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The End of Miracle?

China's Economic Growth Pattern

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[Abstract] Despite her recent "unprecedentedly" high and sustained economic growth, China has been long expected to suffer from sudden growth slowdown soon and eventually. We examine her growth pattern in the past three decades as income catching-up processes in developing economies such as those in East Asia, analyzing it in the conventional framework of economic growth based on an internationally comparable macroeconomic database. We find that her growth pattern is not exceptional in any sense, but very parallel with forerunners in East Asia, and that her growth is still in an early stage, so that we argue that her catching-up could be sustained, even if it were for possible short-term growth slowdowns.

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Introduction

Ten years after the door-opening policy by Deng Xiao Ping, the USSR collapsed in 1989 and Central and Eastern Europe were thrown out for market economy transitions, resulting in declines in life expectancy in the following decade. Then, East Asia well known for miraculous economic growth turned out not immune either, suffering from the Asian Financial Crisis in 1997. Further on, the global economy was hit by the Global Financial Crisis in 2008 and then by the Covid-19 Crisis in 2020.

Under the circumstances, China's growth over the last few decades is said to "stand out as a positive historical (and persistent) anomaly by any measure (Prasad 2023)."

Meanwhile, mean reversion (Pritchett=Summers 2014), middle income trap (Kharas=Indermit 2020), or other models have been used for years and mostly predicted an imminent sharp decline in China's growth. Many have simply argued that China's low levels of financial and institutional development, state-dominated economy, nondemocratic government, and other inadequacies should have dragged down growth. Is the much anticipated and long foretold day of reckoning finally at hand?

Worries also appear to come from China's recently emerging vulnerabilities. Their long list includes lower private investment and higher private debt, stagnant TFP growth, too high household saving and deposits, and declining population, on top of her long-term weak economic fundamentals.

Therefore, usual observations and assertions are summarized as:

China's growth over the last five decades has been spectacular and unique in recent history. It has done all of this without a well-functioning financial system, a strong institutional framework, a market-oriented economy, or a democratic and open system of government. Thus, "if the government's goal is to sustain growth, it needs to find ways to improve the allocation of resources within the economy and enhance productivity growth (Prasad 2023)."

This paper examines whether these observations and assertions are empirically warranted, from the perspective of a conventional economic growth model using internationally comparable database (Penn World Table (PWT) 10.01, Feenstra, Inklaar and Timmer, 2015). We identify common as well as uncommon features of China's growth pattern from those of developing and/or emerging market economies.

We should note, at the outset, that developing economies are far from homogeneous and, then, that only few of them have succeeded in attaining income convergence to advanced economies and most others have failed so

far (Kohsaka 2020 and Kohsaka 2022). Nevertheless, many people used to enjoy and have enjoyed talking about how developing economies are emerging to catch up with advanced economies eventually. They have created phrases such as NIEO, NICs, NIEs, New Convergence, BRICs, since the early 1970s, and, nowadays, Global South. In fact, however, income convergence and/or catching-up have never been a rule, but an exception so far. We have cared, but those advocates do not really, because they are forgetful in nature, so that history repeats.

We note that there is no such a thing as a "mean or typical" developing economy in terms of economic growth performance. In this paper, we focus on income catching-up processes of these few converging emerging market economies in East Asia as possible fore-runners to China. We identify their production functions and economic growth paths within a conventional neoclassical growth model, examine their growth patterns as catching-up process to the US economy in GDP per capita, and clarify their implications for China's past and future growth patterns.

Section 1 summarizes how China's high growth has been perceived, identifies their moot points and links them to our perspectives. In Section 2, to see if China's recent high growth is really unprecedented, we compare economic growths of China and other East Asian economies empirically using the PWT data, assess their similarities and dissimilarities, and ensure that China's recent high growth is exceptional, but not unprecedented. In Section 3, we place their data in the framework of a neoclassical growth model and see how the drivers of economic growth and the changes in other growth parameters affect their growth paths. In Section 4, we clarify the source of shifts of production functions through the decomposition of growth factors and find that growth contribution of TFP growth is rather limited than what has been said, but that of capital deepening is more important during the periods of 1960-1990 as well as of 1990-2019 in these economies, and that, particularly, high growths in East Asia including China commonly depend heavily on capital deepening.

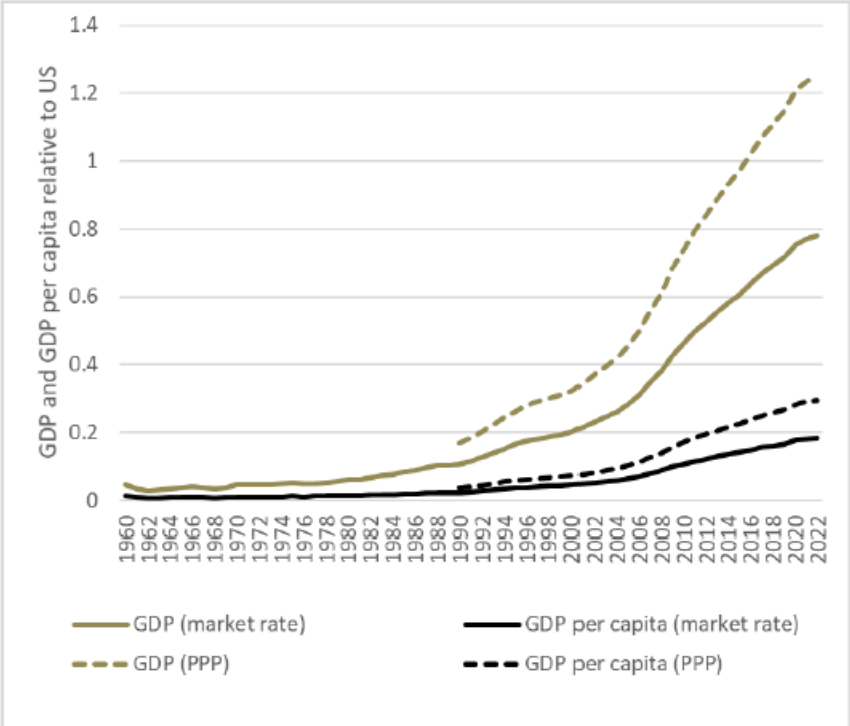
Section 5 then ponders the reasons for this. We show by a counter-factual experiment to what extent slow decreasing returns on capital work out in our framework, and suggest that continuous upward shifts of production functions also prevent the rate of return on capital from falling, as if economic growth paths look as approaches to ever-getting-away targets (steady-state equilibriums). In Section 6, we exhibit factual economic growth paths in a textbook-like, factor input-output or (k, y) space, illustrate catching-up processes of East Asian economies to the US and then discuss that China is possibly following East Asian trails. Finally, in Section 7, we

show several alternative scenarios of China's growth prospects based on combinations of growth parameters, i.e. TFP growths, capital income ratios and investment ratios. Without any a-priori presumptions on these parameters, we show that we can draw a wide variety of growth scenarios for China's growth prospects from quick slowdowns before catching-up to overpassing the US. Finally, Section 8 concludes.

1. China may have surpassed the US in GDP

In the past three decades, China jumped up from a low income country to a higher middle-income country. Her GDP surpassed that of the US in PPP in 2016 and reached 18 trillion US dollars in market exchange rates or as large as 73% of that of the US in 2022 (Figure 1). As compared to just 7% in 1990, its proportion became more than 10 times larger during the period.

Figure 1. GDP and GDP per capita, China relative to US



Note: GDP (market rate): 2015 constant US$, GDP (PPP): 2021 constant international $.
Data: World Bank, World Development Indicators.

Nevertheless, there still remains a large gap in per capita terms between China and the US. Her per capita GDP is US$13,000 or 17% of that of the US in 2022, while it was only 2% in 1990 (Figure 1). Also, her GDP growth appears to show some downward trend since the Global Financial Crisis (GFC) in 2008. Many economists who have predicted sooner or later China's growth slowdown might want to say I told you so.

If we note global economic slowdown since the GFC, however, it may be too early to say a sure thing. Particularly, while many tend to regard China as a typical developing economy as compared to advanced economies, we need to carefully scrutinize China's *unprecedented, miraculous* economic growth in comparison with developing economies in Asia, Latin America, Europe, Middle East and Africa, who has heterogeneous and diverse geographical and geopolitical backgrounds.

To those who believe in a *typical* developing economy, East Asia had appeared a miracle, which is why *East Asian Miracle* (World Bank 1993) appealed as publication title. Then, recent high growths in China and India seem to generate the fourth *Asiaphoria* (Prichett and Summers 2014, PS2014 hereafter), following the first (post-WWII Japan), the second (East Asia) and the third (Southeast Asia). This time in the fourth Asiaphoria, both economies are large economies of more than one billion in population, which is further unprecedented.

Forecasting these large economies' growth, PS2014 identified the mean reversion with respect to many developing economies' economic growth. In view of this, China's growth would not sustain that long, they argue. Also, while the growth processes of advanced economies are characterized by trend economic growth and business cycles around the trend, those of developing economies are characterized by no such trend growth, but by occasional sudden stops of growth, expressed as "the cycle is the trend" (Aguiar and Gopinath 2007). Therefore, PS2014 argue, China's (and India's) rapid growths would return to the mean eventually, and possibly abruptly.

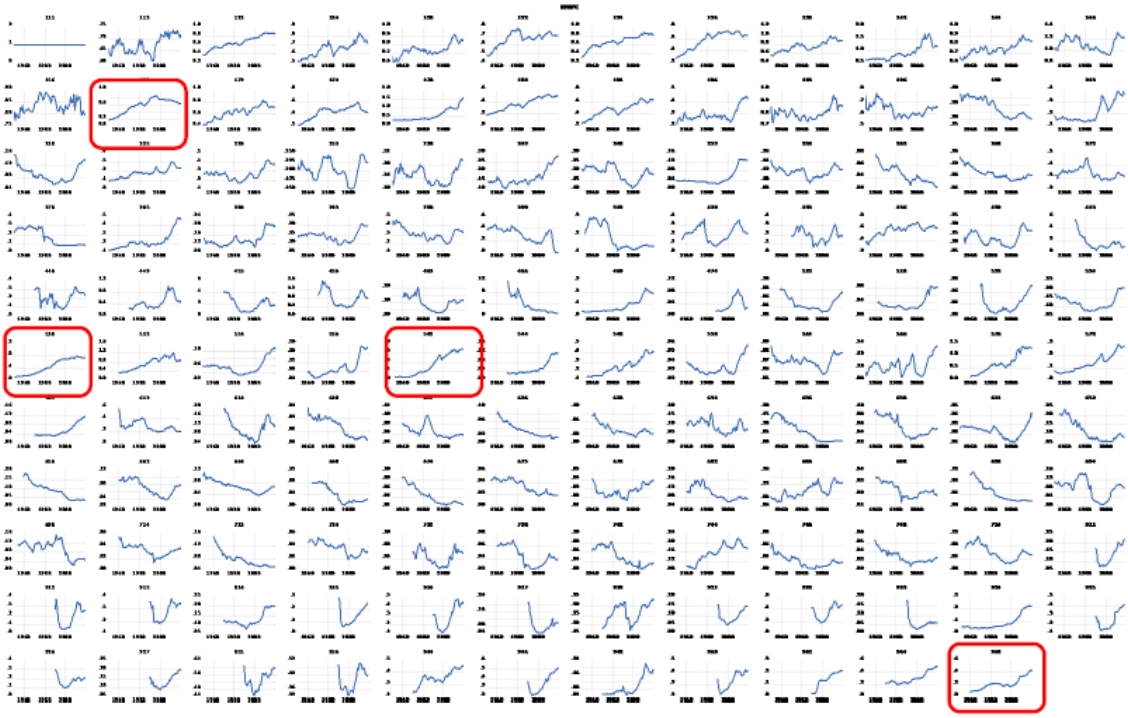
Furthermore, PS2014 stated: "Someone looking to predict the future health status of a 60-year old would give some weight to her health history but probably much more weight to the available information on the past populations of 60-year-olds. In the same way, ... in forecasting growth rates over the long term, forecasters should give heavy weight to the growth rate of all countries."

But, is it appropriate to treat an individual country's growth history as a mean of many countries' growth histories, as treating an individual health history as a mean of many individuals' health histories where the law of large numbers applies?

Above all, we already recognized distinct growth histories between advanced economies and developing economies. Then, why not we see distinct growth among developing economies too? In fact, just look at histories of 131 economies' growths relative to the US during the period of 1950-2019 in Figure 2. We find no general income convergence or positive slopes except for few including advanced economies (first two rows) and few

emerging market economies including East Asia (red circled, from the above, Japan, Taiwan, Korea and China). Is the mean of their growth performances meaningful for any individual economy? In the following, we examine to what extent and how China is exceptional to or distinct from the *mean* developing economy where "the cycle is the trend".

Figure 2. GDP Per capita relative to US, 1950-2019



Data: PWT10.01.

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2. China's growth has been exceptionally spectacular in recent history?

We start by showing that, in view of growth experiences in East Asia in the last six decades, China's rapid growth in the last three decades is as spectacular and exceptional as its priors in East Asia among emerging market economies, but rather not unprecedented, nor unique, which is pointed out by Fernandez-Ellaverde, Ohanian and Yao (2023). We ascertain that the East Asian fore-runners attained more spectacular growth performances than China.

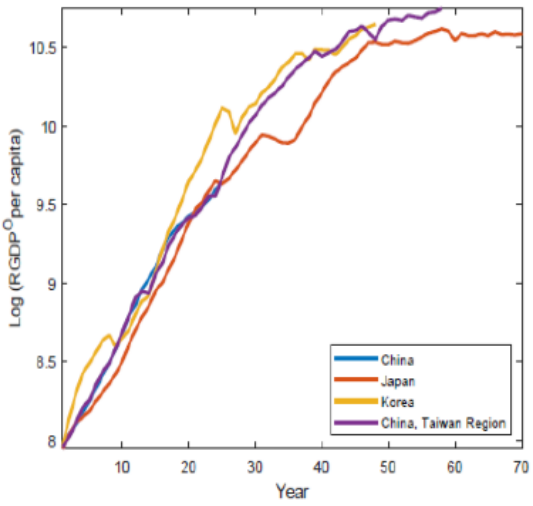
Is the China's rapid growth truly unprecedented in history? What about Japan, the first example of Asiaphoria? What about the second, i.e. Korea and Taiwan, and the third, i.e. Southeast Asian countries?

Fernandez-Villaverde, Ohanian and Yao (2023) demonstrate that China's growth pattern surprisingly resembles those of East Asian economies, i.e. Japan, Korea, and Taiwan as well as Hong Kong and Singapore, and that

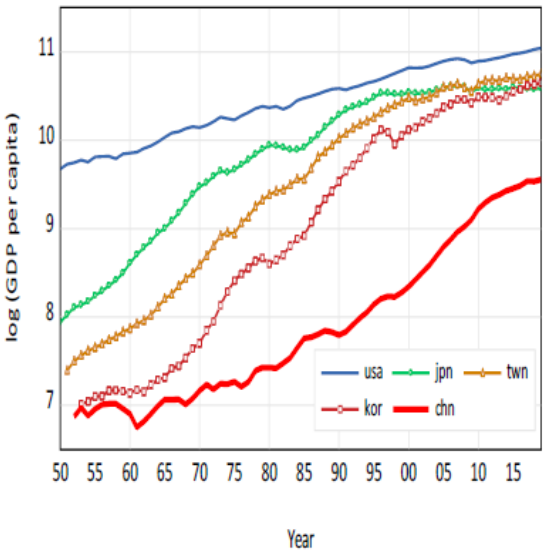
their growth rates declined significantly after their initial high growth (Figure 3, Panel a). Panel a shows the patterns of their GDP per capita growths from the level of US$2,825 (constant 2015 US$), which is China's GDP per capita in 1995. Since the years when GDP per capita reached US$2,825 are 1950 (Japan), 1962 (Taiwan) and 1972 (Korea), the spans of their time series become 70 years for Japan, 58 years for Taiwan, 48 years for Korea and 25 years for China. Their growth paths appear generally duplicated, and surprisingly so, particularly in the first half of the period.

Figure 3. GDP per capita

a. GDP per capita at US$2,825 (PWT10.0) as a starting year



b. Time series (PWT10.01), 1950-2019



Note: country codes are as: jpn: Japan, twn: Taiwan, kor: Korea, chn: China, hereafter.
Source: Panel a: Fernández-Villaverde, Ohanian and Yao (2023), Figure 3.1. Panel b: PWT10.01.

If we observe their growth paths in a usual timeline (Figure 3, Panel b), we can detect similar high growth of Japan for 1950-1980 (1990), of Taiwan for 1960-2000, and of Korea for 1965-1995, by their slopes. We note that China's high growth for 1990-2015 is not comparable to those of the three economies both in terms of growth rates and their durations. As a consequence, their gaps from the US in GDP per capita persistently narrowed during these respective periods, faster than the case of China. We also note, however, that their growths have shown trend slowdowns in Japan from the 1990s, in Taiwan and Korea from the Asian Financial Crisis (AFC) in 1997.

In other words, China's high growth during the recent three decades is not historically unprecedented, but mostly comparable with prior high growth economies in East Asia or East Asian Miracle. While their trend growth slowdowns to medium growth started after the bubble-burst in Japan and after the AFC in Taiwan and Korea, China's started after the GFC.

Whether these ends of rapid growth are endogenous to economic growth or just the by-products of structural transformations of the global economy, could be intriguing research agenda for future.

3. China in view of a neoclassical growth model

To examine their growth performances in a bit more analytical conceptual framework, we set up production functions and growth transition paths of four economies in East Asia (China, Japan, Korea, Taiwan) and US in a most simple neoclassical growth model with exogenous technological progress and saving rates, and trace their growth experiences in comparison during the period of 1960-2019. using PWT10.01. We reveal that China's growth has been heavily dependent on capital accumulation rather than on TFP growth. However, the pace of capital accumulation in Korea and Taiwan has gone beyond China's, resulting in their income convergence to the US, which is exceptional among emerging market economies.

We presume a production function of Cobb-Douglass type as:

$$Y/L = A\,(K/L)^{\theta} \qquad (1)$$

where Y: output (GDP), L: labor input, K: capital input, A: factor productivity (TFP), θ: capital income share. Here, with a constant θ, labor productivity (Y/L) growth depends on a rise in A or TFP growth, and a rise in a capital-labor ratio (K/L) or capital deepening. In this framework, while TFP growth promotes labor productivity growth proportionately, capital deepening can do so less than proportionately as far as θ is less than 1.

Dividing both sides of (1) by total population (N), we obtain:

$$Y/N = A(K/N)^{\theta}\,(L/N)^{(1-\theta)} \qquad (2)$$

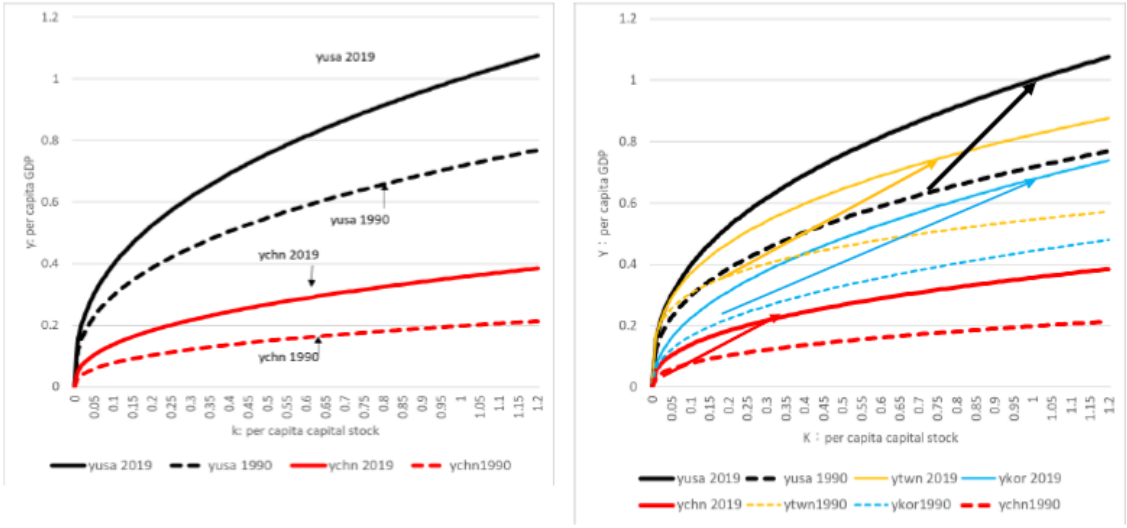
where Y/N: GDP per capita, K/N: capital stock per capita, L/N: labor participation ratio (labor ratio, hereafter). Equation (2) gives a basic analytical framework in the following. Using PWT10.01, Figure 4 (Panel a) illustrates production functions of China and US for 1990 and 2019, given actual L/N and θ, where we normalize both GDP per capita, capital stock per capita and TFP of the US in 2019 as one. Table 1 gives normalized measures of Y/N, K/N and TFP of each economy-year pair[1].

[1] Among variables included in PWT10.01, we use "rgdpna" for Y, "pop" for N, "emp" for L, "rnna" for K, (1 – "labsh") for θ, "cshi" for s, and "delta" for δ. TFP is calculated according to Equation (2) as a residual.

Figure 4. Production functions and growth transition paths

a. Production functions: usa, chn

b. Transition paths: usa, twn, kor, chn



Note: yusa 2019: production function of usa, 2019, etc. Per capita GDP and per capita capital stock: normalized as those of usa, 2019 = 1. Production function: $y_t = A_t k_t^{\theta}$ (y: per capita GDP, A: TFP, k: per capita capital stock, θ: capital income share).

Table 1. GDP per capita (y), capital stock per capita (k) and TFP (USA, 2019 = 1)

	Per capita GDP (y)	Per capita Capital stock (k)	TFP
usa			
1960	0.305	0.379	0.434
1990	0.632	0.722	0.717
2019	1.000	1.000	1.000
jpn			
1960	0.087	0.070	0.379
1990	0.469	0.586	0.426
2019	0.634	0.898	0.436
twn			
1960	0.042	0.015	0.254
1990	0.359	0.192	0.254
2019	0.747	0.759	0.349
kor			
1960	0.020	0.030	0.353
1990	0.221	0.197	0.430
2019	0.675	0.993	0.483
chn			
1960	0.016	0.005	0.408
1990	0.039	0.018	0.408
2019	0.226	0.331	0.414

As each production function is a locus of a combination of capital stock and GDP per capita representing technology frontier of each economy-year pair, an actual data is a point on each production function curve, i.e. (1, 1) gives the US economy in 2019. Likewise, since US TFP in 1990 is 0.717 as compared to that of 2019, a combination of capital stock and GDP per capita for 1990 are (0.722, 0.632) on a dotted US production function curve for 1990. A dynamic path from this point to (1, 1), is illustrated as an arrow in Figure 4, Panel b, gives a US growth transition path for the period of 1990-2019.

In the same way, we can observe China's production functions for 2019 as a solid curve second from the bottom and for 1990 as a dotted curve at the bottom. We note first that her TFP increase for 1990-2019 is smaller than that of US (Table 1). Consequently, her marginal rate of return on capital is smaller than that of US, even though her capital stock is far lower than that of US. Panel b shows that China's growth path from (0.018, 0.039) to (0.331, 0.226) during the period of 1990-2019 did not appear to show income converge to that of the US.

By contrast, Korea and Taiwan visibly narrowed differences in GDP per capita from that of the US for the period (Table 1). Their engines of growth are not TFP, but apparently capital deepening. Figure 4, Panel b, demonstrated that their growth paths are horizontally stretched beyond that of the US for the period. In other words, the contribution of capital deepening is far larger in Korea and Taiwan than in China.

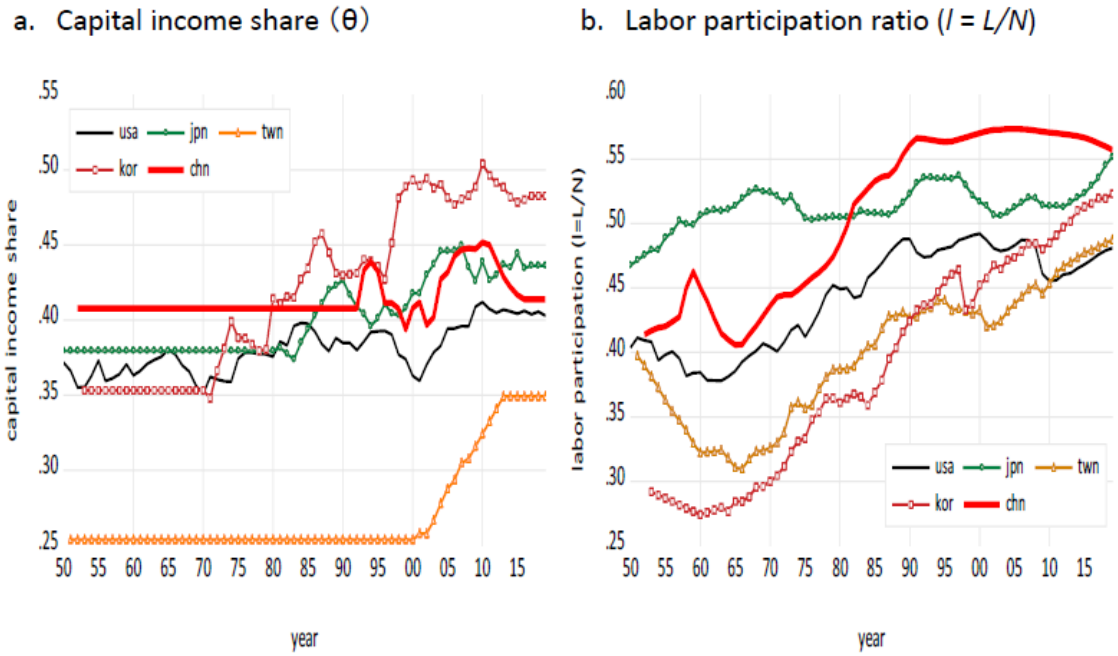
4. Drivers of growth: Growth decomposition

As illustrated by Figure 4 in the previous section, production function curves in the (K/N, Y/N) space shift upward period by period, e.g. the growth effect of capital deepening during the period of 1990-2019 along the 1990 production function curve constitutes only a small part of total growth during the period. In other words, economic growth is not an economic transition along a fixed production function curve, but a shift of a combination of output and capital stock across shifting production function curves. Therefore, while marginal rates of return on capital decrease along with capital deepening under a fixed production function, they may not necessarily decrease along with capital deepening across shifting production functions.

What then determines levels of production function curves? Equation (2) tells us that they are A, θ and L/N. While an importance of A, i.e. TFP, is well-known, rarely discussed are the roles of changing θ, i.e. capital income share, and L/N, i.e. labor ratio. In fact, if we look at actual capital

income shares (Figure 5, Panel a), they have shown more or less upward trends in recent periods, although, for the former periods, only their average figures are available[2]. Likewise, labor ratios (L/N) also have shown upward trends toward recent periods (Panel b). Thus, all these three growth parameters have helped production function curves shift upward in those economies during the period.

Figure 5. Capital income share and labor participation ratio, 1950-2019



Based on these observations, we decompose GDP per capita growth between period 0 and T into contributions of not only TFP increase and capital deepening, but also changes in capital income shares and labor ratios. Rewriting $Y/N = y$, $K/N = k$, and $L/N = l$, Equation (2) can be expressed as:

$$\log y_T - \log y_0 = (\log A_T - \log A_0) + \theta_0 (\log k_T - \log k_0) + (1 - \theta_0) (\log l_T - \log l_0) + (\theta_T - \theta_0) \log k_T - (\theta_T - \theta_0) \log l_T \quad (3)$$

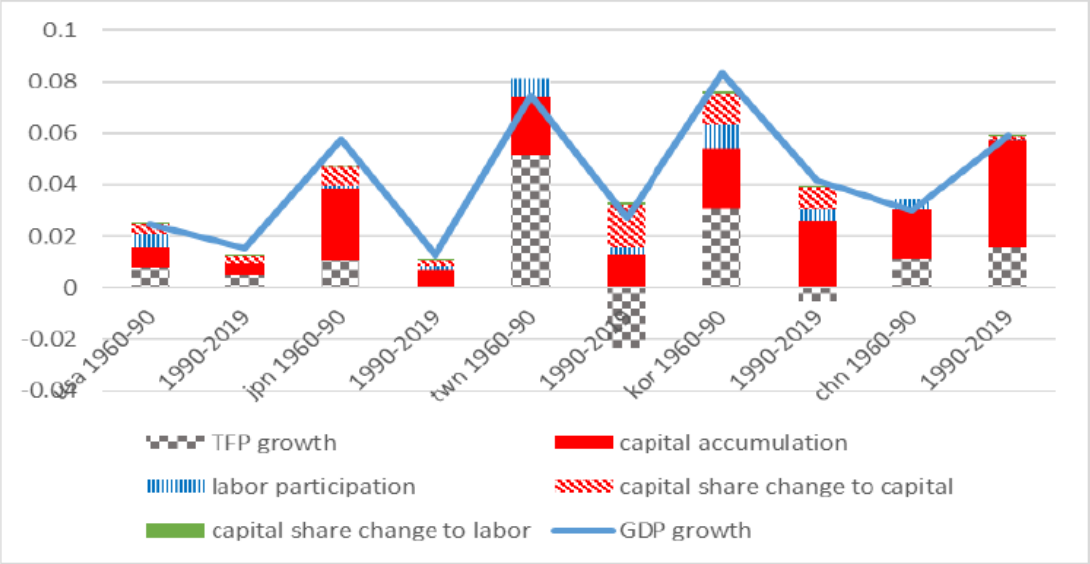
Equation (3) tells us that GDP per capita growth on the left-hand side can be decomposed into ①TFP increase (first term of the right-hand side), ② beginning-of-the-period capital income share times capital deepening (second term), ③beginning-of-the-period labor income share times labor ratio increase, ④ capital income share change times end-of-the-period capital-labor ratio, and ⑤ capital income share change times

[2] Fernandez-Eillaverde, Ohanian and Yao (2023) argue that, according to PWT, Taiwan's labor income share (0.73) during the former period, appears too high due to measurement problems of her small and medium firms. If this is the case, it follows that her capital income share and, therefore, the contribution of capital deepening is understated and that of TFP is overstated.

end-of-the-period labor share.

Figure 6 and Table 2 show the result of this decomposition of GDP per capita growth of each economy during two periods of 1960-1990 and 1990-2019. To illustrate the case of the US, her GDP per capita growth (2.46% per year) during 1960-1990 consists of 0.8% by TFP growth (one third), 0.79% and 0.37% by capital deepening and capital income share increase respectively (a half together), and 0.51% by labor ratio increase (the rest). The contribution of TFP growth remains secondary during 1990-2019, while that of capital deepening and capital income share increase becomes slightly smaller.

Figure 6. Decomposition of GDP per capita growth: 1960-90 and 1990-2019



Note: Growth decomposition: $\log y_T - \log y_0 = (\log A_T - \log A_0) + \theta_0(\log k_T - \log k_0) + (1 - \theta_0)(\log l_T - \log l_0) + (\theta_T - \theta_0)\log k_T - (\theta_T - \theta_0)\log l_T$.

Contributions to GDP growth through: 1) TFP growth: $\log A_T - \log A_0$, 2) capital accumulation: $\theta_0(\log k_T - \log k_0)$, 3) labor participation: $(1 - \theta_0)(\log l_T - \log l_0)$, 4) capital share change to capital: $(\theta_T - \theta_0)\log k_T$, 5) capital share change to labor: $-(\theta_T - \theta_0)\log l_T$.

Table 2. Decomposition of GDP per capita growth: 1960-90 and 1990-2019

	GDP growth	TFP growth	capital accumulation	labor participation	capital share change to capital	capital share change to labor
usa						
1960-1990	0.0246	0.0080	0.0079	0.0051	0.0037	0.0002
1990-2019	0.0156	0.0050	0.0044	-0.0003	0.0026	0.0002
jpn						
1960-1990	0.0576	0.0108	0.0279	0.0007	0.0080	0.0004
1990-2019	0.0125	0.0003	0.0068	0.0013	0.0024	0.0001
twn						
1960-1990	0.0745	0.0514	0.0227	0.0070	0.0000	0.0000
1990-2019	0.0273	-0.0233	0.0127	0.0031	0.0165	0.0010
kor						
1960-1990	0.0832	0.0309	0.0229	0.0095	0.0118	0.0010
1990-2019	0.0417	-0.0050	0.0257	0.0044	0.0091	0.0005
chn						
1960-1990	0.0302	0.0112	0.0190	0.0044	0.0000	0.0000
1990-2019	0.0593	0.0157	0.0419	0.0001	0.0010	0.0001

How about China? During the rapid growth period of 1990-2019 (5.9% per year), the contribution of TFP growth is 1.57%, while that of capital deepening amounts to 4.19%, which suggests, without doubt, investment-led growth as opposed to TFP-led growth. Turning to Japan's rapid growth period of 1960-1990 (5.8% per year), the contribution of TFP growth is only 1.08%, while those of capital deepening and capital income share increase are 2.8% and 0.8% each, which is another example of investment-led growth. We can detect a similar pattern of investment-led growth for Korea during 1960-1990, where again TFP growth is secondary.

Put it differently, according to this neoclassical growth framework, even in the US, being regarded as a representative economy of TFP-led growth, TFP contribution is one third of the total growth and that of capital deepening is almost equivalent. If we take into account the growth effect of capital income share, their combined growth effects are dominant, TFP being as secondary. Furthermore, in East Asian growth patterns as in Japan, Korea, Taiwan and China, overwhelmingly dominant as contrasting to the case of the US are growth effects of capital deepening, which is the driving force of these economies to narrow the income gaps from the US in the post-WWII period.

To assess relative contributions of capital accumulation to economic

growth, we examined components of these economic growth into capital accumulation, TFP growth, and changes in other growth parameters. This decomposition reveals that, even in US, capital accumulation including the additional effect of capital share increase has contributed to per capita GDP growth more than TFP growth throughout the period. In addition, particularly in East Asia (China, Japan, Korea, Taiwan), capital accumulation has dominated in per capita GDP growth, helping their catching-up with US in the same period.

5. Why capital accumulation dominates TFP growth?

Nevertheless, TFP growth instead of capital deepening has been regarded as the only engine of long-term economic growth. It is often said that technological progress or TFP growth results from ideas or knowledge capital, which is non-rival as well as non-exclusive to any users (e.g. Jones 2023), being free from decreasing returns, while investment-led growth depends on physical capital deepening, being subject to decreasing returns sooner or later, so that capital deepening cannot sustain long-term growth.

As *modern economic growth* (Kuznets 1966) since the 19th century has brought about the Great Divergence, however, we note that technological innovations have never been non-rival, nor non-exclusive at least across economies. Moreover, even in the era of digital revolution in the 21st century, in order for new ideas to generate market values, we need to commoditize ideas and build up a whole process from production to sales with due organizations and institutions, which requires visible and invisible capital accumulation. Or one may be able to say that there would be no TFP growth without due capital deepening.

Even within a neoclassical growth model with decreasing returns on capital, we observed that capital deepening has contributed to post-WWII economic growth at least in these economies more than TFP growth has. What is going on with the rate of return on aggregate capital there?

First, we examine the counterfactual speed of decreasing return on capital without TFP growth, and then the factual or ex post rates of return on capital directly.

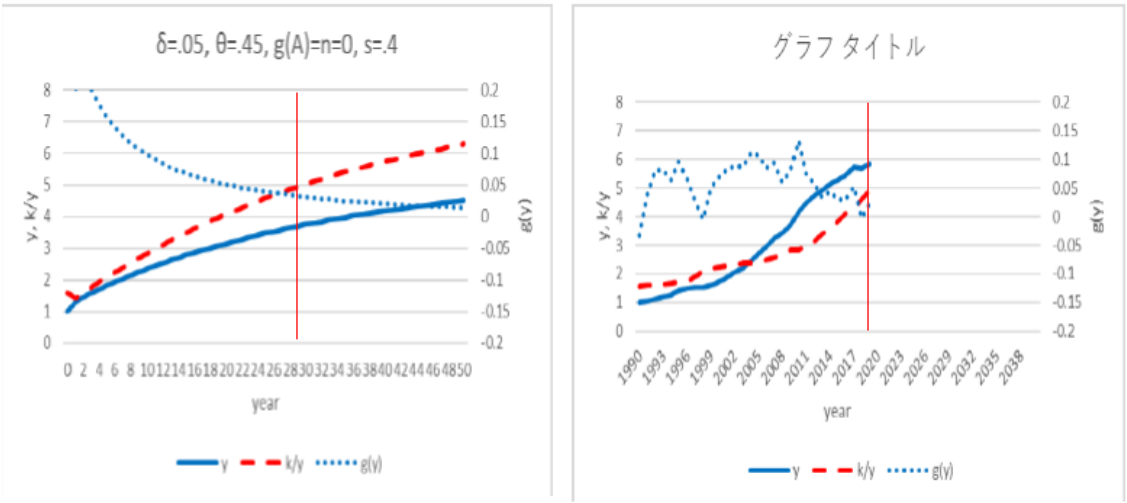
Figure 7, Panel a, illustrates the time-series pattern of counterfactual growth of China for the period of 1990-2019 with zero TFP growth and other growth parameters as constant, using Equation (2). Here we assume the capital income share as 0.45, the investment ratio as 0.4, taking average values for the period. Normalizing her GDP per capita for 1990 as one (capital per capita as 1.58), we measure GDP per capita, y, capital/output ratio, k/y, and GDP per capita growth, g(y) on the vertical axis and years

from 1990 on the horizontal axis. For comparison, we show the actual growth path in Panel b.

Figure 7. Economic growth paths: time series

a. Counter-factural transition without TFP growth: y(1990) = 1

b. Actual transition: y(1990) = 1



Note: y: GDP per capita, k/y: capital/output ratio, g(y): GDP per capita growth. Panel a: $A_t=(1+g(A))^t$, $k_{t+1}=(sy_t+(1-\delta)k_t)/(1+n)$, where g(A): TFP growth, s: investment rate, δ: capital depreciation rate, n: population growth.

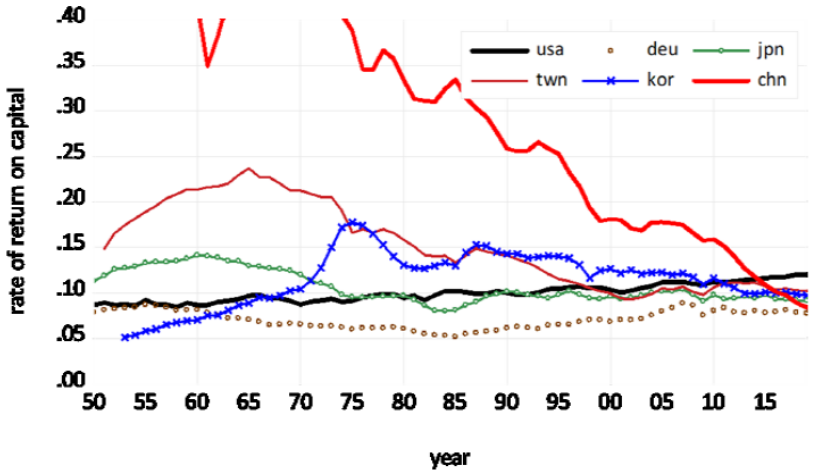
Points to be noted are: First, GDP per capita growth (small dotted line measured on the right-hand side) gradually declines from the initial high but remains above 3% even with only capital deepening until 30 year later or in 2020, when GDP per capita (solid line) increases by mostly 4 times as large. Second, against the steady-state capital/output ratio of s/(depreciation + n) = 8, capital/output ratio (thick dotted line) exceeds only slightly more than 5 in 2020, so that capital accumulation remains positive even in 100 years time from 1990. Compared to these counterfactual figures in Panel a, actual GDP per capita growth is 6.26% per year (1990-2019), GDP per capita increases by 5.8 times as large, and capital/output ratio increases to almost 5 for the period of 1990-2019 (Panel b), which suggests the contribution of other growth factors in addition to pure capital deepening.

The upshot is that capital deepening could sustain the long-term economic growth, to the extent that decreasing returns on capital do not work out until the steady state, which may not be in foreseeable future[3]. In fact,

[3] In fact, if we calculate steady-state capital/output ratios using PWT10.01, actual capital /output ratios remain significantly below the steady-state levels. Particularly, that of the US has trend declined from 4 for the 1950s and approaches to 3 as compared to her steady-state level of 5 to 7. The US economy could be said to be under-capitalized.

our ex-post rates of returns on capital show no converging patterns across economies and periods, as shown by Figure 8.

Figure 8. Rates of return on capital, 1950-2019



Note: caluculated as $\theta y/k$, where θ: capital income share, y: GDP per capita, k: capital stock per capita.

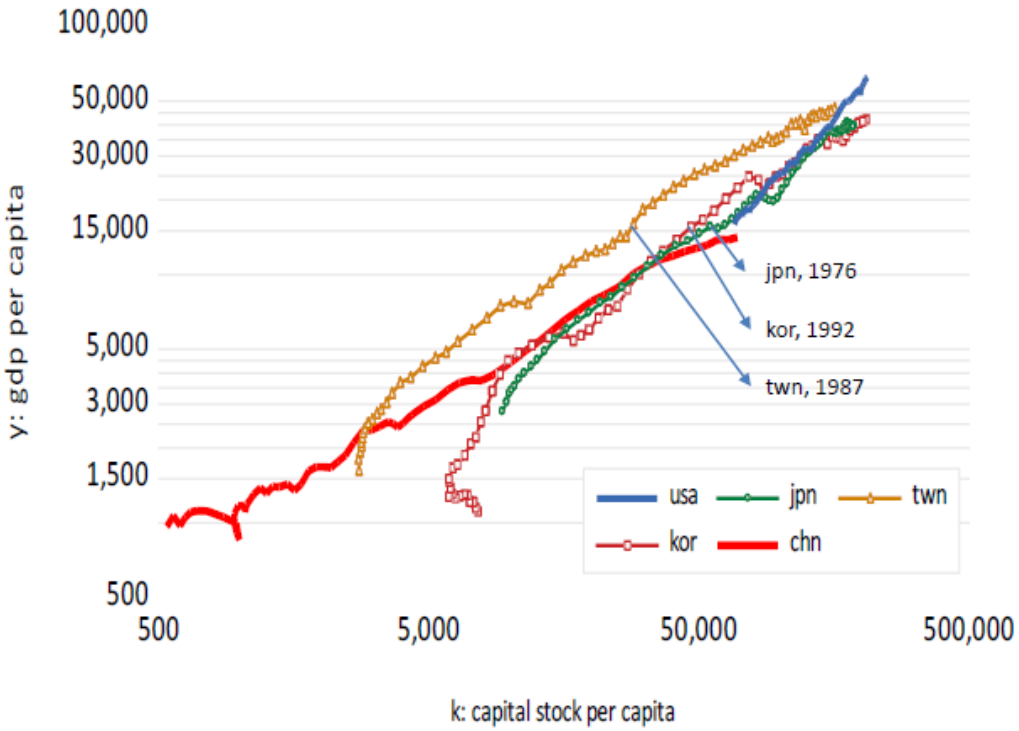
Now, despite diminishing returns to capital in the neoclassical growth model, why does capital accumulation dominate economic growth? Our data on growth experiences suggest that returns to capital diminish rather slowly along with capital accumulation and TFP growth, so that we find that resulting rates of returns on capital do not show any trend decline, but rather even trend increase particularly in the case of US.

6. Comparative growth paths

In reality, economic growth has been sustained by both capital deepening and technology progress, where technological innovations enhance capital efficiency, and capital deepening promotes innovations in a complementary way. In view of the neoclassical growth framework, this complementarity takes the form of continuous upward shifts of production function curves of each economy. The locus of the combination of output and capital stock observed in growth is not a transition to the steady-state equilibrium given by and along with the fixed production curve, but a transition to shifting steady-state equilibria along with shifting production function curves, i.e. an approach to ever-getting-away steady-state equilibria.

Now let us observe the locus of the combination of actual GDP per capita and capital stock per capita directly from the data. Figure 9 shows the loci for the period of 1950-2019, where, for sustained growth, the combinations move from south-west to north-east, shaping an upward-sloping line with capital deepening.

Figure 9. Economic growth path: 1950-2019 （2015 US$）



The US, being a top high-income country throughout the period, started from both high GDP per capita and capital stock per capita levels already in 1950 and reached higher levels in 2019 as an almost straight line. As compared to other economies, her remarkable characteristics are very short length of the line and high GDP per capita relative to capital stock per capita. The former reflects that her output growth and capital deepening are relatively slow, and the latter suggests that the role of TFP and other growth factors than capital deepening is relatively large, resulting in higher capital efficiency.

Turning to East Asia, Japan, Taiwan and Korea started from far lower output and capital stock levels, promoted capital deepening, surpassed the US income level of 1950 (US$16,000) in 1976, 1987 and 1992, respectively, and surpassed the US income level of 1990 (US$39600) in 2005, 2005 and 2017, respectively. Particularly noted is that they kept high capital efficiency during the period and closely traced the US prior locus.

Capital stock per capita in China reached its US level of 1950 toward the late 2010s, while her GDP per capita is still below that of the US, suggesting that her capital efficiency is lower than that of the US in 1950. The longer length of China's locus reflects her faster capital deepening relative the those of the US during the period. Meanwhile, slopes of luci

reflect GDP growth with respect to capital deepening, implying that the US has appeared to have kept highest capital efficiency throughout the period relative to other economies. Just like other East Asian economies, China also appeared to closely trace the US growth locus until recently except for the very recent years, however. Can China trace the past US growth path as did the others and catch up with the US?

7. Growth prospects

Actual growth transitions or growth paths traced as a locus of a combination of GDP per capita and capital stock per capita are illustrated, reflecting both transitions to a steady state equilibrium along a production function and shifts of production functions, which, in the case of four economies in East Asia, show steady income convergence to US, by closely following the US path with a larger stretch.

Finally, we examine alternative scenarios on China's future economic growth, based on alternative values for growth parameters, and find that we could draw any scenarios of either convergence or divergence to US within a reasonable range of parameter values for economic growth, such as capital income share, investment rate and TFP growth rate.

Using a conventional neoclassical model of economic growth with the PWT database, Fernandez-Villaverde, Ohanian and Yao (2023) reproduce growth patterns of East Asian economies and prospects their future patterns via calibration, where they assume the year of 1990 as a steady-state equilibrium and prospect the future growth process as a transition to the new induced steady-state equilibrium in 2100. In so doing, they additionally assume a specific catching-up process in TFP growth, where they particularly presume that China's TFP level +would peak out at about 45% of that of the US by 2040. Consequently, China's GDP per capita would come close to 47% of that of the US in 2100, but not closer thereafter[4].

In the following, free from any arbitrary constraint on TFP growth or steady-state presumption, we will show some alternative growth scenarios from the year of 2019 by selecting combinations of growth parameters such as capital income shares, TFP growths, and investment ratios. Specifically, we select three TFP growths of 0.68%, 0.99% and 1.44%, two investment ratios of 0.3 and 0.4, and two capital income shares of 0.35 and 0.4. Note that TFP growth, investment ratio and capital income share are 1.79%, 0.35, and 0.42 on average, respectively in China for the period of 1990-2019. We

[4] According to the UN population projection, population of China and the US in 2100 are 767 and 394 million respectively, so that, based on the prediction by Fernandez-Villaverde et al (2023), China's GDP would reach 85% of that of the US in 2100.

simply calculate economic growth paths of China's GDP per capita, based on combinations of parameter values, and show the results relative to US GDP per capita in 2050 and 2100, where US growth is assumed at 2% per year as in the past 100 years (Table 3).

Table 3. China's GDP per capita: prospected as a ratio to US

capital share (θ)	0.35		0.4	
investment rate (s)	0.3	0.4	0.3	0.4
TFP growth (g(A))	2050			
0.0068	0.366	0.417	0.440	0.516
0.0099	0.413	0.471	0.499	0.586
0.0144	0.492	0.562	0.599	0.705
	2100			
0.0068	0.247	0.288	0.321	0.387
0.0099	0.322	0.407	0.462	0.558
0.0144	0.577	0.673	0.788	0.952

Note: $y = Ak^{\theta/(1-\theta)}$, $A_t=(1+g(A))^t$, $k_{t+1}=(sy_t+(1-\delta)k_t)/(1+n)$, where y: per capita GDP, k: per capita capital, g(A): TFP growth, s: investment rate, δ: capital depreciation rate, n: population growth. US GDP per capita to grow at 0.02.

According to PWT10.01, China's GDP per capita is 22.6% of that of the US for the year of 2019 (Table 1). Table 3 suggests that, if China's TFP growth remains at her average figure for the past 60 years (0.68%), the combination of high capital income share (0.4) and high investment ratio (0.4) would allow her to catch up to 51.6% of that of the US by 2050, although the income gap would expand again to 38.7% by 2100. Even if the TFP growth is as high as that of Japan for (1960-1990), i.e. 0.99%, her catch up would slow down as from 58.6% to 55.8% in 2100.

If China could maintain higher TFP growth (1.44%) as Taiwan did for 1990-2019, however, even the combination of low capital income share (0.35) and low investment ratio (0.30) would allow her to catch up to 49% of that of the US in 2050 and then 58% in 2100. Furthermore, the combination of high capital income share and high investment ratio would allow her to reach 71% in 2050 and 95% in 2100 (and more later on). In other words, if China could realize sufficient capital deepening and TFP growth as experienced by East Asian forerunners in the post-WWII period, she could naturally catch up with the US even in terms of GDP per capita.

8. Concluding remarks

Many people including economists have appeared to perceive that China's high economic growth sustained in the past 30 years is exceptional and unprecedented. At the same time, though, they appeared to regard that her growth would not last long and/or end soon, probably abruptly and disastrously. We have examined whether these perceptions and prospects are warranted, using internationally comparable data (PWT10.01) within a conventional framework of economic growth

Prior to our findings, we must remind, first, that developing economies are quite heterogeneous, so that there is no such a thing as the "mean" developing economy. Likewise, there is no such a thing as the mean pattern of economic growth across developing economies. Also note, second, that some economies, well known as Asian Tigers, in East Asia, where China is located, are exceptional in the sense that they succeeded in catching up with advanced economies such as the US in per capita income levels in the past 60 years, while many others did not and some others have suffered from frequent sudden stops of foreign capital inflows, resulting in cycles as trends. Thus, we examined China's growth pattern particularly in the past 30 years in comparison with these economies in East Asia as well as the US and obtained several observations which are rather negative to the popular perceptions and prospects. We summarize them as follows:

Looking at the growths of East Asian economies such as Japan, Taiwan and Korea in the past 60 years, China's high growth in the past 30 years can be said to be comparable to them, but not unprecedented.

Looking at China's economic growth in view of a neoclassical growth model, her growth has depended not on TFP growth but heavily on capital deepening. In this respect, however, the paces of capital deepening in forerunning Taiwan and Korea in the past 60 years overwhelm that of China, which contributed most in narrowing their income gaps from the US.

Looking at China's counterfactual growth path only with capital deepening in the model, it could sustain her GDP per capita growth at higher than 3% at least for the fist three decades because of rather slow decreasing returns on capital. In reality, of course, TFP growth has contributed to improve capital efficiency hand in hand with capital deepening.

Looking at the growth paths of the East Asian economies during the post-WWII period, they started from far lower levels of GDP and capital stock per capita than those of the US, promoted capital deepening more rapidly, and exceeded the US 1990 level of GDP per capita by the beginning of the 21st century. During the process, they maintained high capital efficiency and well traced the US growth path. We observe that China has

also followed her forerunners, well tracing the US path until recently.

Looking into more recent periods, we detect secular stagnation in Japan after 1990 onward due to financial bubble burst, transitions from high to medium growth in Korea and Taiwan after the Asian Financial Crisis in 1997, and some growth slowdown in China after the Global Financial Crisis in 2008. It remains to be seen or for future research agenda whether these setbacks from initial high growth are intrinsic or endogenous in economic growth dynamics, or exogenous or due to global cycle factors.

To sum, the high growth economies in East Asia did not mean-revert to meaningless developing economies' mean. Observing that China has taken a similar growth pattern to these economies, we see no reason why we must expect abrupt collapse of her miraculous rapid growth soon for sure, and why we cannot expect how far she catches up with the US.

To repeat, China's recent high growth is never exceptional nor unprecedented. It is similar to those experienced and attained by some East Asian economies. Particularly, Taiwan and Korea initiated their high growths under financial and institutional underdevelopment, sovereign-dominated economies, and non-democratic governments and other inadequacies to the market. While their catching-ups are not completed yet, China's has rather just begun. As these East Asian economies have muddled through, China would have to overcome many obstacles and hardships. And they must be different from those experienced by her forerunners in the past, quantitatively as well as qualitatively, because both international economic environments and technologies have vastly changed from those of 60 years ago. Moreover, China is a very large economy, affecting the global economy to a significant degree. By contrast, East Asian Miracles were only periphery.

Nevertheless, as China's growth performance has revealed so far, we see no reason why she cannot attain what her forerunners in East Asia have attained so far. As pointed out (e.g. Prasad, 2023, and Rogoff and Yang, 2021), there are mountainous problems and obstacles to overcome with respect to political governance as well as market institutions. But, economic growth and/or development are China's national goals. Able and non-anachronistic leaders would have no choice but to select policies which help attain the goals. If this is the case, those who are concerned with the global economy and developing economies cannot but be concerned with China.

References:

Aguiar, Mark and Gita Gopinath (2007) "Emerging Markets Business Cycles: The Cycle Is the Trend." Journal of Political Economy, 115, 69-102.

Feenstra, Robert C., Robert Inklaar, and Marcel P. Timmer (2015) “The Next Generation of the Penn World Table.” American Economic Review 105, no. 10: 3150-3182.

Fernández-Villaverde, Jesús, Lee E. Ohanian and Wen Yao (2023) ”The Neoclassical Growth of China,” NBER Working Paper 31351, June 2023.

Jones, Charles I. (2021) Macroeconomics, 5th edition, W. W. Norton & Company, 2021.

Jones, Charles I. (2023) "The Outlook for Long-Term Economic Growth," NBER Working Paper 31648, August 2023.

Kharas, Homi and Indermit S. Gill (2020) “Growth Strategies to Avoid the Middle-Income Trap.” Duke Global Working Paper Series, no 17.

Kohsaka, Akira and Jun-ichi Shinkai (2015) “It is Not Structural Change, but Domestic Demand: Productivity Growth of Japan”. In: Yun-Peng Chu, ed., *Lost Decades in Growth Performance*, Palgrave-MacMillan, London, pp. 53-74.

Kohsaka, Akira (2015) ed. Macrofinancial Linkages and Financial Deepening in the Pacific *Region*, Routledge, 2015.

Kohsaka, Akira (2020) Global Economic Integration and Regional Agglomeration: Business Cycles, Economic Growth and Disparities, in Japanese, Nihon Keizai Shimbun Shuppan, 2020.

Kohsaka, Akira (2022) “No Great Convergence, but not Myth: Stabilization and Growth in East Asia, 1990-2018,” Journal of APEC Studies, Vol. 14 No. 1, June 2022.

Kuznets, Simon (1966). Modern Economic Growth, Yale University Press.

Prasad, Eswar S. (2023) “Has China’s Growth Gone from Miracle to Malady?” NBER Working Paper 31151, April 2023.

Pritchett, Lant, and Lawrence Summers (2014) “Asiaphoria Meets Regression to the Mean.” Prospects for Asia and the Global Economy: 33–71. San Francisco: Federal Reserve Bank of San Francisco.

Rogoff, Kenneth, and Yuanchen Yang (2021) “Has China’s Housing Production Peaked?” China and the World Economy 29, no. 1: 1–31.

Rostow, W. W. (1960) The Stages of Economic Growth: A non-communist manifesto, Cambridge University Press.

Young, Alwin (1995) “The tyranny of numbers: Confronting the statistical realities of the East Asian growth experience,” The Quarterly Journal of Economics, 110, no. 3: 641–680.