI as a share of GDP was trending downwards since post-2008 crisis peaks.**[2] This was mostly due to declining inward FDI, a trend which accelerated in 2022-23, while outward FDI remained stable as a share of GDP. While several major Asian economies saw a sharp decline in inward FDI in 2022-23, China experienced the sharpest decline with FDI inflows reaching record-low levels (as a share of GDP).

Foreign Direct Investment
(SA, in percent of GDP)



Sources: SAFE; National Bureau of Statistics of China; Haver Analytics; and IMF staff calculations.

Inward FDI in Selected Asian Countries
(SA, in percent of GDP)



Sources: SAFE; National Bureau of Statistics of China; Haver Analytics; and IMF staff calculations.

2. **This Selected Issues Paper aims to identify main drivers behind both inward and outward FDI with a focus on recent years.** Regarding inward FDI, the paper analyzes which

[1] Prepared by Ashique Habib, Dmitry Plotnikov and Andrea Presbitero.

[2] This is based on BOP-consistent FDI data published by SAFE, which have somewhat different dynamics than the "FDI capital utilized" measure published by MOFCOM.

determinants of FDI drive the recent FDI decline. Existing hypotheses include a weaker growth outlook amid the property sector contraction, higher US interest rates, concerns regarding geopolitical tensions with the US and economic policy uncertainty. Regarding outward FDI, the paper aims at analyzing the potential changes underlying the apparent stability in China's outward FDI with a focus on the post-2018 period following imposition of US tariffs. Following Gopinath et al (2024), the role of "connector" countries is explored together with more traditional measures within a gravity-type equation.

3. **The paper finds that the inward FDI decline is associated primarily with an increase in geopolitical risk and economic policy uncertainty, while China's outward FDI is increasingly diverse geographically and relies increasingly on geopolitically aligned countries.** While perceived weaker prospects for China matter for inward FDI, their role is smaller than that of geopolitical tensions and policy uncertainty. Global interest rates do not seem to be associated with changes in inward FDI, once controlling for the other factors. For outward FDI, to enhance granularity the paper complements official data with proprietary private sector data from fDi Markets, based on public announcements. The regressions show higher reliance on host countries that are geopolitically aligned after the 2018 US tariff increase, with lower importance of the physical distance between China and a host country. China's FDI is also shifting away from large economies consistent with growing importance of "connector" countries.

4. **The paper covers inward FDI and outward FDI in separate sections.** Section B analyzes the determinants of inward FDI by utilizing cross-country panel regressions, and documents recent trends across sectors. Section C examines China's outward FDI through a gravity-type equations using both OLS and Poisson Pseudo Maximum Likelihood (PPML). Finally, the last section concludes and offers policy recommendation both for China and potential recipients of China's FDI.

B. Inward FDI

5. **To better understand the contributions of several factors to the recent FDI decline, a cross-country panel regression is estimated.** The dependent variable is quarterly BOP-consistent inward FDI/GDP for all specifications since 2000, where available. The included covariates are actual real GDP growth y_{it}, expected one year-ahead real growth from Consensus Forecasts (CF), $E_{it}[y_{it+4}]$[3], the interest rate differential between the US interest and the domestic short-term rate augmented by CF-based exchange rate expectations and EMBI spread. The regression also includes an economic policy uncertainty index (EPU, Davis, Liu and Sheng (2019)) and China's geopolitical risk index (GPR, Caldara and Iacovello (2022)).[4] Finally, the specification controls for global volatility

[3] A weighted average of the current and next year growth expectations with the corresponding weights depending on the quarter.

[4] The EPU index is a monthly scaled frequency count of articles about policy-related economic uncertainty in mainland China newspapers. The GPR index is a normalized monthly China-specific share of articles mentioning adverse geopolitical events and tensions.

captured by the VIX and a year-ahead expected US growth. To minimize endogeneity, the explanatory variables are lagged (as in the equation below).

$$\frac{FDI_{it}}{GDP_{it}} = f_i + \beta_1 \frac{FDI_{it-1}}{GDP_{it-1}} + \beta_2 y_{it-1} + \beta_3 E_{it-1}[y_{it+3}] + \beta_4 (i_{t-1}^{US} - (i_{it-1} + E_{it-1}[e_{it+3}] - embi_{it-1}) + \beta_5 EPU_{it-1} + \beta_6 GPR_{it-1} + \beta_7 VIX_t + \beta_8 E_t[y_{t+4}^{us}] + \epsilon_{it}$$

6. **The regression attributes most of the decline in inward FDI in recent years to higher policy uncertainty, geopolitical risks and, to a smaller extent, lower future growth expectations.** The results of the regression and the corresponding decomposition of FDI dynamics are below.[5] The results suggest both higher geopolitical tensions, proxied by GPR, as well as increased policy uncertainty are associated with lower FDI. Future domestic growth expectations as well as expected growth in the US also matter for FDI into China. All of these are statistically significant. The FDI decomposition, which is below, has a good fit.

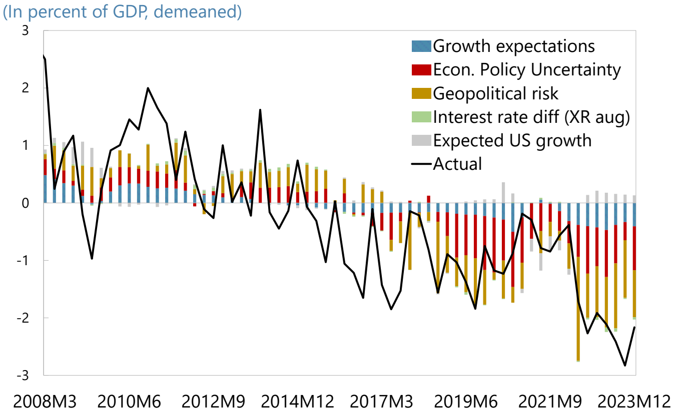
Inward FDI (In percent of GDP)

Lag	0.078	0.057
	(0.07)	(0.06)
Real growth, lagged	-0.024	-0.011
	(0.02)	(0.02)
Expected real growth, lagged	0.199 **	0.153 *
	(0.08)	(0.08)
VIX	-0.009	-0.011
	(0.01)	(0.01)
Int. rate diff., lagged	-0.009	-0.006
	(0.02)	(0.02)
Expected US real growth	-0.098 *	-0.104 **
	(0.06)	(0.05)
EPU, lagged	-0.003 ***	-0.002 ***
	(0.00)	(0.00)
GPR, lagged		-1.738 ***
		(0.44)
N	457	457

*** p<0.01, **< p<0.05, * p<0.1 All specifications are fixed effects with Driscoll-Kraay errors to account for common factors over time.

Inward FDI and Contributions

(In percent of GDP, demeaned)



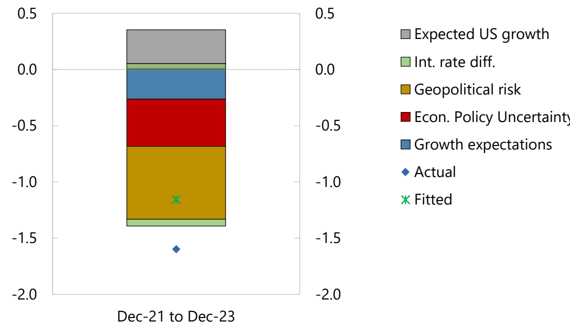
Source: IMF staff calculations.

7. **The decline in FDI inflows since end-2021 is estimated to have been primarily driven by geopolitical risk, policy uncertainty, and weaker perceived growth prospects.** An out-of-sample forecast of the FDI-to-GDP ratio suggests that of the actual 1.6 pp of GDP decline in inward FDI over this period, the regression attributes about 0.6pp of GDP to the increase in geopolitical risk, 0.4 pp of GDP to rise in policy uncertainty and 0.3 pp of GDP to worsening growth prospects. Surprisingly, the estimated role of the interest rate differential is small (0.1pp of GDP), despite

[5] Availability of EPU and GPR is the main sample constraint.

incentives to move earnings offshore to take advantage of higher interest rates abroad.[6] Overall, the regression explains about 75 percent of the cumulative FDI decline since 2021Q4.[7]

FDI Change Since End-2021
(In percent of GDP)

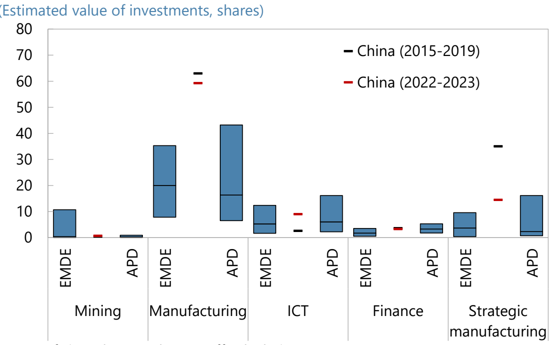


Source: IMF staff calculations.

8. To improve granularity, the remainder of the paper complements official BOP-based FDI data with private sources. In the official data, a breakdown of FDI by sector is unavailable, and the breakdown by country for Mainland China is dominated by Hong Kong SAR and British Virgin Islands, which only channel, rather than originate investments. To address this issue, the paper uses proprietary data on bilateral gross greenfield FDI flows from fDi Markets, a service from the Financial Times which tracks new physical projects and expansions of existing investments that create new jobs and capital investment.[8] The data are collected primarily from publicly available sources (e.g., media sources, industry organizations, investment promotion agency newswires) between January 2003 and December 2023. For each investment, the data indicate the source and destination countries, as well as the sector and volume (in USD) and other characteristics (Aiyar et al (2023)).[9]

9. According to fDi markets data, FDI into China is concentrated in manufacturing, including in strategic industries, which experienced outflows in 2022-23.[10] In China, FDI concentration in these sectors is much higher than in other Asian countries and EMDEs. The chart suggests that lower manufacturing FDI in

Sectoral Distribution of FDI Hosted in China
(Estimated value of investments, shares)



Sources: fDi Markets; and IMF staff calculations.
Notes: Box plots show median, 25th and 75th percentiles of distributions.

[6] Even though the US interest rate significantly correlated with China's inward FDI, the correlation disappears once controlling for the other factors, including geopolitical tensions which broadly coincided with the increase in the US-China interest rate differential.

[7] For example, one additional factor that can partially explain the declining trend of inward FDI is a lower share of manufacturing FDI, which tends to be more capital-intensive and require larger investments. In the fDi markets data, the share of manufacturing FDI declined from 70 percent in 2017-19 to 60 percent in 2022-23.

[8] fDi Markets does not track mergers and acquisitions and other international equity investments, or investment projects that do not create new jobs, or companies which establish a foreign subsidiary without a physical company presence.

[9] For China, the fDi markets data diverge from the official SAFE BOP-consistent data, especially for inward FDI (see figure in appendix). Aiyar S. et al (2023) show that fDi markets data is broadly consistent with official BOP data for countries in the aggregate.

[10] Strategic manufacturing includes production of semiconductors, telecommunications and 5G infrastructure, equipment needed for the green transition, pharmaceutical ingredients, and strategic and critical minerals (the list proposed by the Atlantic Council) augmented by industry groups which fall in the top-3 deciles of mentions of reshoring-related terms in companies' earnings calls between 2017-2022. See Aiyar et al (2023) for details.

2022-23, which declined by about 70 percent in value terms on average between 2022-23 and 2015-19 (by 81 percent for strategic manufacturing), was a major driver behind the overall decline in FDI.[11] In terms of source countries, the reduction was primarily due declines of flows coming from the U.S. and advanced Asian economies.

Post-pandemic: Sectoral composition of FDI, hosted in China 1/
(Estimated value of investments; shares)

Source region and income group pairs	Mining	Manufacturing	ICT	Finance	Other	Strategic manufacturing 2/
AFR-EMDE					0.2 (0.2)	
APD-AE	0.0 (-0.3)	7.7 (-9.0)	4.3 (3.5)	1.3 (0.1)	3.7 (-10.7)	1.4 (1.4)
APD-EMDE		1.0 (-0.5)	0.7 (0.6)	0.3 (0.1)	0.0 (-3.2)	0.7 (0.7)
EUR-AE	0.1 (0.0)	39.0 (15.5)	1.2 (0.3)	1.4 (0.1)	11.9 (5.0)	15.0 (15.0)
EUR-EMDE		0.0 (-0.6)	0.2 (0.2)	0.3 (0.2)	0.9 (0.3)	
MCD-EMDE		2.0 (1.5)		0.3 (0.0)	0.3 (0.0)	
WHD-AE		14.1 (-5.8)	2.2 (1.3)	1.8 (1.1)	4.9 (0.2)	4.4 (4.4)
WHD-EMDE		0.4 (0.0)				

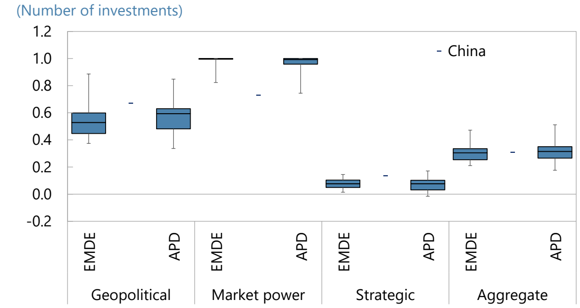
Sectors

Sources: fDi Markets; Atlantic Council; NL Analytics; and IMF staff calculations.
1\ Shares less than 0.1 are shown as empty cells. Green (orange) cells correspond to large increase (declines) in shares in 2022-2023 relative to 2015-2019. Shares of the first five columns (the numbers outside parenthesis) sum up to 100 percent.
2\ The shares sum up to the share of value of investments in strategic manufacturing in total investments in China.

10. To assess future fragmentation risks to inward FDI beyond the regression analysis, we use the IMF's recently constructed fragmentation vulnerability index. The index is country-specific and has three dimensions: geopolitical, market power, and strategic. The geopolitical vulnerability is higher, the greater is the share of investments from more geopolitically distant countries. This vulnerability could be partly offset if the country has a significant market share, as foreign companies will find it costly to relocate to different countries or regions. Finally, the strategic dimension reflects the notion that FDI in strategic sectors faces heightened vulnerabilities regardless of geopolitical distance, as the source country may be motivated to bring such investments closer to home.

11. China's large market size mostly offsets higher sensitivity to fragmentation risks coupled with a sizable share of strategic manufacturing, resulting in an overall estimated vulnerability that is close to the EMDEs median. China's geopolitical vulnerability is above the 75th percentile among EMDEs and Asia (the first subchart of the text chart), and its large share of strategic manufacturing creates an additional vulnerability for the future (the third subchart). However, as the second largest economy, China's market size is a mitigating factor as it remains an important destination for potential FDI (the second subchart). Aggregating these subindices, overall vulnerability index is broadly in line with the median EMDE.

Vulnerability Indices for FDI, hosted in China
(Number of investments)



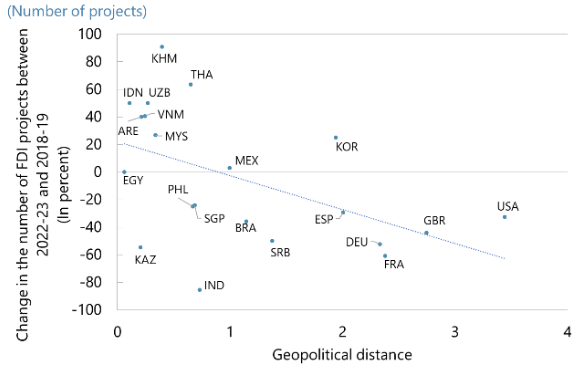
Sources: fDi Markets; Trade Data Monitor; Bailey and others (2017); Atlantic Council; NL Analytics; and IMF staff calculations.
Note: Please see WEO April 2023 Chapter 4, technical annex, for calculation details.

[11] The increase in the FDI share of ICT and European AEs and mostly reflects the decrease in the share of manufacturing FDI and from North American AEs.

C. Outward FDI

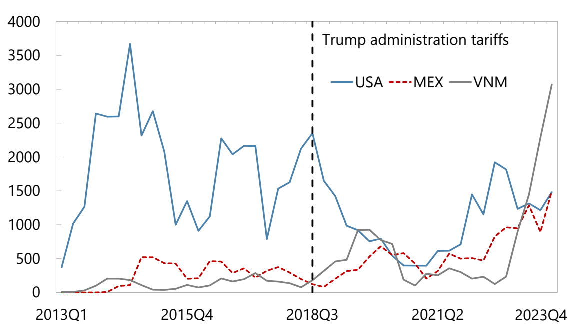
12. Recent changes in China's FDI appear to be related to geoeconomic shifts. According to fDi markets data, in 2022-23 the number of China's outward FDI projects declined substantially for many European and Asian AEs, while total flows to non-aligned "connector" countries – most notably Mexico, Vietnam – have more than doubled (Gopinath et al (2024)). Specifically, China's announced FDI to Vietnam and Mexico in 2022-23 relative to 2018-19 was about 170 and 300 percent, equivalent to 2 and 0.5 percent of these countries' GDP respectively. Ideal point distance (IPD), a measure of geopolitical distance used in this paper, which is based on voting at the UN General Assembly (Bailey et al (2017)), is strongly negatively correlated to these FDI changes.

Geopolitical Distance as a Factor in China's FDI
(Number of projects)



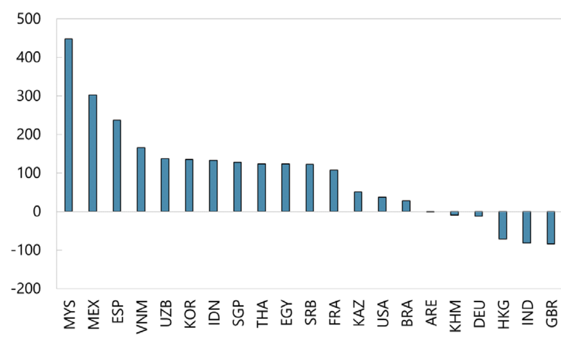
Sources: Bailey et al. (2017), fDi markets and IMF staff calculations.

China's Greenfield FDI in Selected Economies
(4-quarter moving average; in millions of USD)



Sources: fDi markets; and IMF staff calculations.

China's FDI USD Flow Change for Selected Economies
(Percent 2022-23 over 2018-19)



Source: fDi markets and IMF staff calculations. HKG stands for China's Hong Kong SAR.

13. To formally incorporate the idea of connector countries into a regression analysis, we consider the following definition of "proximity-to-GDP". Simplifying, when choosing a country to invest in country i, an investor should be maximizing sales of goods produced as a result of the investment domestically and externally (i.e, exports). Assuming exports behave according to a standard gravity equation, in a given period investor maximizes $\sum_j Exports_{ij} = \sum_j G_i(X_i)Y_i Y_j d_{ij}^{-\theta}$, where Y_i is GDP of country i, d_{ij} is distance between country i and j , $G_i(X_i)$ is a function of other characteristics of county i and $\theta > 0$ (typically $\theta = 1$). Then $\sum_j Exports_{ij} = G_i(X_i)Y_i \sum_j Y_j d_{ij}^{-\theta} = G_i(X_i)Y_i Y^{tot} \tilde{d}_i^{-\theta}$, where Y^{tot} is world GDP and $\tilde{d}_i = \left(\sum_j \frac{Y_j}{Y^{tot}} d_{ij}^{-\theta}\right)^{-\frac{1}{\theta}}$ is CES-aggregated distances to all potential trading partners weighted by their relative market size. We call this measure "proximity-to-GDP" and it captures the attractivennes of a country as a destination for investment based on its relative size. For example, in choosing whether to set up production in a large country like the US or a smaller neighboring country like Mexico, it's generally more practical to produce directly in the US, where "proximity-to-GDP" is higher, if you plan to sell mainly in the US. This is because products made in the US would have lower shipping costs than those made in Mexico, assuming shipping costs increase with distance. Hence, a negative relationship between investment and "proximity-to-GDP" would be consistent with FDI shifting away from large economies and emergence of "connector" countries.

14. To compare the relative importance of various factors as well as empirical relevance of proximity-to-GDP, a gravity model for China's outward FDI is estimated. When estimating the relevance of various FDI determinants, country-year pairs that had no China's FDI also contain information about how these factors affect FDI. Moreover, as Santos Silva and Tenreyro (2006) argue, OLS coefficients are likely to be inconsistent as the error term would be likely depend on covariates. To address this issue, the benchmark results are obtained using Poisson pseudo-maximum likelihood (PPML, specifications (3)-(5) in Table 1). Nevertheless, OLS results are also presented for comparison in Table 1 (specifications (1) and (2))[12]. The coefficients in all of the specifications correspond to semi-elasticities between either the annual number of new investment projects or annual investment value flow and corresponding potential determinants.[13] The equations also include a post-2018 dummy variable, including interaction terms to gauge changes since 2018 when the US imposed tariffs on China.

15. This is one of the first studies that analyzes the determinants of both number of projects as well as nominal investment value based on fDi Markets data. For example, Gopinath et al (2024) focuses on the number of projects because in some cases value of investment is estimated by fDi Markets. The other difficulty is that the right tail of the density of investment values is fat, which biases linear model towards high-value invesments.[14] This paper addresses the latter issue by presenting a PPML regression for investment values where the largest 5 percent of observations are discarded (Table 1, specification 5). As such, specification 3, which treats all projects equally independent of value, is more comparable to specification 5.

16. All specifications include standard gravity-model controls most of which are significant and have expected signs. The controls in all specifications (Table 1) include destination country and China GDP, lagged FDI variables (number of projects or investment value), labor costs (proxied by GDP USD per capita to minimize sample loss) and business start-up costs. All these variables are significant, except the start-up cost, which is insignificant after controlling for past FDI.

17. Chinese FDI is increasingly focused on geopolitically aligned countries. Geopolitical distance was already important for Chinese investors before 2018, indicated by a significant negative coefficient, for the number of projects (specification 3), but not for the investment value (specifications 4-5). Geopolitical distance appears to be secondary for large investment projects that require higher skilled labor, technology or know-how that advanced economies tend to have. Post-

[12] For the OLS regressions the LHS variable is $\log(x + \sqrt{1 + x^2})$, where x is either the number of projects or investment value. This function is well defined at $x = 0$ and quickly converges to $\log(2x)$.

[13] For PPML equations, the semi-elasticity is equal to exp(β)-1, where β is the number in the table, however for |β|<1, $\exp(\beta) - 1 \approx \beta$.

[14] In the China's investment value distribution, the maximum USD value is about 6.5 times larger than the 95th percentile.

2018, the negative significant interaction terms (at -0.16 in specifications 3 and 5) indicate a further increase in reliance on geopolitically aligned countries for both FDI variables.

18. The coefficients on proximity-to-GDP are consistent with emergence of "connector" countries. Pre-2018 proximity-to-GDP contributed negatively to the number of FDI projects, but positively to investment value. This finding suggests that prior to 2018 higher-value projects, which dominate coefficients in specifications 4-5, were located in large economies where proximity-to-GDP is maximized.[15] Diverse, but less expensive projects (that imply a large number of projects) were hosted in "connector" countries, with lower "proximity-to-GDP". The hypothesis that it is larger projects that drive the positive coefficient in specification 4 is supported by a lower coefficient on proximity-to GDP in specification 5. However, post-2018, even larger investments were moved away from larger economies (in specification 5 the total coefficient on proximity-to-GDP post-2018 is -0.23, very close to the one is specification 3).

19. Importance of physical distance has declined indicating geographic diversification of China's FDI. Physical distance (measured in kms) tended to negatively affect investment value (a significant negative coefficient of -0.2) pre-2018 (specification 4 and 5), likely driven by higher costs associated with managing larger projects that are farther away. However the positive significant interaction term for distance (specification 5) implies that, post-2018, China's FDI were destined to more distant countries.[16]

20. Unsurprisingly, a free trade agreement (FTA) and greater reliance on manufacturing exports tend to attract Chinese FDI. An active FTA is significantly associated with about 30 percent higher number of projects and 20-30 percent increase in annual China's FDI. Having manufacturing exports as the main source of exports earnings (WEO classification) further significantly boosts the annual number of projecsts by 40 percent and annual value by about 25 percent, since most of China's outward FDI is in manufacturing. EMs that rely on fuels for exports have received large China's FDI (see the positive significant coefficient in specification 4), but these are likely limited in the number of projects (the negative significant coefficient in specification 3) mostly focused on extraction (Molnar et al (2021)).

21. Higher domestic economic policy uncertainty appears to drive investments outward (specification 5). Statistically, higher domestic EPU is significantly associated with higher outflows. This indicates that the increase in EPU in 2022 all else equal was associated with about 20 percent increase in outward FDI value.

D. Conclusions and Policy Recommendations

22. The recent lower inward FDI in China reflects both cyclical and structural factors and could contribute to future lower growth. Weaker growth prospects, elevated policy uncertainty, and increased geopolitical risks have contributed to lower inward FDI in recent years. This may lead

[15] Consistent with the discussion in the previous paragraph.

[16] The total coefficient in specification 5 post-2018 on log distance is 0.11.

to a vicious cycle as lower FDI inflows could further weigh on productivity and future economic activity, underscoring the need to reverse the trend going forward.

23. Steps to open up the economy to more inward FDI (consistent with the authorities' plans), reduce economic policy uncertainty, mitigate geopolitical risks, and advance structural reforms would support greater FDI inflows to China. The analysis suggests that higher geopolitical risks and economic policy uncertainty are the two major factors that have negatively affected inward FDI since 2022. Thus, reducing those should help minimize the negative impacts on foreign investment. Pressing ahead with pro-market structural reforms to boost productivity and improve growth prospects would also help attracting more inward FDI, which in turn have additional positive feedback effects on growth.

24. China appears to continue investing in high-value projects even in geopolitically distant, large economies, while simultaneously building a network of geopolitically aligned "connector" countries through which it maintains market access to larger economies. ? The analysis suggests that the most promising policy avenues for EMDEs to attract Chinese FDI are to work on diversification of exports towards manufacturing, and increase trade linkages with China, including by establishing FTAs.

Table 1. China: Estimation Results from a Gravity Model for China's Outward FDI

	OLS		PPML		
	Number of projects	Value of investment	Number of projects	Value of investment	Value of investment 1\
	(1)	(2)	(3)	(4)	(5)
Destination country variables					
Log distance	-0.150 ***	-0.705 ***	-0.020	-0.203 *	-0.207 **
	(0.027)	(0.091)	(0.061)	(0.119)	(0.084)
Log proximity-to-GDP	0.122 ***	0.676 ***	-0.310 ***	0.685 ***	0.446 ***
	(0.033)	(0.113)	(0.105)	(0.167)	(0.110)
Log political distance	0.009	0.031	-0.119 ***	0.037	-0.009
	(0.011)	(0.038)	(0.029)	(0.056)	(0.043)
Post-2018	0.458	3.456 *	0.001	2.736	2.537 **
	(0.532)	(1.819)	(1.222)	(1.766)	(1.266)
Post-2018 x					
log distance	0.029	0.149	0.094	-0.006	0.319 ***
	(0.045)	(0.155)	(0.089)	(0.169)	(0.106)
log proximity-to-GDP	-0.098 *	-0.613 ***	-0.138	-0.350	-0.680 ***
	(0.054)	(0.183)	(0.148)	(0.243)	(0.148)
log political distance	-0.049 **	-0.182 ***	-0.164 ***	-0.127	-0.166 ***
	(0.020)	(0.068)	(0.056)	(0.083)	(0.058)
Active FTA	0.015	0.137	0.293 ***	0.324 **	0.195 *
	(0.033)	(0.115)	(0.080)	(0.163)	(0.114)
Export earnings: Fuel (=1)	-0.197 ***	-0.462 ***	-0.268 ***	0.368 *	-0.025
	(0.033)	(0.110)	(0.101)	(0.200)	(0.119)
Export earnings: Manuf. (=1)	0.143 ***	0.608 ***	0.418 ***	0.264 *	0.239 **
	(0.042)	(0.142)	(0.078)	(0.161)	(0.096)
Log labor cost (proxy) 2\	0.020 *	-0.039	-0.096 **	-0.240 ***	-0.133 ***
	(0.010)	(0.036)	(0.039)	(0.082)	(0.042)
Cost of business start-up 3\	0.000 *	0.000	-0.001	-0.002	0.000
	(0.000)	(0.000)	(0.001)	(0.002)	(0.001)
Lag FDI variable	0.592 ***	0.306 ***	0.020 ***	0.152 ***	0.142 ***
	(0.014)	(0.016)	(0.003)	(0.041)	(0.016)
Log destination USD GDP	0.145 ***	0.593 ***	0.602 ***	0.558 ***	0.430 ***
	(0.007)	(0.023)	(0.022)	(0.057)	(0.029)
China variables					
Log geopolitical risk 4\	0.056	-0.074	0.249	0.010	-0.234
	(0.055)	(0.188)	(0.160)	(0.310)	(0.175)
Log econ. policy uncertainty 4\	0.024	0.275 **	-0.088	-0.028	0.274 **
	(0.034)	(0.116)	(0.093)	(0.265)	(0.119)
Log China USD GDP	0.031	0.139	0.550 ***	0.723 ***	0.112
	(0.028)	(0.095)	(0.089)	(0.171)	(0.112)
R-squared/Pseudo R-squared	0.69	0.49	0.67	0.49	0.40
Number of observations	3674	3674	3674	3674	3456

*** p<.01, ** p<.05, * p<.1

1\Excluding top 5 percent of largest values.

2\ Proxied by USD GDP per capita. Other measures lead to significant sample loss. China's USD GDP per capita when included separately is insignificant in all specifications, keeping all other coefficents virtually unchanged.

3\ Measured as percent of GNI.

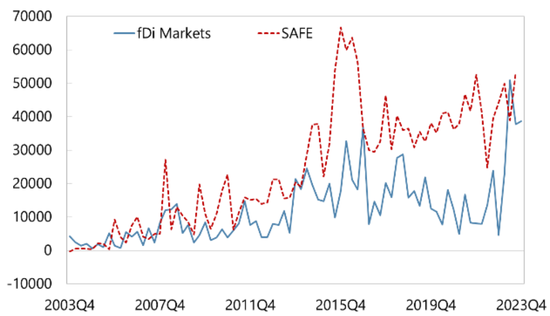
4\Normalized so that the long-term average is one.

Figure 1. China: Specifics of Data Used for China

While value of outward FDI is qualitatively similar to the official BOP data…

China Outward FDI

(In millions of USD)

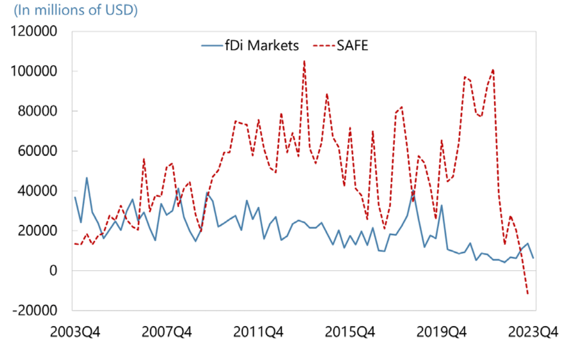


Sources: SAFE and fDi markets

…inward FDI is very different, apart from the long-term trend.

China Inward FDI

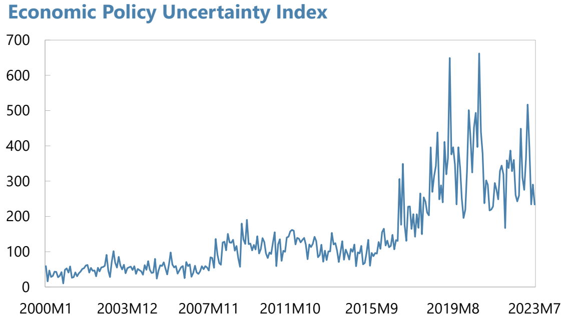
(In millions of USD)



Sources: SAFE and fDi markets.

The Economic policy uncertainty started to increase in 2016

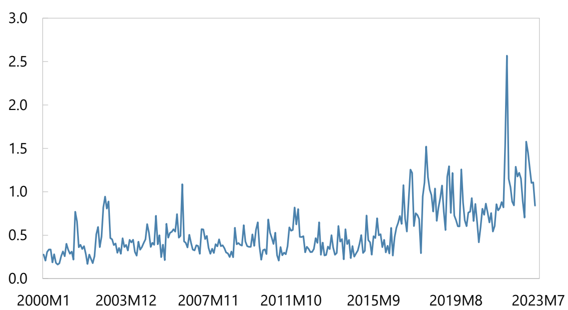
Economic Policy Uncertainty Index



Sources: "Economic Policy Uncertainty in China Since 1949: The View from Mainland Newspapers," by Steven J. Davis, Dingqian Liu and Xuguang S. Sheng, 2019.

…similarly with measured geopolitical risks that after declining in 2020-21, spiked in 2022.

Geopolitical Risk Index



Sources: Caldara, Dario and Matteo Iacoviello (2022), "Measuring Geopolitical Risk".

References

Aiyar S., Habib A., Malacrino D, and Andrea F. Presbitero (2023) "Investing in Friends: The Role of Geopolitical Alignment in FDI Flows", International Monetary Fund, August 2023

Bailey, Michael A., Anton Strezhnev, and Erik Voeten. "Estimating dynamic state preferences from United Nations voting data." Journal of Conflict Resolution 61.2 (2017): 430-456

Conte, M., P. Cotterlaz and T. Mayer (2022), "The CEPII Gravity database". CEPII Working Paper 2022-05, July 2022.

Davis S., Liu S. and Xuguang S. Sheng (2019) ''Economic Policy Uncertainty in China Since 1949: The View from Mainland Newspapers"

International Monetary Fund (2022), "*The Liberalization and Management of Capital Flows: An Institutional View",* Washington, DC: International Monetary Fund.

International Monetary Fund (2012), "*The Liberalization and Management of Capital Flows: An Institutional View",* Washington, DC: International Monetary Fund.

Caldara, D., and Matteo Iacoviello (2021), "Measuring Geopolitical Risk," working paper, Board of Governors of the Federal Reserve Board, November 2021

Gopinath, G., Gourinchas P., Presbitero A. and Petia Topalova (2024) "Changing Global Linkages: A New Cold War?" IMF Working paper No. 2024/076

M. C. Santos Silva and, Silvana Tenreyro (2006) "The Log of Gravity". *The Review of Economics and Statistics* 2006; 88 (4): 641–658. doi: https://doi.org/10.1162/rest.88.4.641

Molnar, M., T. Yan and Y. Li (2021), "China's outward direct investment and its impact on the domestic economy", *OECD Economics Department Working Papers*, No. 1685, OECD Publishing, Paris, https://doi.org/10.1787/1b1eaa9d-en.

ASSESSING VULNERABILITIES OF CHINA'S CORPORATE SECTOR[1]

China's corporate debt to GDP ratio is among the highest in the world, and it continues to increase. For nonfinancial firms (excluding real estate firms), pandemic-induced scarring effects are still evident, mainly in the form of declining profitability. The rapid increase in bank lending to small businesses poses financial stability concerns as such lending now accounts for a large share of banking sector assets and a thick tail of financially weak small firms could result in sizeable credit losses. Financial vulnerabilities of property developers are significant amid the ongoing property sector downturn. Furthermore, corporate debt-servicing capacity is generally vulnerable to a sustained increase in funding costs. As a matter of urgency, China should take a proactive approach to deal with debt of financially weak nonfinancial firms to safeguard macro-financial stability, including by maintaining prudential norms, facilitating debt restructuring where needed, supporting market-based mechanisms for credit allocation, and developing contingency planning for managing systemic risk events.

A. Introduction

1. **China's economy has experienced significant cyclical and structural adjustments in recent years, potentially affecting corporate financial conditions.** The post-pandemic economic recovery has revealed scarring effects in certain sectors, which could amplify existing corporate sector vulnerabilities such as high leverage and liquidity risks. In addition, China has undergone significant adjustment in the property sector since mid-2021, resulting in increased financial stress among property developers. Several other developments have affected corporates' financial situation, including regulatory tightening in some sectors (e.g., internet platforms, education, and entertainment) and increased policy support to strategic sectors (e.g., semiconductor, green technology, and advanced manufacturing).

2. **This *Selected Issues* paper aims to assess China's corporate sector vulnerabilities after the pandemic.** The objectives of the analysis are three-fold. First, the analysis serves as a stock-taking exercise to provide an updated view on underlying nonfinancial corporate sector vulnerabilities. Second, the analysis examines signs of corporate deleveraging, which will likely happen in highly leveraged sectors. Third, the analysis assesses financial stability implications of financially vulnerable corporate entities. The analysis is organized into two parts covering nonfinancial firms in (i) the corporate sector excluding the real estate sector and (ii) the real estate sector.[2] The real estate sector deserves separate attention, given ongoing financial stress of property developers.

---

[1] Prepared by Phakawa Jeasakul and Hong Xiao (IMF Resident Representative Office in Hong Kong SAR).

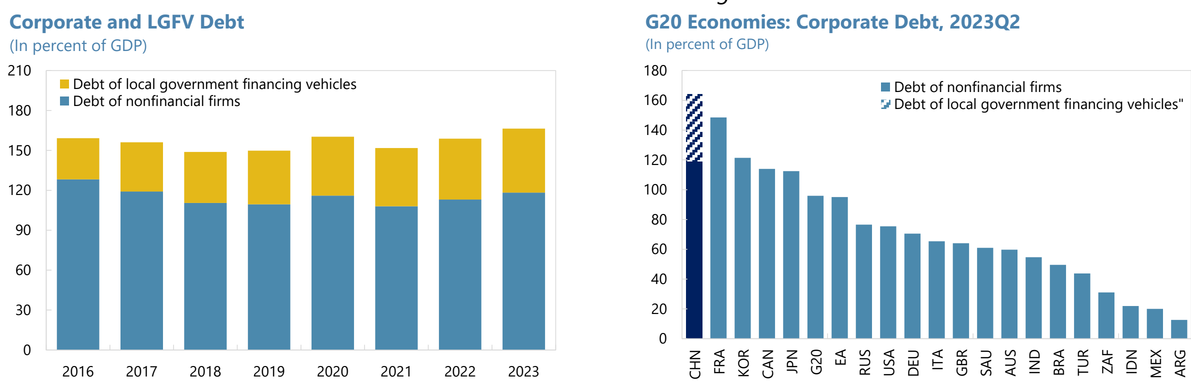
[2] The analysis excludes local government financing vehicles (LGFVs) as even though they are legally corporate entities, they help local governments borrow funds to finance public investment projects. Hence, their debt is included in the IMF's definition of general government debt, consistent with the IMF's Government Finance Statistics Manual (2014).

3. China's corporate debt as a share of GDP is among the highest in the world. The combined debt of nonfinancial firms and LGFVs amounted 172 percent of GDP as of end-2024Q1 based on BIS data, rising from 106 percent of GDP at end-2009Q1.[3] The figure, if LGFV debt is excluded, drops to 131 percent of GDP, which is still at the high end for the group of G20 economies. In terms of financing sources, corporate debt is mainly funded domestically, with bank lending accounting for 74 percent, followed by bond financing (15 percent) and nonbank financing (9 percent).[4] Within domestic bank lending, the manufacturing, business services, and transport sectors are the main borrowers, each accounting for about 15 percent of bank lending.

Figure 1. China: Corporate and LGFV Debt

China's corporate and LGFV debt continued to rise, surpassing 170 percent of GDP as of 2024Q1, and ...

... is relatively large among major economies even when considering only debt of nonfinancial firms excluding LGFVs.



Sources: CEIC; and IMF staff estimates.

Sources: BIS; and IMF staff estimates.

4. The *selected issues* paper is organized as follows. Section B presents the financial situation of nonfinancial firms excluding those in the real estate sector. The section discusses (i) the overall corporate leverage and deleveraging pattern; (ii) the post-pandemic scarring effects and notable financial vulnerabilities; and (iii) the financial weakness of small businesses. Section C analyzes the financial situation and vulnerabilities of property developers. Section D summarizes and offers some policy recommendations on how China could mitigate corporate debt vulnerabilities to safeguard macro-financial stability.

B. Financial Situation of Nonfinancial Firms

Overall Corporate Leverage

5. Corporate leverage remained broadly stable during 2019-23, while the immediate solvency risk appears limited. The aggregate ratio of total debt to total assets fluctuated around 38 percent, and a similar ratio based on total liabilities stood at 66 percent in 2023. However, corporate indebtedness—as measured by net debt (i.e., debt net of cash) relative to earnings before

[3] The figure is based on the BIS statistics, which measure corporate debt based on all legally corporate entities (thus including LGFVs).

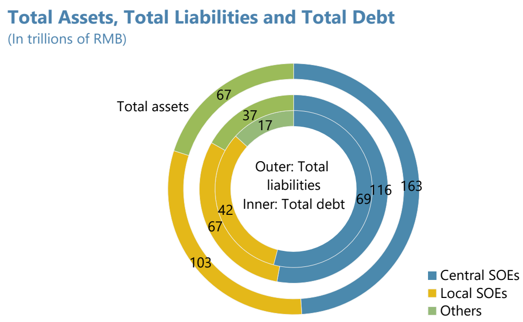
[4] Nonbank financing comprises trust loans, entrust loans and undiscounted banker's acceptance bills.

interest, taxes, depreciation, and amortization (EBITDA)—has edged up slightly, due to a more moderate increase in earnings compared to debt growth. Corporate leverage and indebtedness indicators are highest for central state-owned enterprises (SOEs). SOEs enjoy better financing access and lower funding costs than private firms, partly due to market perception of implicit government supports. For nonfinancial firms excluding real estate firms, the immediate solvency risk appears limited, as the share of firms with negative common equity has been close to zero.[5]

6. Within broadly stable corporate leverage overall, a notable portion of firms have deleveraged in recent years. Overall, slightly more than half of firms in terms of assets reduced leverage (i.e., total liabilities relative to total assets). Meanwhile, there is no strong evidence for large-scale debt reduction by nonfinancial firms in China, as only firms accounting 13 percent of corporate sector assets (excluding real estate firms) reduced debt in 2020-23. Private firms tended to reduce debt more than SOEs, although a larger share of central SOEs have managed to contain leverage.

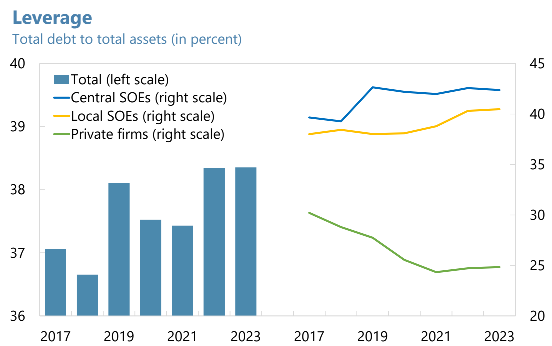
Figure 2. China: Nonfinancial Firms' Corporate Leverage

Central SOEs account for about half of the sample in terms of assets and liabilities, while private firms account for the smallest share.



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

Corporate leverage (based on total debt to total assets) remained broadly stable during 2019-23.



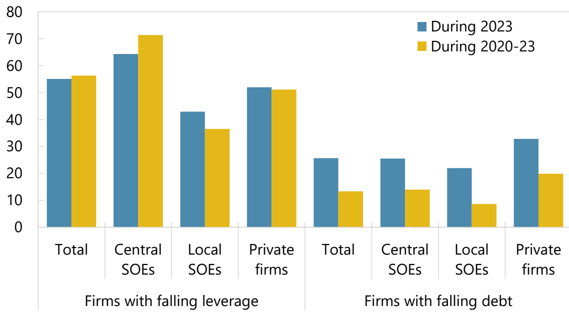
Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

[5] Firms are considered being at solvency risk if their common equity is negative.

Figure 2. China: Nonfinancial Firms' Corporate Leverage (Concluded)

Private firms have a greater tendency to reduce debt in recent years.

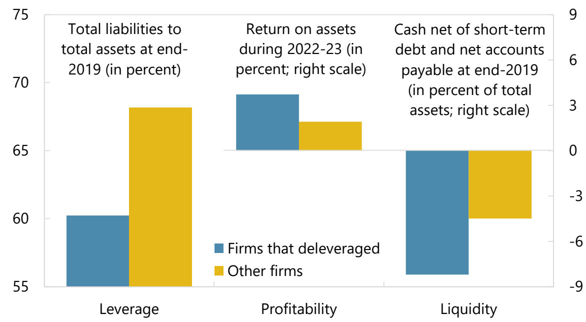
Share of Firms That Reduce Debt and Leverage
In percent of aggregated total assets



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

Both stronger profitability and weaker liquidity conditions appear to drive deleveraging efforts.

Characteristics of Frism that Deleveraged during 2020-23
In percent of aggregated total assets



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

Post-Pandemic Scarring Effects

7. **Corporate profitability has been on a declining trend since 2017.** The overall return on assets had fallen to 1.9 percent in 2023 from 2.4 percent in 2017. Profits margins also showed a declining trend,[6] falling from 18.4 percent to 16.3 percent over the same period. The decline in profit margins was driven by reduced sale revenues relative to total assets despite falling production costs (relative to total assets), pointing to signs of an increasingly intense market competition. The pandemic appeared to have scarring effects on corporate profitability, as firms accounting for 7 percent of corporate sector assets (excluding real estate firms) faced profitability risk in 2023.[7] The share of firms facing profitability risk remains higher than pre-pandemic levels. Private firms, though generally more profitable than SOEs, have a larger fraction of loss-making firms.

8. **Firms are inherently exposed to liquidity risk due to their negative cash position adjusted for short-term and net accounts payable.** In aggregate, cash held by firms amounted to 10 percent of total assets in 2023. However, sizeable short-term debt (16 percent of total assets), along with net accounts payable (2 percent of total assets), would result in a negative adjusted cash position (8 percent of total assets). If additional types of cashflows are considered, particularly earnings (5 percent of total assets) and net interest expense (1 percent of total assets), the expected cash position would remain negative (4 percent of total assets). Such aggregate liquidity conditions suggests that firms inherently face material liquidity risk especially if their ability to refinance maturing debt suddenly weakens.[8] The majority of firms faced liquidity risk, with about two-thirds of

[6] Profit margins are defined as sale revenues net of production costs (relative to sale revenues).

[7] Firms are considered being at profitability risk if their return on assets is negative.

[8] The estimation for adjusted cash and expected cash is a simplified cashflow-based liquidity stress test, which assumes that firms will not be able to refinance all short-term debt while maintaining their accounts receivable and accounts payable (for adjusted cash estimation) and will manage to generate the same amount of earnings and net interest expenses (for expected cash estimation).

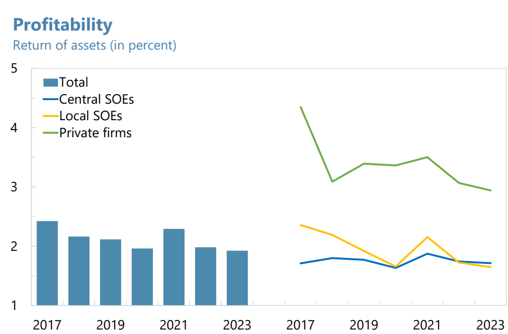
firms in terms of assets having a negative adjusted cash position, and slightly more than half of firms having a negative expected cash position.[9]

9. The pandemic has increased firms at viability risk, but the share of debt of firms with structurally weak debt-servicing capacity still appears manageable. Firms are considered as (i) being at viability risk if their earnings before interest and taxes (EBIT) are less than net interest expenses; and (ii) having structurally weak debt-servicing capacity if they have been at viability risk for three consecutive years.[10] The share of firms at viability risk in terms of assets had been around 8 percent during 2021-23, with a relatively high share for private firms. While the pandemic seems to reduce profitability of SOEs and private firms to a broadly similar degree, private firms appear to face greater viability risk as the impact of falling earnings on debt-servicing capacity is more evident given their higher funding costs. The share of debt of firms with structurally weak debt-servicing capacity (henceforth, "risky debt") had increased to 2.9 percent in 2023, which still looks manageable.

10. Firms' debt-servicing capacity is vulnerable to a sustained increase in funding costs. The share of risky debt will increase slightly if firms face temporary income and funding cost shocks (i.e., shocks that last for one year). However, more permanent shocks (i.e., shocks that last for more than three years) could structurally weaken firms' debt-servicing capacity. In particular, a permanent reduction in earnings by 10 percent would raise the share of risky debt by 6 percentage points, while a permanent increase in funding costs by 1 percentage point would raise the share of risky debt by 26 percentage points. Hence, firms appear susceptible to structurally higher funding costs. A high level of corporate debt could be a major reason behind such vulnerabilities.

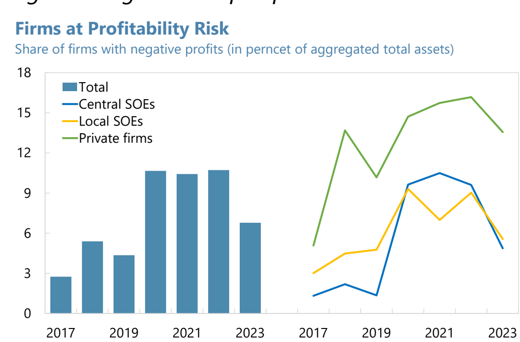
Figure 3. China: Nonfinancial Firms' Financial Vulnerabilities

Corporate profitability has been on a declining trend, …



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

… and the share of loss-making has fallen in 2023 though still higher than pre-pandemic levels.



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

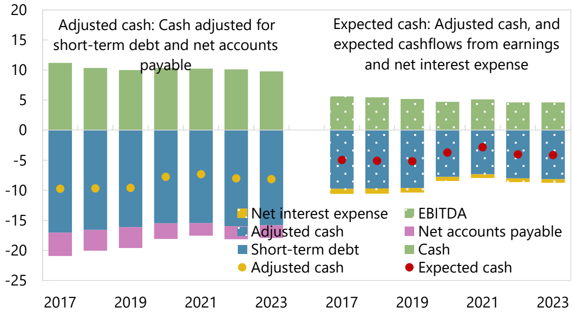
[9] Firms are considered being at liquidity risk if their adjusted or expected cash positions are negative.

[10] In this analysis, firms' debt-servicing capacity is assessed based on their viability—particularly, their ability to generate earnings to cover interest expenses. The structurally weak debt-servicing capacity builds on the "at viability risk" concept with an aim to gauge the presence of firms that would be structurally incapable of repaying debt. If firms are identified as having structurally weak debt-servicing capacity, it is likely that their debt could become nonperforming, thus inducing losses to creditors.

Figure 3. China: Nonfinancial Firms' Financial Vulnerabilities (Concluded)

Firms are inherently exposed to liquidity risk given their negative adjusted cash position, …

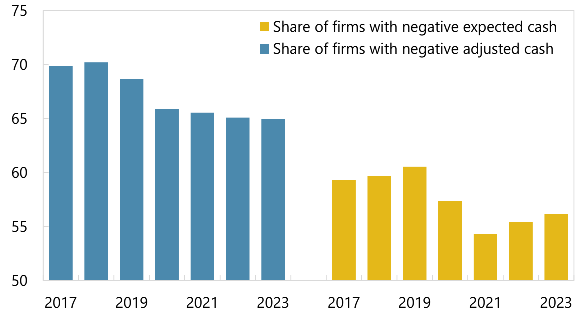
Liquidity
(In percent of total assets)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

… with a large share of firms with negative adjust cash and/or negative projected cash.

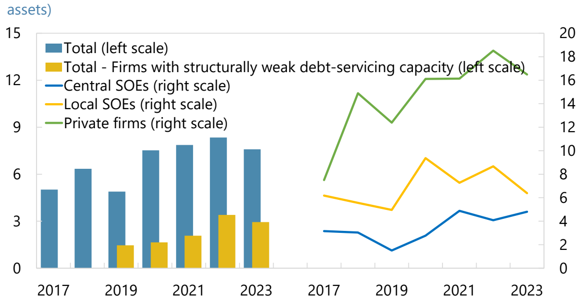
Firms at Liquidity Risk
(In percent of aggregated total assets)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

The share of firms at viability risk has increased through the pandemic, especially among private firms.

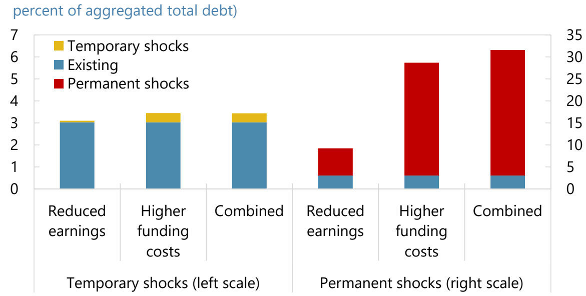
Firms at Viability Risk
Share of firms with EBIT less than net interest expense (in perncet of aggregated total assets)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Non-viable firms are those with EBIT less than net interest expense for 3 consecutive years. Data exclude real estate firms and local government financing vehicles.

Firms' debt-servicing capacity appears vulnerable to a sustained increase in funding costs.

Debt of Firms with Structurally Weak Debt-servicing Capacity in Adverse Scenarios
Debt of firms with EBIT less than net interest expense for 3 consecutive years (in percent of aggregated total debt)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

Financial Weakness of Small Businesses

11. **In aggregate, small firms appear financially stronger, with lower leverage and indebtedness, higher profitability, and a stronger liquidity position.** Small firms' lower leverage and indebtedness potentially reflects their inability to obtain external financing due to lack of collateral or credible financial information essential for credit decision-making. Although small firms are more profitable, they have also faced declining profitability in recent years. Nevertheless, small firms as a whole enjoy a relatively strong liquidity position, thanks to their positive net cash position and positive earning cashflows. While in aggregate, small firms look financially stronger, their financial soundness diverges considerably. For example, the distribution of small firms' profitability shows thick tails on both ends, with a large portion of both loss-making and highly profitable businesses.

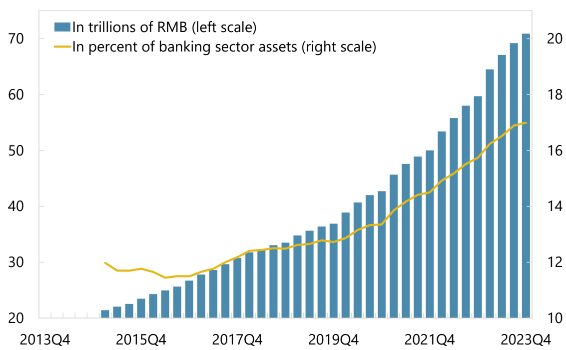
12. **Banks could face material credit losses associated with their lending to small businesses, given the large presence of financially weak small firms.** Bank lending to small businesses has increased substantially in recent years, raising two concerns about banks' asset

quality. First, the rapid increase in bank lending, partly driven by policy guidance, could be associated with weakening credit underwriting practices; second, a relatively large fraction of small firms face profitability risk and have structurally weak debt-servicing capacity. The share of small firms with negative profits increased to 24 percent in 2023 (compared to 7 percent for all firms), reflecting the challenging business conditions during the pandemic and thereafter. Furthermore, the share of small firms with structurally weak debt-servicing capacity amounted to 9 percent (compared to 3 percent for all firms), and small firms' debt-servicing capacity is vulnerable to both sustained income and funding cost shocks.

Figure 4. China: Financial Vulnerabilities of Small Firms

Bank lending to micro and small enterprises has increased sharply in recent years, driven by policy guidance.

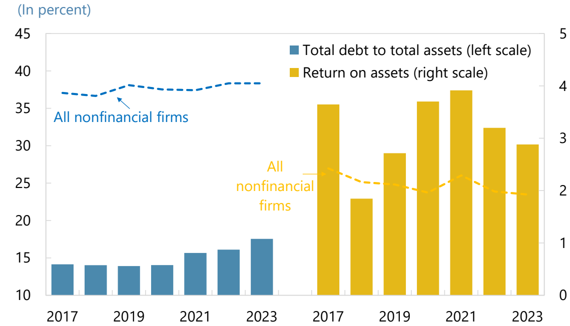
China: Bank Lending to Micro and Small Enterprises



Sources: CEIC; and IMF staff calculations.

In aggregate, small firms are less leveraged and more profitable than overall nonfinancial firms.

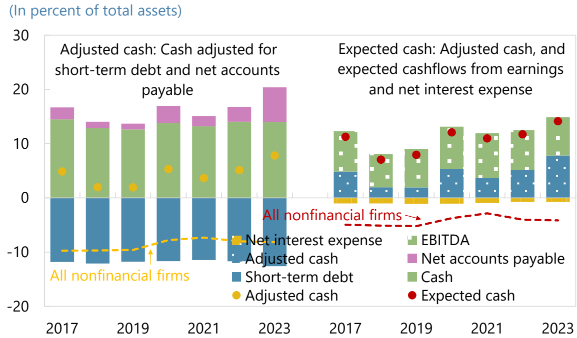
Small Firms: Leverage and Profitability
(In percent)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

Small firms also have a positive adjusted cash position and generate adequate earnings to cover interest expenses.

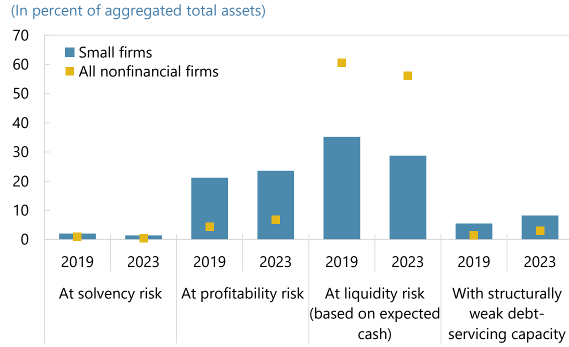
Small Firms: Liquidity
(In percent of total assets)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

However, a larger portion of small firms have negative profits and structurally weak debt-servicing capacity.

Small Firms at Risk
(In percent of aggregated total assets)



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude real estate firms and local government financing vehicles.

C. Financial Situation of Property Developers

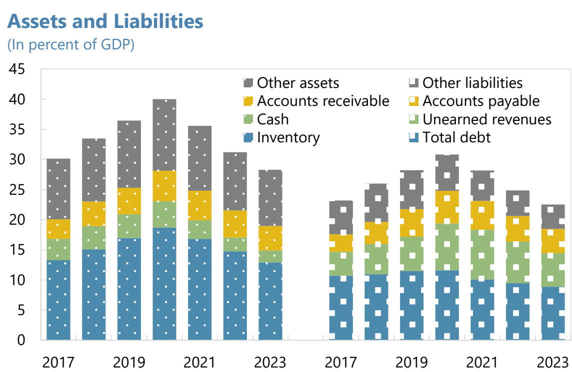
13. Property developers are highly leveraged. In 2023, their total liabilities to total assets stood at 80 percent, well above the level of overall nonfinancial firms. Despite being the largest component of liabilities, debt only accounted for 39 percent of total liabilities. Property developers also have other forms of liabilities, including unearned revenues associated with presales of yet to-be-delivered properties (26 percent of total liabilities) and accounts payables to contractors and suppliers (17 percent).

14. Financial vulnerabilities of property developers have risen sharply, including their sustained operating losses, exposure to liquidity and solvency risks, and weak debt-servicing capacity. In aggregate, property developers have been experiencing losses since 2021. Their liquidity position is also weak, resulting in financial stress. Particularly, their earnings are insufficient to cover interest expenses, leading to widespread defaults in recent years. Indeed, their solvency risk is already material and could increase further amid falling property prices. For example, if property developers facing liquidity shortfalls are forced to liquidate some assets at prices below book values, many of them could see their common equity becoming negative.

15. Despite the low direct exposure of banks to property developers, financial stability risks need to be monitored. Bank lending to property developers amounted to 3 percent of banking sector assets at end-2023. However, overall losses faced by banks could become much larger if the unfinished housing problem remains unaddressed and/or financial stress spills over to business partners of property developers.[11] While about 72 percent of property developers (in terms of assets) in the sample have defaulted on their bonds (mostly, offshore bonds), contagion from property developers to the financial system has been limited. Offshore bond defaults do not appear to have a direct impact on the onshore financial system. Meanwhile, the lack of loss recognition, partly driven by regulatory forbearance for banks, has temporarily limited stress in China's financial system. Only certain investors such as investors in trust products have experienced losses so far.

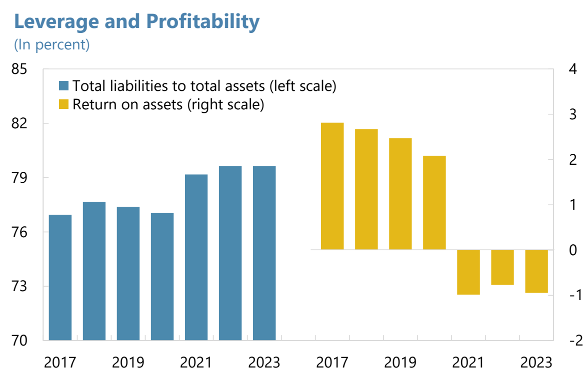
Figure 5. China: Real Estate Firms' Financial Vulnerabilities

Property developers have been deleveraging, although inventory and unearned revenues remain sizeable, reflecting difficulty to deliver pre-sold housing.



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude local government financing vehicles.

Property developers have experienced persistent losses during the property sector downturn.



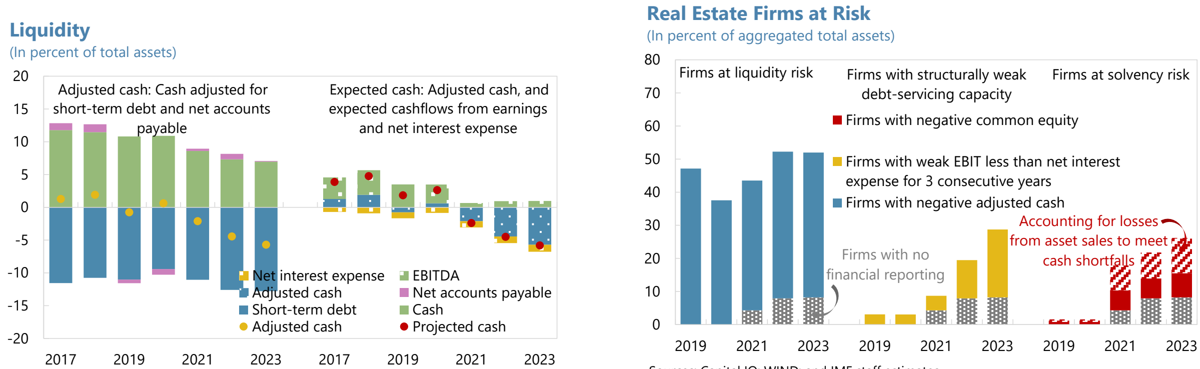
Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude local government financing vehicles.

[11] A non-negligible portion of mortgages are backed by unfinished housing.

Figure 5. China: Real Estate Firms' Financial Vulnerabilities (Concluded)

Property developers face significant liquidity risk due to their negative adjusted cash position and weak earning cashflows.

Furthermore, property developers are vulnerable to solvency risk and have a weak debt-servicing capacity.



Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude local government financing vehicles.

Sources: Capital IQ; WIND; and IMF staff estimates.
Note: Data exclude local government financing vehicles.

D. Conclusion

16. Pockets of corporate sector vulnerabilities are currently concentrated in property developers and small nonfinancial firms. Against the backdrop of existing high corporate debt, the pandemic-induced scarring effects are mainly in the form of declining profitability, which in turn resulted in the weakening of debt-servicing capacity in general. While there are no immediate financial stability concerns given that the amount of risky debt of nonfinancial firms excluding real estate firms remains manageable, the analysis of this *selected issues* paper points to several key vulnerabilities in the corporate sector:

- **Insolvency of several property developers.** Amid the ongoing property sector downturn, financial vulnerabilities of property developers have risen sharply, including due to their sustained operating losses, significant exposure to liquidity and solvency risks, and weak debt-servicing capacity. The large fraction of property developers facing structurally weak debt-servicing capacity and acute solvency risks highlights the urgent need to accelerate restructuring and/or orderly exits while ensuring the delivery of pre-sold housing

- **Asset quality risks related to financially weak small firms.** Owing to the rapid increase in bank lending to small businesses, partly driven by policy guidance, credit underwriting practices of bank could weaken as banks lend to borrowers with no credit history. The relatively large fraction of small firms facing profitability risk and structurally weak debt-servicing capacity suggest that banks could face significant asset quality risk.

17. China should take a proactive approach to deal with debt of financially weak nonfinancial firms to safeguard macro-financial stability. An accelerated cleanup of existing asset quality problems would help reduce risks of a long economic slump arising from adverse balance sheet effects. Key actions should include:

- **Maintaining prudential norms.** Some regulatory forbearance was introduced during the pandemic and in response to the property sector downturn. Such regulatory forbearance should be removed so that lenders are required to properly recognize credit losses and appropriately provision. Prudential requirements should be strictly enforced, supported by credible recovery planning to ensure the financial institutions' adequate capitalization, which can support their ability to manage nonperforming assets and perform credit intermediation to support the real economy.

- **Facilitating debt restructuring.** Modernization of the corporate bankruptcy framework could help improve the effectiveness of reorganization and enhance the use of hybrid restructuring techniques. A special insolvency process for small businesses should also be established. Introduction of a nationwide legal framework for personal insolvency could help facilitate the orderly resolution of financial difficulty of sole proprietors.

- **Supporting market-based mechanisms for credit allocation.** Policy guidance on overall credit growth targets, preferential access to credit for certain industries, and implicit government support, should be phased out as they result in inefficient resource allocation, mispricing of credit risk, and inadequate risk management.

- **Developing contingency planning.** It is important to develop contingency planning to mitigate financial contagion and support the functioning of core funding markets so that disruptions to economic activity would be minimized. In particular, market-wide liquidity support schemes could be developed to ease financial stress in core funding markets, including corporate bond and repo markets. Such financial stress could arise when markets reassess credit risk of credit bonds.

Appendix I. Data Description

1. Granular entity-level data are used to analyze corporate sector vulnerabilities. The analysis consists of two main components—(i) nonfinancial firms excluding those in the real estate sector, and (ii) firms in the real estate sector. The analysis covers Chinese corporate entities with publicly available financial information, with combined financial data from S&P Capital IQ and WIND database. The analysis covers the 2017-23 period.

- *Nonfinancial firms excluding those in the real estate sector*. The sample includes nearly 20,000 entities,[1] with aggregated total assets of 333 trillion RMB (264 percent of GDP) and aggregated total debt of 128 trillion RMB (101 percent of GDP). The sample comprises listed firms on major exchanges from S&P Capital IQ, listed firms on regional exchanges from WIND, non-listed bond issuers from WIND, and other non-listed firms from S&P Capital IQ.

- *Real estate firms.* The sample includes around 470 entities, with aggregated total assets of 36 trillion RMB (29 percent of GDP) and aggregated total debt of 11 trillion RMB (9 percent of GDP). The sample mainly comprises property developers, with financial data from S&P Capital IQ.

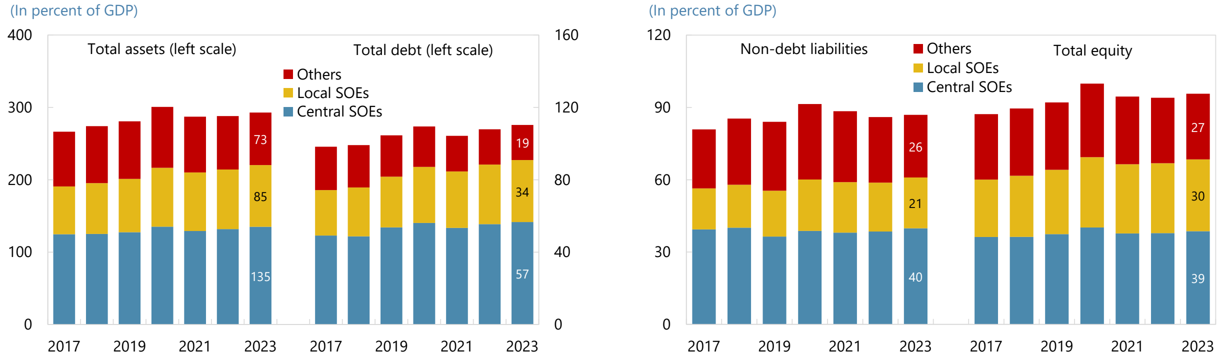
Text Figure 1. China: Assets and Liabilities of Corporate Entities in the Analysis

The analysis includes more than 24,000 corporate entities, with total assets of 398 percent of GDP and …

… total debt of 151 percent of GDP. Non-debt liabilities are also large at 105 percent of GDP.

Total Assets and Total Debt (In percent of GDP)

Non-debt Liabilities and Total Equity (In percent of GDP)



Sources: Capital IQ; WIND; and IMF staff estimates.

2. The analysis of small firms captures listed firms on the National Equities Exchange Quotations (NEEQ) and regional exchanges, with financial data from WIND database. Firms are considered small if their total assets are less than 1 billion RMB. The analysis includes about 6,400 entities, with aggregated total assets of about 1,400 billion RMB and aggregated total debt of about

[1] In terms of ownership, the sample includes around 1,100 central state-owned enterprises (SOEs), 2,600 local SOEs and 16,300 other entities (i.e., private firms and entities with unidentifiable ownership type). While the number of private firms dominates, their combined balance sheets are generally smaller than those of SOEs. In terms of assets, central SOEs account for 49 percent of the sample, followed by local SOEs (31 percent) and other entities (21 percent).

250 billion RMB. While the subsample of small firms includes relatively small corporate entities available in S&P Capital IQ and WIND database, such small firms are not a good representative for micro and small enterprises according to the official classification, which consider firms with much smaller balance sheets, revenues and employment.