

Analysis of Lantau Tomorrow's **Impact on Hong Kong Public Finance**

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Chapter 1 Introduction

In the economic literature, population aging has been widely recognized to cause strong headwinds to economic growth. Regarding many industrial countries that are facing a rapidly aging population, such as the “Group of Ten” (G-10) (members include Belgium, the Netherlands, Canada, Sweden, France, Switzerland, Germany, the United Kingdom, Italy, the United States and Japan), their medium- to long-term economies experienced a slowdown in growth, leading to a gradual decrease in government revenue, while at the same time public spending on the elderly continues to increase. If the situation persists, the public finance in a certain country or region will undoubtedly become a critical issue.

Hong Kong has become an aging society, the substantial increase in public expenditure related to the elderly in recent years was a good evidence. Even worse, Hong Kong’s economy continues to remain in the doldrums following the 2008-2009 financial tsunami, which could be attributed to the slowdown in local labour force and labour productivity. According to the projections of the Census and Statistics Department, the local labour force has a good chance of starting to reach its peak. For some labour-intensive industries, local labour

shortages will definitely impede economic performance, and hence impose pressure on government revenue.

When an area's economic engine weakens, many social problems will arise accordingly. Despite the fact that the HKSAR government is now sitting on abundant fiscal reserves, the HKSAR government will enter the age of financial deficits in a foreseeable future. The government revenue is expected to decrease due to population aging. Its expenditure on public spending is raising, specifically on elderly related welfare policies. Hence, financial deficits are bound to happen and the government needs to have a plan of action to combat against these potential deficits.

To explore the impact of population aging on the HKSAR government's public finance, this report aims to estimate the time points at which Hong Kong's structural deficit will occur and the reserves will be depleted by employing the model of government revenue and expenditure used in the Report of the Working Group on Long-Term Fiscal Planning in 2014. Different studies show that population aging can relieve the housing market, and put current imbalance in supply and demand in the housing market at ease. To conclude, the HKSAR government intends to invest a considerable amount of money to increase land

reserves, such as the development of farmland owned by real estate developers, the large-scale reclamation project on Lantau Tomorrow, and so on. Due to these outlays, the HKSAR government may have already faced a crisis in public finance. If the HKSAR government insists on these development plans, will the public finance of Hong Kong worsen?

This report will unveil the result.

Chapter 2 Rapid Population Aging

2.1 Population Aging Brings Shocks to Economic Development

The HKSAR government is sitting on ample fiscal reserves. On the basis of the final figures for the 2019-2020 fiscal year, the HKSAR government's fiscal reserves are as high as HK\$1,160.3 billion (approximately US\$150 billion). Given that many major industrial countries are facing high debt levels, Hong Kong, a special administrative region with a population of only 7.5 million, still has such abundant fiscal reserves. Hong Kong citizens should certainly be proud of this achievement.

Sufficient fiscal reserves do not guarantee financial stability and prosperity. The HKSAR government has already spent at least HK\$287.5 billion in fiscal reserves to combat the epidemic, which poses extra stress on the public finance. Based on the government's projection, it forecasts deficits in the coming five financial years for its operating account (2020-2021 to 2024-2025), which has not yet counted in the upcoming one-time handouts. A basket of factors contributed to these deficits, including the aging population puts pressure on public finance, relief measures to respond to the impact induced by coronavirus,

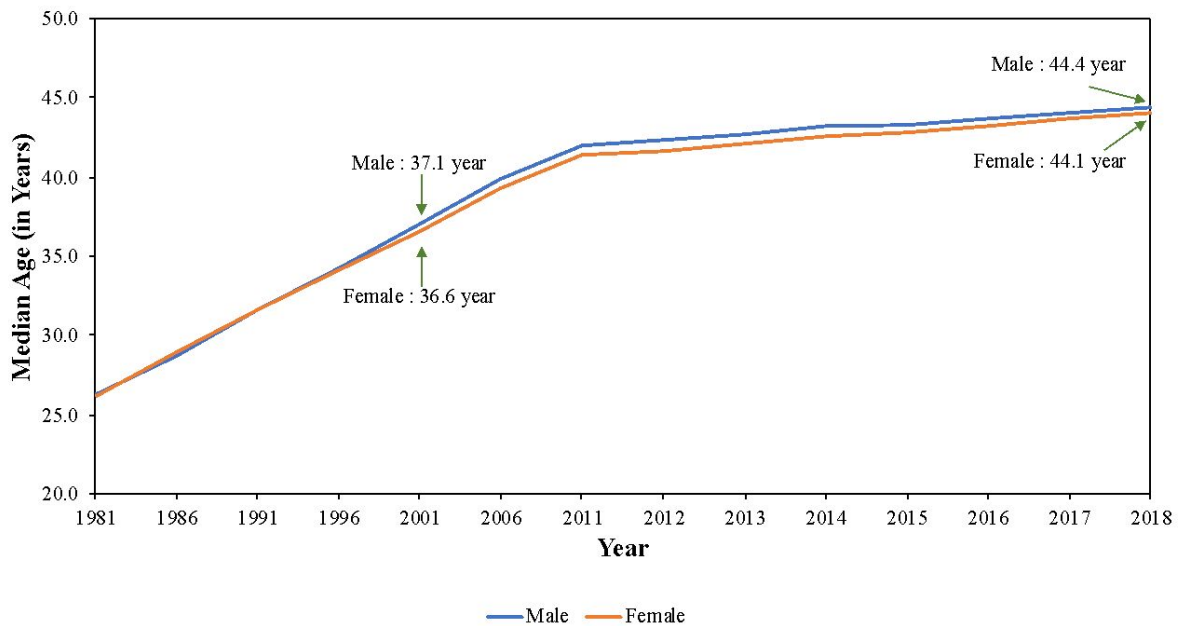
and budget overrun of different large-scale infrastructure projects. The combination of the rapidly aging population and the spiralling cost of the city's large-scale infrastructure projects (e.g land reclamation project - Lantau Tomorrow) could jeopardise the health of Hong Kong public finance, and further escalate the deficits. The government should carry out a fiscal reform in a timely manner.

Many industrial countries, such as Japan, have started to reflect on aging population and its implications on fiscal sustainability. Identical to Japan, Hong Kong has entered an era of aging population, and “Will Hong Kong economy follow Japan’s footsteps?” has become one of the top agenda the government would need to tackle. Chapter 2 will dive deep and discuss the implications of an aging population to Hong Kong’s fiscal stability.

Population aging in Hong Kong is an undeniable fact. According to the “Global Ranking of Average Lifespans for Men and Women” published by the Ministry of Health, Labour and Welfare of Japan, Hong Kong men and women had the highest life expectancy worldwide in 2018, which was 82.17 years and 87.56 years respectively. In addition, according to the public information of the Census and Statistics Department, the median age of Hong Kong men is 44.4

years, while that of women is 44.1 years, which is significantly higher than the median age of 37.1 years and 36.6 years for men and women in 2001 (Figure 2.1). The above two demographic datasets show that Hong Kong population is aging rapidly. Aging population poses a set of challenges for the government. The two major impacts of aging population on Hong Kong's fiscal sustainability include a decrease in the workforce which essentially leads to reduction in tax revenue, and increased government spending in old age-related welfare and policies. The HKSAR government's fiscal reserves has dropped from HK\$1,100 billion to around HK\$800 billion, with the foreseeable reductions in revenue and increases in spending, the fiscal gap of Hong Kong public finance will widen, which will eventually bring serious shocks to Hong Kong's medium- and long-term economic development.

Figure 2.1
Median Age of Hong Kong Population by Gender (1981-2018)



Population aging is common to many mature economies, and Japan is a fine example to showcase how aging society affects its economy. Japan entered into a lost era since the burst of bubble economy in the early 1990s and experienced a series of recessions in the past 30 years. Japan experienced its first shrinking in population in 2010. It is one of the first developed economies to enter the stage of population shrinking (Figure 2.2), and shrink in population drives the national economy into a “secular stagnation” (Figure 2.3). Many analysts believe the Japanese economy will not be able to recover unless the Japanese government finds effective ways to ease the population decline.

Figure 2.2
Japan Population (1980-2018)

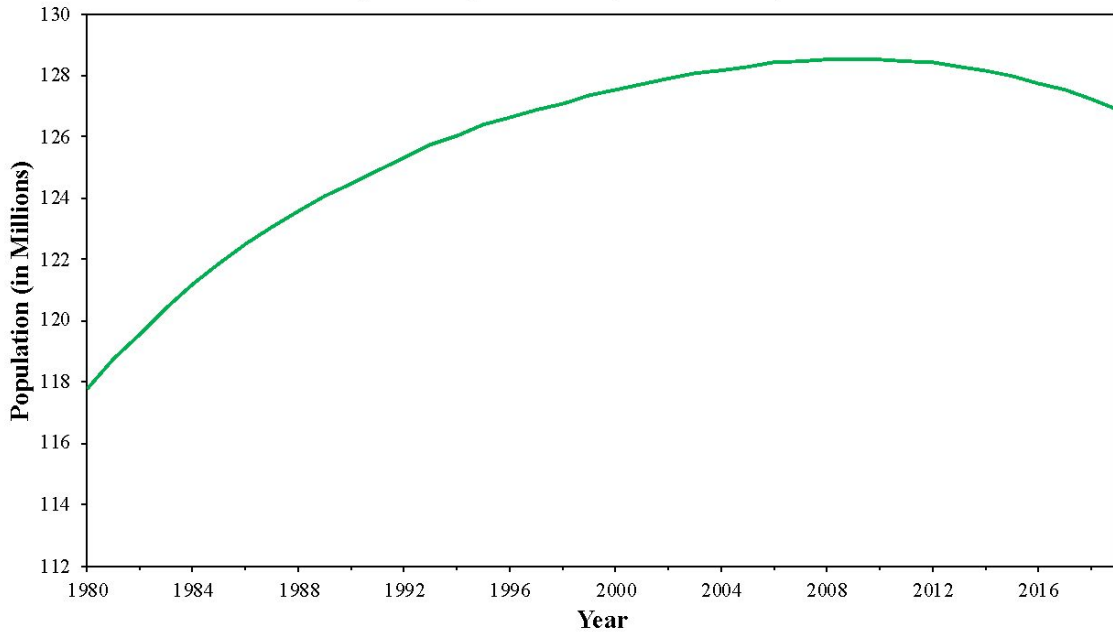


Figure 2.3
Japan Real GDP Growth Rate (1980-2019)



Japan and Italy have the oldest population compared to the rest of the major economies, and are currently experiencing population shrinking. According to the World Population Prospects developed by the Population Division of the Department of Economic and Social Affairs of the United Nations, other major economies such as Germany and China are expected to have shrinking populations from 2020 and 2035 respectively (Figure 2.4A and Figure 2.4B). This indicates that the global economy has a good chance of a sustained slowdown which would cause a strong headwind to any open and externally-oriented economy, like Hong Kong.

Figure 2.4A
Germany Population (2020-2050)

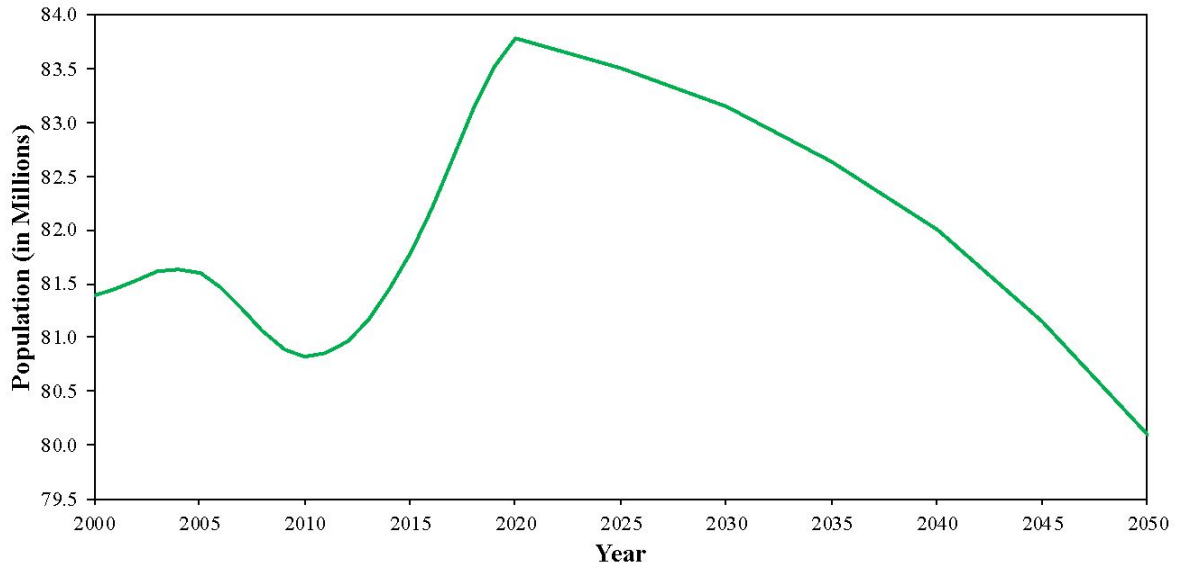
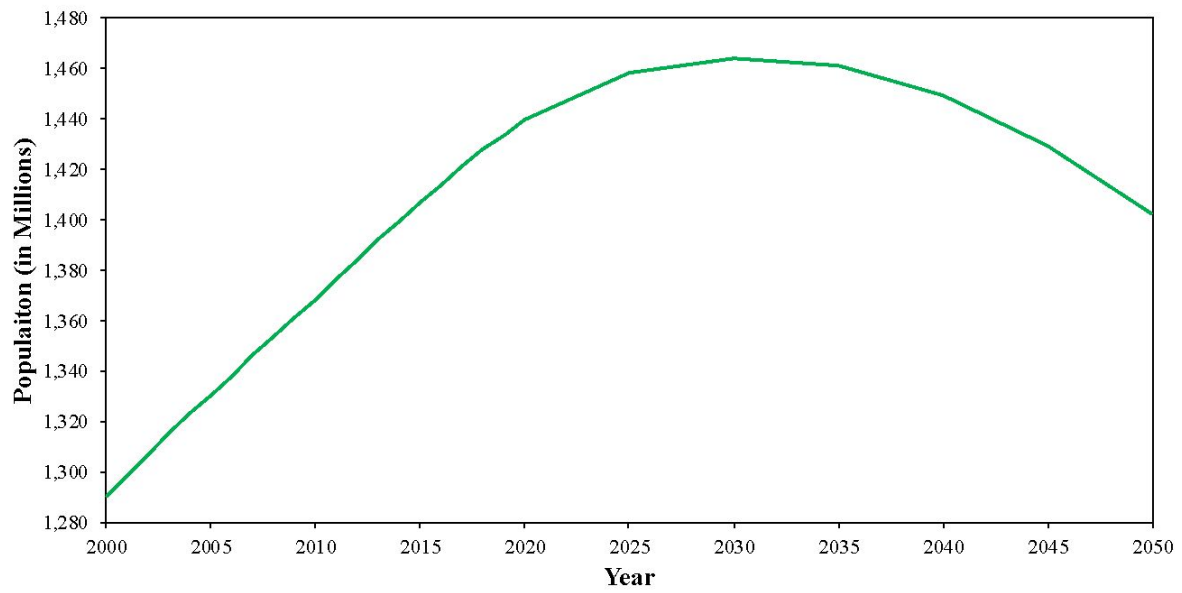


Figure 2.4B
China Population (2020-2050)



2.2 Shrinking of Hong Kong Population

There is a high possibility that Hong Kong will follow the footsteps of Japan and Italy and enter the stage of population shrinking. According to the “Hong Kong Population Projection 2017-2066” published by the Census and Statistics Department, Hong Kong population is expected to grow until reaching the peak of 8.22 million in 2043 and then decline to 7.72 million by 2066, reflecting a drop of 450,000 people as compared to the peak (Figure 2.5). The aging population also introduces a downward pressure on the labour workforce. The Census and Statistics Department projects that the Hong Kong labour force will peak between 2019 and 2022, and then gradually decline (Figure 2.6). This phenomenon reflects that in the presence of labour shortages, Hong Kong’s economic growth will slow down, hence putting upward pressure on government taxation in the future.

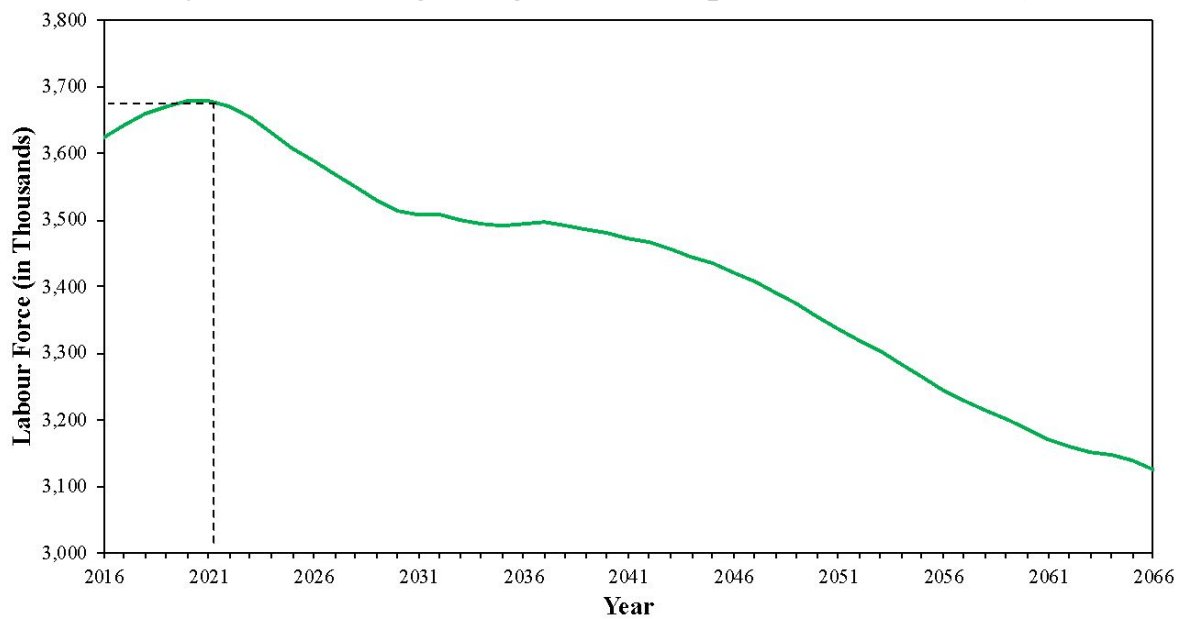
Whether Hong Kong’s economy will experience a long-term stagnation, like Japan's economy, depends on how the HKSAR government responds in laying out effective policy to ease the society’s population aging. Unfortunately, even if governments across the world understand the gravity of the situation, there continue to be challenges in terms of actual implementation and political

pressures, eventually failing to achieve the ultimate policy goal. Therefore, population aging has become an insurmountable problem that cannot be solved for majority of mature economies.

The novel coronavirus first broke out in Wuhan City, Hubei Province of China in December of last year and has been spreading around the world. Until now, more than 28 million people have been diagnosed and at least 900,000 people have died (as of September 11, 2020). The world economy has fallen into recession as the rapid spread of the coronavirus dealt a severe blow to economic activities, this also applies to Hong Kong, being an externally-oriented economy.

Figure 2.5
Projection of Hong Kong Resident Population (2016-2066)

Figure 2.6
Projection of Hong Kong Labour Population (2016-2066)

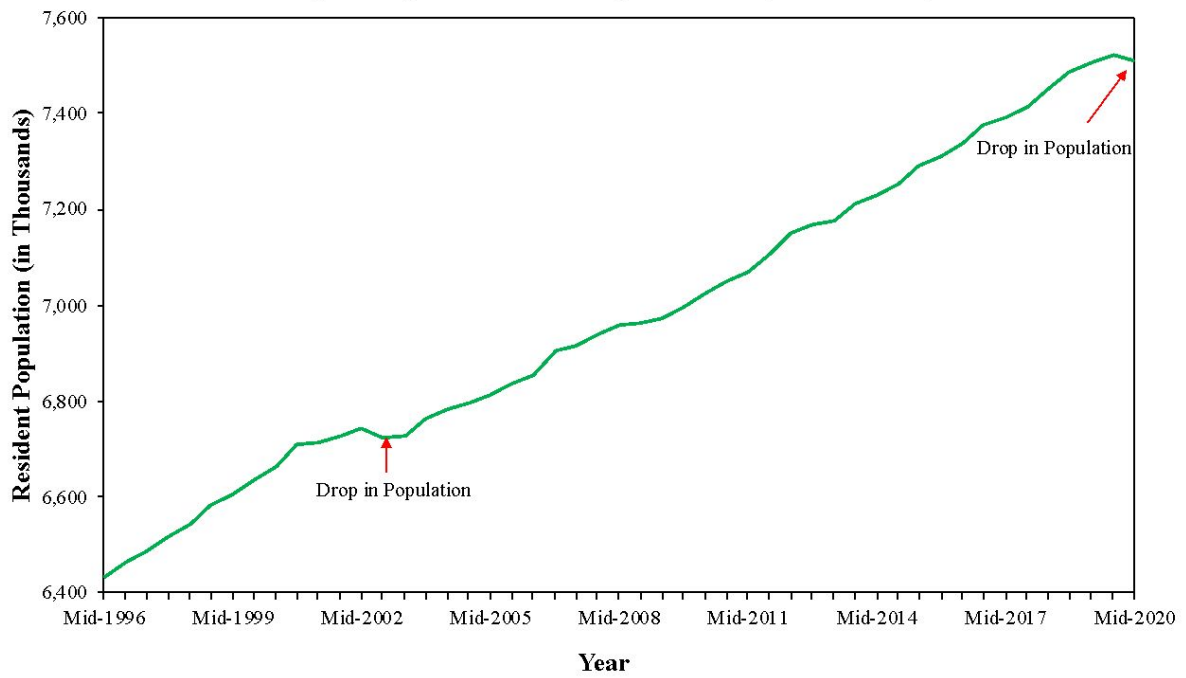


The local GDP fell notably by 9.1% year-on-year in the first quarter this year, showing that Hong Kong's economic outlook is highly uncertain. Under the circumstances, it is expected that the labour market naturally undergoes significant shocks. Tourism related sectors, including retail, catering and hospitality have been devastated by the coronavirus outbreak, leading to a high unemployment rate as compared to other industries. In addition, job vacancies have decreased substantially during severe economic downturn, which particularly affects the low-skilled and low-educated workers' chances of getting hired, ultimately causing a continuous decline in the workforce. According to the workforce data released by the Census and Statistics Department, the local workforce kept falling over the past ten months from June to August 2019 to March to May 2020, posting its worst performance since the start of data collection. It is assumed that the local labour market may fall into contraction, provided accurately projected by the Census and Statistics Department.

The latest data on population shows an interesting phenomenon and profound implications. Not only has the social and economic situations in Hong Kong deteriorated, but population growth also has undergone a subtle change since social movements in March last year. In mid-2020, Hong Kong population was

7.509 million, representing a decrease of 11,000 as compared to 7.52 million at the end of 2019 (Figure 2.7). The HKSAR government should note that a series of material factors may give rise to population decline, including economic recession since the third quarter of 2019, tense and polarized social atmosphere caused by social movement and government governance, coronavirus outbreak and the implementation of Hong Kong National Security Law. Given these factors, it is recommended that the HKSAR government should apply a rigorous analysis on population trend. If the population of Hong Kong continues to shrink in the future, it is possible that the population peak will be greatly pushed forward. It will also rapidly slow down Hong Kong's medium- and long-term economic growth, and eventually affect the sustainability of public finance.

Figure 2.7
Hong Kong Resident Population (1996-2020)



Chapter 3 Population Aging and Fiscal Sustainability

3.1 Population Aging Causes Rising Fiscal Burden

Countries with mature economies have already demonstrated salient trends and characteristics of population aging. Prolonged life expectancy, significant increase of the elderly proportion, growing welfare expenditure on the elderly are some good examples. Long life expectancy, one of the great triumphs of modern society, can become a challenge for government authorities. Population aging will contribute to a shrinking labour force, placing considerable pressure on government revenue. Meanwhile, rising population of the elderly will lead to an increase in public expenditure on health and welfare which might cause the government to fail to make ends meet, and eventually fall into a debt spiral.

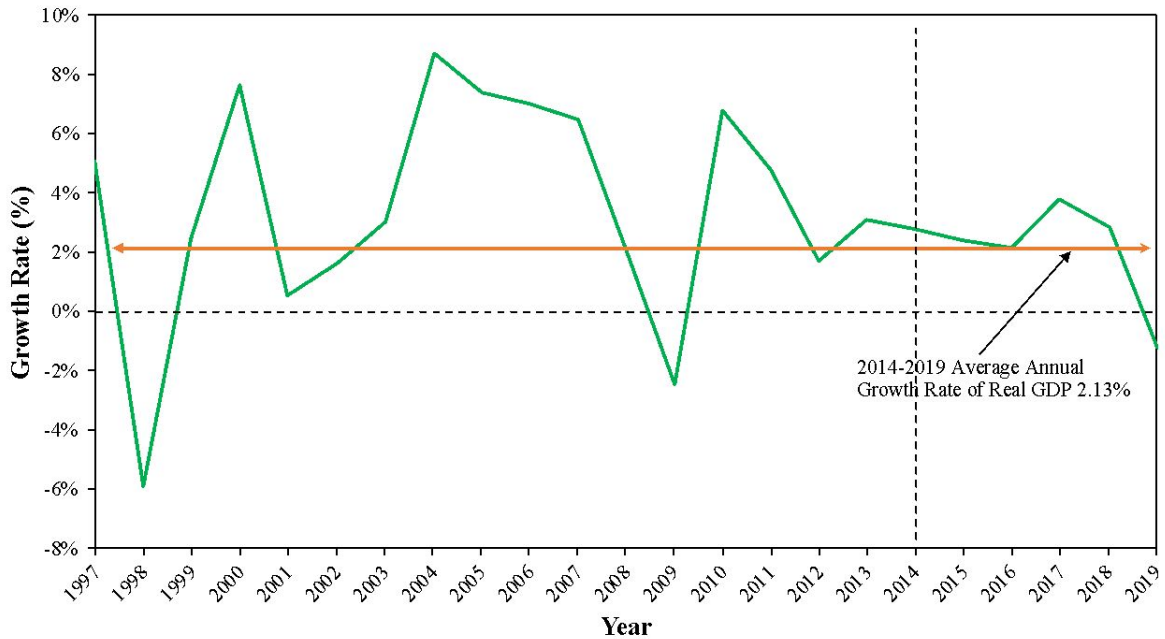
Take the public finance of the seven major industrial countries as an example. The national debt-to-GDP ratios of Japan, Italy and the United States are 238%, 135% and 107% respectively, indicating a relatively high level of debt to GDP as compared to other countries (Table 3.1). With population aging, mature economies have long been in serious debt. Thus, it is necessary for these countries to speed up fiscal reforms in order to prevent the looming debt crisis.

Although Hong Kong is sitting on abundant fiscal reserves, the rapid aging of the population poses a potential threat to the stability of public finance. According to the medium- and long-term economic growth estimated by the Working Group on Long-term Fiscal Planning in 2014, the annual growth of real GDP would stay at 3.5% from 2014 to 2021 and gradually decelerate to 3% from 2022 to 2025, and further to 2.5% from 2026 to 2041. In reality, the annual average real GDP growth from 2014 to 2019 was only 2.13% (Figure 3.1), reflecting that the trend of a mid- to long-term economic slowdown in Hong Kong could be even worse than expected.

Table 3.1

Country	Life Expectancy (years)	National Debt to GDP Ratio (%)
Japan	85.0	238.0
Italy	84.0	135.0
France	83.1	98.1
Canada	83.0	89.7
Germany	81.9	61.9
United Kingdom	81.8	80.7
United States	79.1	107.0

Figure 3.1
Hong Kong Real GDP Growth Rate (1997-2019)



For government revenue, it has not been affected by the underperforming economy in recent years. Land sales is one of the government’s main revenue sources. The thriving property market is bringing significant revenue to the government due to high rates of property turnover. Although the public revenue has been tremendously improved, over-reliance on non-recurring income, such as land sales, would be strategically dangerous. For example, land income will be substantially reduced if property prices plummet under economic fallout like in the 1997-2003 period. Furthermore, the economy will deteriorate significantly during the collapse of property prices, and recurring income will also fall sharply. By that time, the fiscal revenue of the HKSAR government will definitely be in crisis. This also explains why many economic analysts

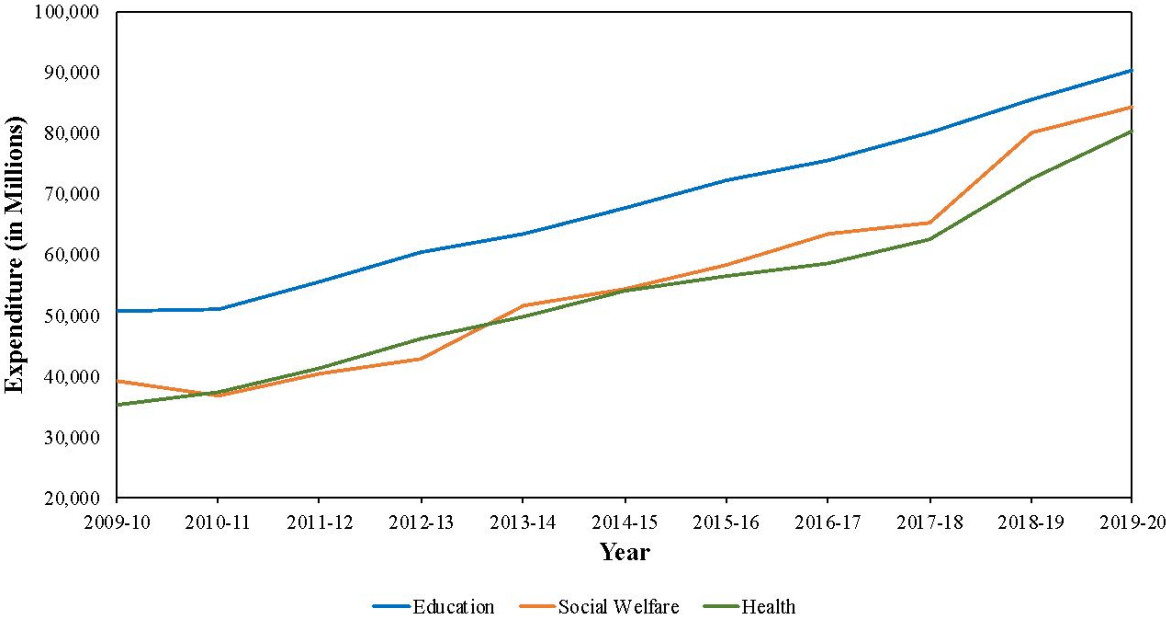
propose to improve the structure and quality of public finance, hoping to reduce the HKSAR government's excessive dependence on land revenue.

In recent years, major recurrent government expenditure including social welfare, health and education, have displayed a noticeable upward trend (Figure 3.2). One of the main reasons attributable to this is that an aging population will increase social welfare and health related expenditure. Additionally, Chief Executive Carrie Lam encouraged greater spending on recurrent education expenditure in the early stage of taking her official post. Although the rise in public expenditure for the above three categories appears to be reasonable, the government's future revenue is expected to decline under an aging society. Continuous increase in recurrent expenditure will eventually become a drag on the stability of public finance. It is suggested that the government officials should review the sustainability of government finance promptly, which in turn would enable them to respond to risks more proactively.

According to a research article by the Office of the Government Economist (titled "Population Ageing Trend of Hong Kong"), the size and share of elderly population (aged 65 and above) are 1.27 million and 17.9% respectively. In 2028, these two figures are projected to jump to 1.97 million and 26.4%

respectively, indicating the elderly population has surged by 700,000 people in just 10 years. For the HKSAR government, there are underlying concerns that the public finance would deteriorate gradually, due to a surge of expenditure on welfare and health related to the increasing elderly population.

Figure 3.2
Hong Kong Government Recurrent Expenditure (2009-2020)



3.2 Examining the Sustainability of Public Finance from Projections of Revenue and Expenditure

To examine the sustainability of the public finance of the HKSAR government, this research report adopts the revenue and expenditure projection model of the Working Group on Long-Term Financial Planning to have a better understanding of the HKSAR government's public finance, by comparing government expenditure and government revenue in the future. This report aims to estimate the time at which Hong Kong's structural deficit will occur, namely continued imbalance in revenue and expenditure, particularly considering the influence of population aging. When a structural fiscal deficit emerges, the HKSAR government needs to make use of fiscal reserves to support expenditure. The rising social cost and fiscal deficit mean the government may have to rely on borrowing to maintain the status quo.

The Working Group on Long-Term Fiscal Planning has assumed four expenditure scenarios in the calculation of the revenue and expenditure model:

- (1) Calculate government revenue and government expenditure in the future while maintaining the current service level;

- (2) The service level will be enhanced by 1% per annum;
- (3) The service level will be enhanced by 2% per annum; and
- (4) The service level will be enhanced per annum according to historical trend.

In this study, the following three approaches will be used for projection of government revenue:

- (1) Assuming the proportion of government revenue to nominal GDP maintains between a 19%-20% range. Based on the public finance data in 1989-2018, the average proportion of government revenue to nominal GDP is 19%, the minimum is 15% and the maximum is 23%. As pointed out in the Report of the Working Group on Long-Term Fiscal Planning, under the Article 108 of Basic Law guarantee the protection of Hong Kong taxation system¹, the proportion of government revenue to nominal GDP shall not exceed 20%. Thus, 20% is used in this report as the highest proportion of government revenue to nominal GDP for projection of government deficit.

¹ Article 108 of Hong Kong Basic Law

The Hong Kong Special Administrative Region shall practise an independent taxation system.

The Hong Kong Special Administrative Region shall, taking the low tax policy previously pursued in Hong Kong as reference, enact laws on its own concerning types of taxes, tax rates, tax reductions, allowances and exemptions, and other matters of taxation.

(2) Cointegration Theory - This theory was proposed by Clive Granger, a Nobel Prize winner in 2003. Actually, this theory is related to the time series analysis of statistical theory. The most essential contribution of this theory is that when there are two or more than two non-stationary time series which share the common factor(s), they possess a kind of cointegration relationship which signifies a long-run equilibrium relationship. In the past, this theory was widely applied in the analysis of financial transactions. For example, suppose that there are two financial assets whose rates of return are cointegrated, that is, a long-run equilibrium relationship exists between these two series. When the rate of return of one of financial assets is available, the rate of return of other financial assets can be derived easily. In the current study, the cointegration of two time series (nominal GDP and government revenue) will be used for the projection of government revenue. (The detailed explanation of the cointegration test and the projection of government revenue under cointegration are provided in Annex 1).

(3) Macroeconomic literature has long pointed out that most of the medium- and long-term economic growth patterns of mature countries display an “Exponential Trend”, that is, the country's economic growth will

gradually slow down over time. From Figure 3.3A to Figure 3.3K, it is obvious that the economic growth of these mature economies, including Japan, Hong Kong, South Korea, Singapore, Taiwan, France, Italy, Germany, Spain, Canada, etc., have shown a trend similar to the “Exponential Trend”. Besides, the Working Group assumed that real GDP growth during the projection period would be 3.5% in 2014-2021, 3% in 2022-2025, and 2.5% in 2026-2041. However, the average annual real economic growth from 2014 to 2019 was only 2.13%, which is far lower than the government's assumption. Therefore, this study also uses the Exponential Trend Model to project the future trend of Hong Kong’s real GDP, with the purpose of improving the accuracy in projecting government revenue (Annex 2).

Figure 3.3A
Japan Real GDP Growth Rate (1971-2019)

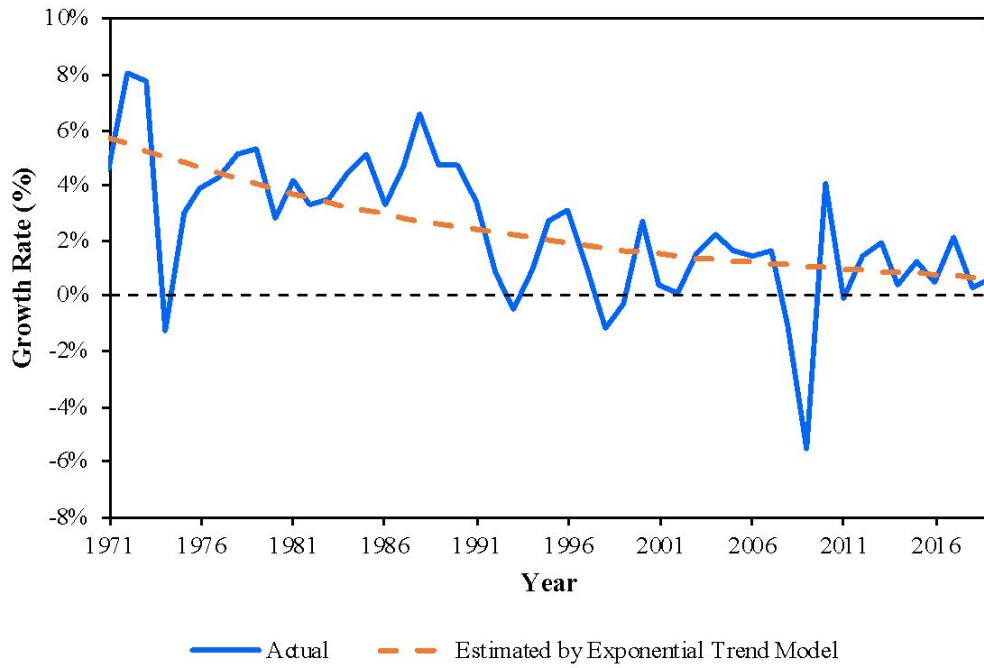


Figure 3.3B
Hong Kong Real GDP Growth Rate (1971-2019)

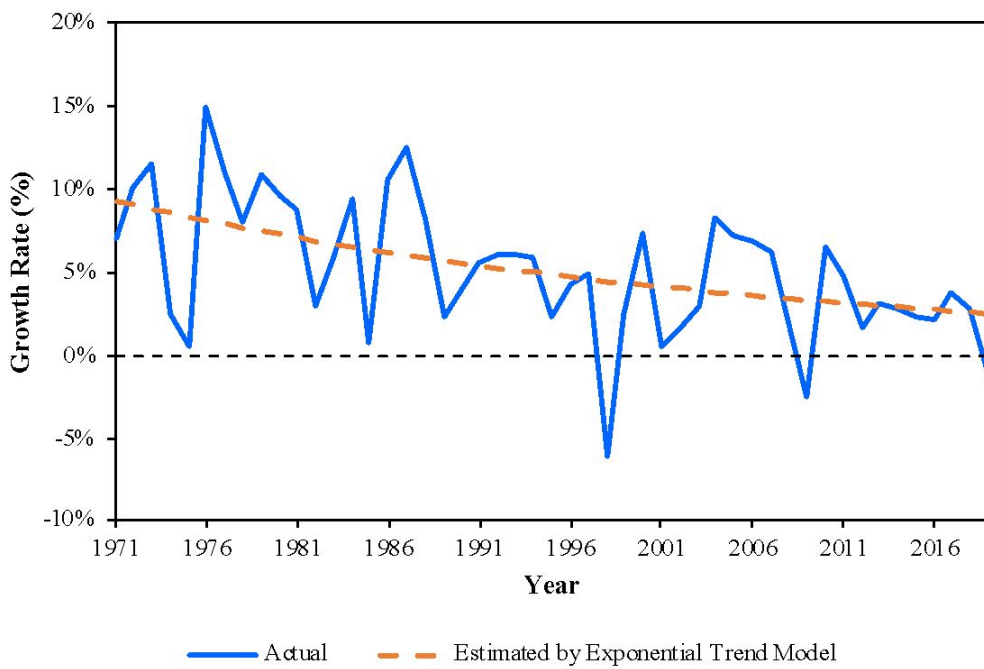


Figure 3.3C
South Korea Real GDP Growth Rate (1971-2019)

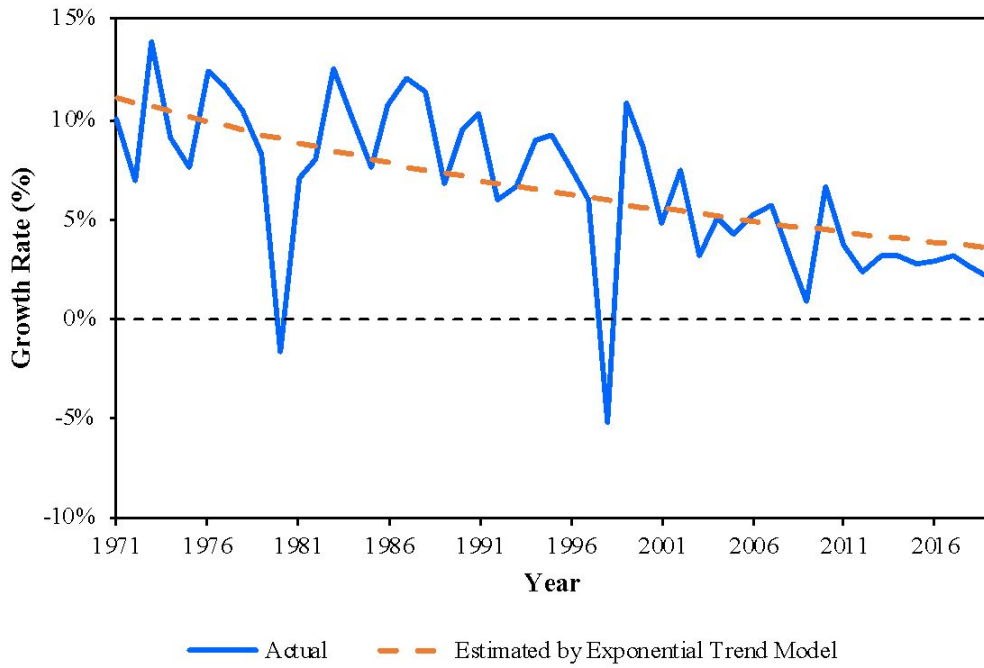


Figure 3.3D
Singapore Real GDP Growth Rate (1971-2019)

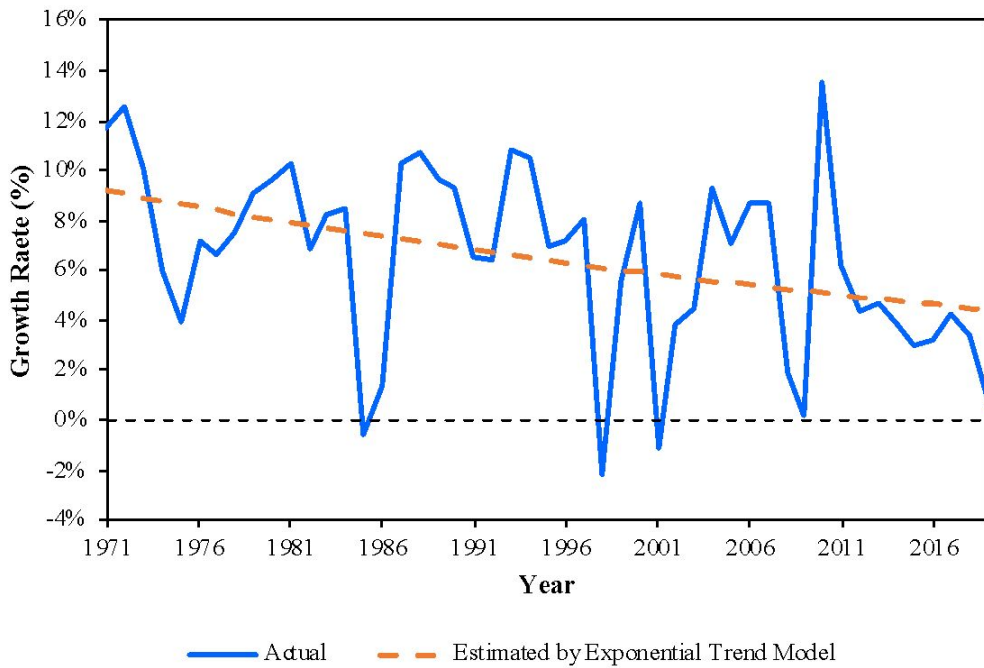


Figure 3.3E
Taiwan Real GDP Growth Rate (1971-2018)

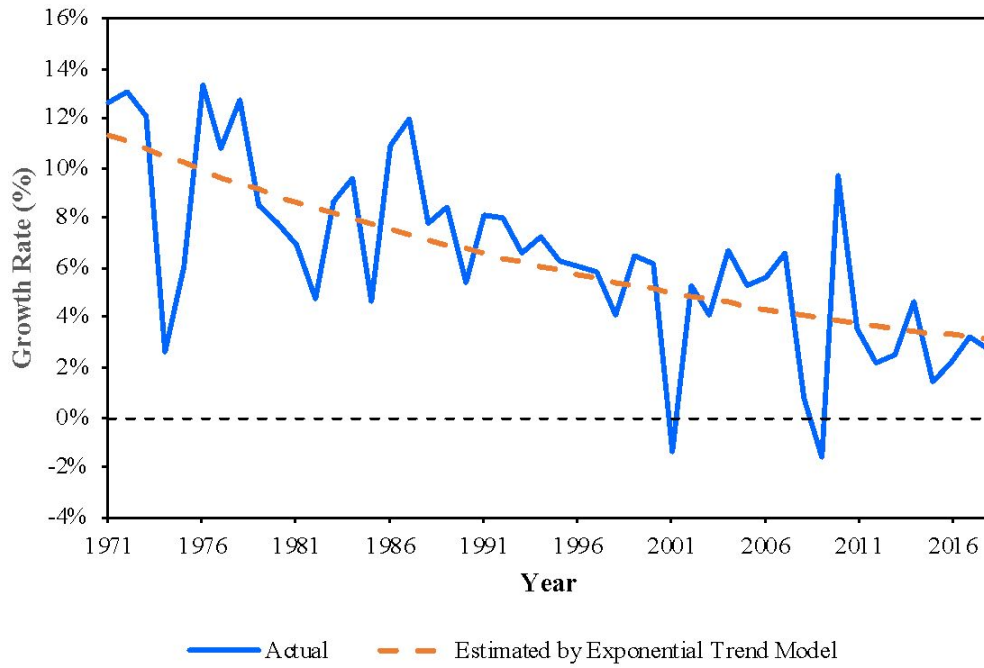


Figure 3.3F
Belgium Real GDP Growth Rate (1971-2019)

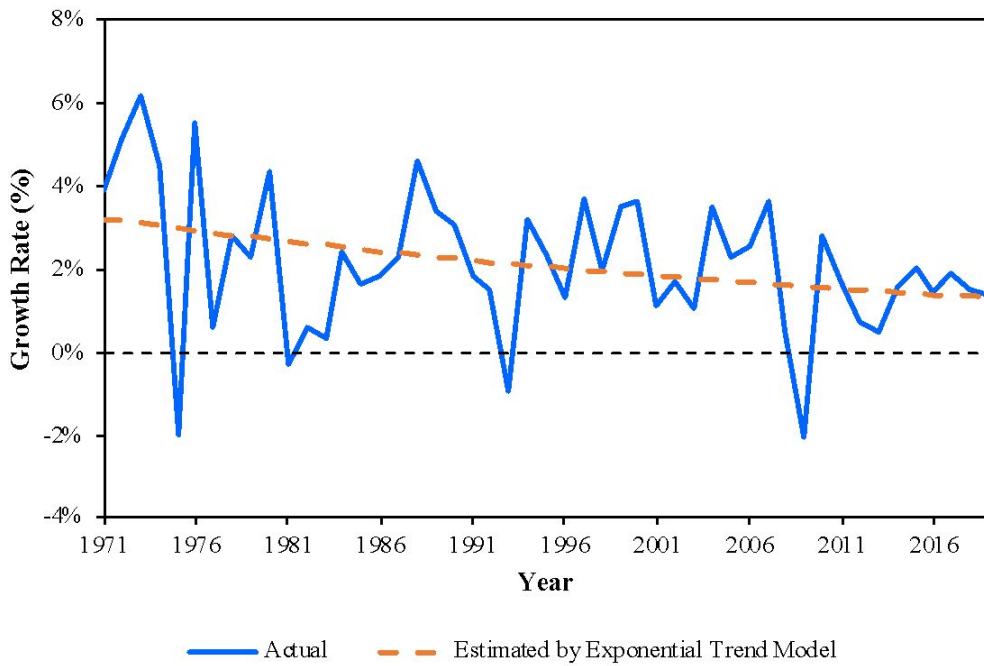


Figure 3.3G
France Real GDP Growth Rate (1971-2019)

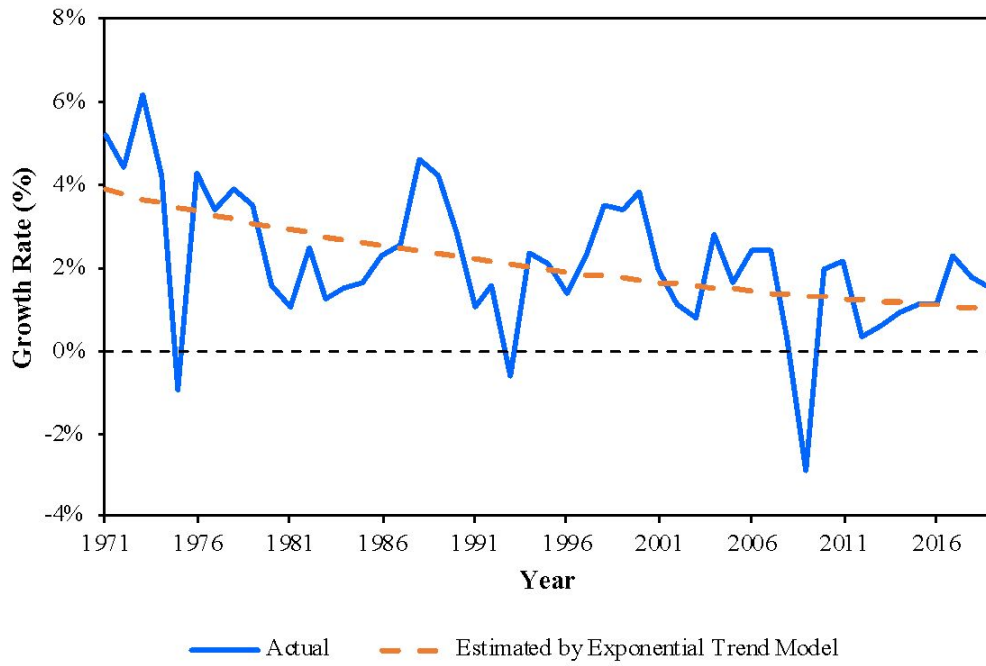


Figure 3.3H
Italy Real GDP Growth Rate (1971-2019)

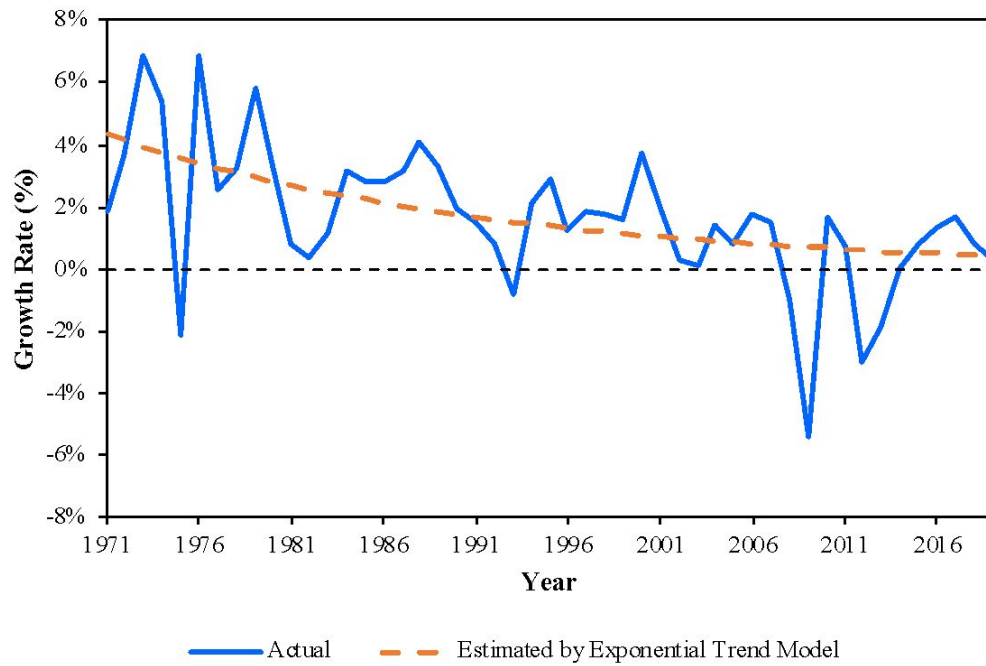


Figure 3.3I
Germany Real GDP Growth Rate (1971-2019)

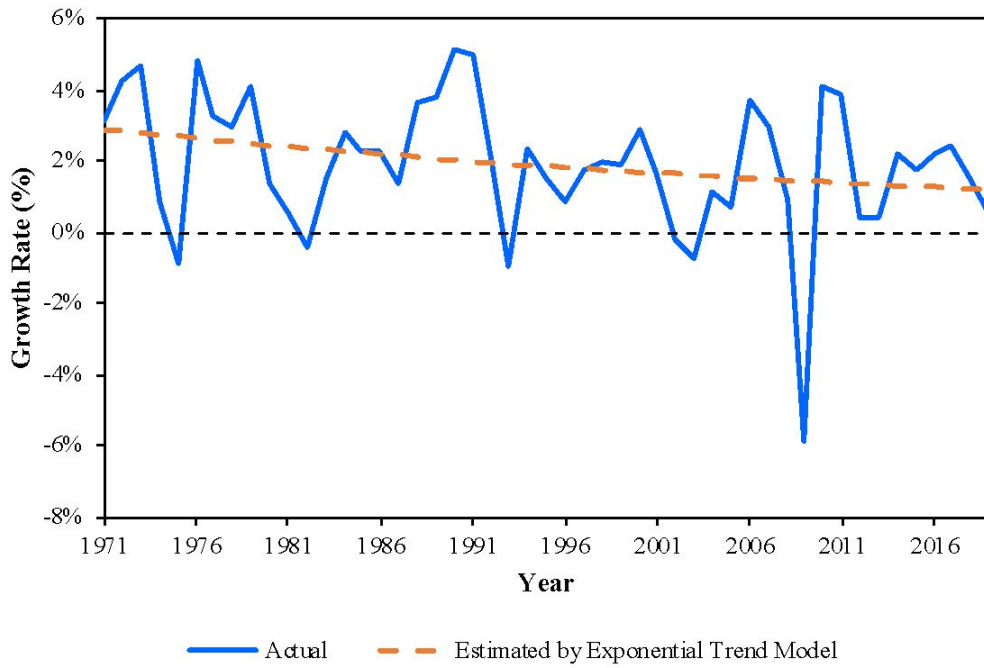


Figure 3.3J
Spain Real GDP Growth Rate (1971-2019)

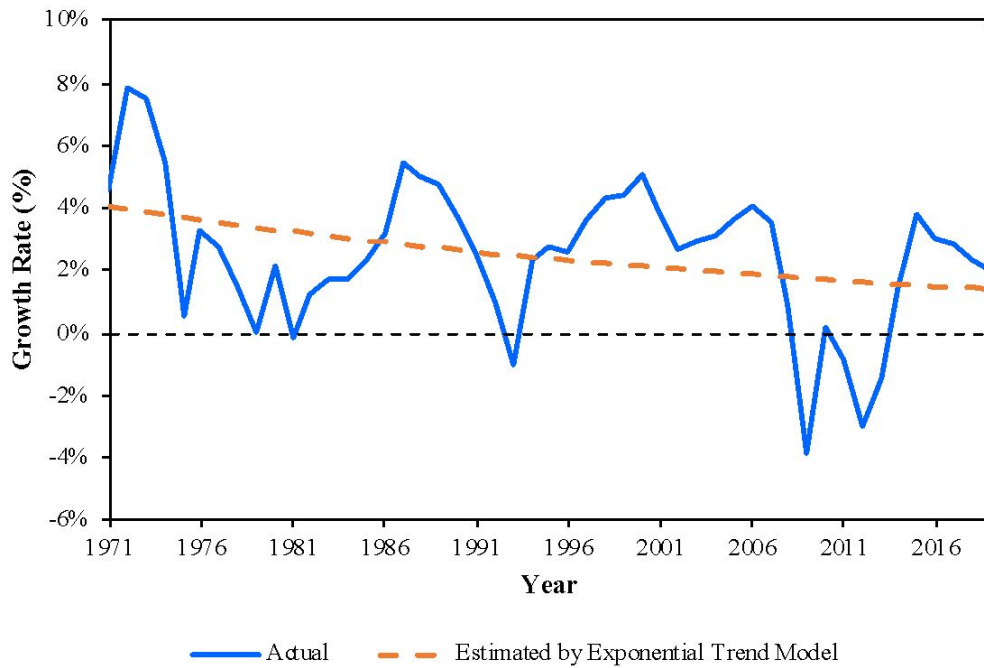
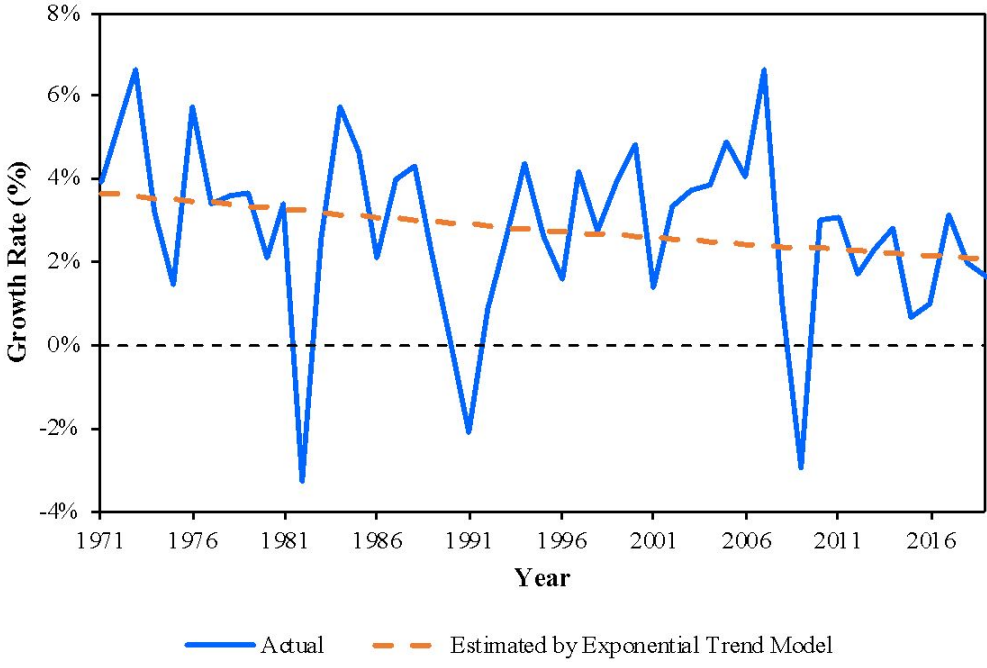


Figure 3.3K
Canada Real GDP Growth Rate (1971-2019)



3.3 Projection Results of Revenue and Expenditure

3.3.1 GDP Estimates Under the Assumptions of the Working Group and the Exponential Trend Model

According to the four service levels and the real GDP growth trend assumed by the Working Group, when the proportion of government revenue to nominal GDP remains at 19% between 2019-20 and 2041-42, Table 3.2 shows that the structural fiscal deficit will occur during the four fiscal years from 2019-20 to 2022-23 (Figure 3.4 to Figure 3.7). If government revenue to nominal GDP increases to the upper limit of 20%, the problem of structural fiscal deficit will appear in the fiscal year 2028-29 at the latest, indicating that regardless of this assumption of higher government revenue, it is expected that Hong Kong will run a structural fiscal deficit in 8 years from 2020-2021.

Table 3.2
Projected Fiscal Deficits Based on Real GDP Growth Rate by
the Working Group on Long-Term Fiscal Planning

		First Occurrence of Fiscal Deficit	Fiscal Deficit as at 2041 (in Millions)
Expenditure	Government Revenue (19%)	2022-2023	-351,471
Scenario 1	Government Revenue (20%)	2028-2029	-278,165
Expenditure	Government Revenue (19%)	2020-2021	-638,609
Scenario 2	Government Revenue (20%)	2024-2025	-565,303
Expenditure	Government Revenue (19%)	2019-2020	-970,643
Scenario 3	Government Revenue (20%)	2022-2023	-897,336
Expenditure	Government Revenue (19%)	2019-2020	-1,413,660
Scenario 4	Government Revenue (20%)	2021-2022	-1,340,354

Figure 3.4
Projected Government Revenue and Expenditure Under the
No Service Enhancement Scenario by the Working Group

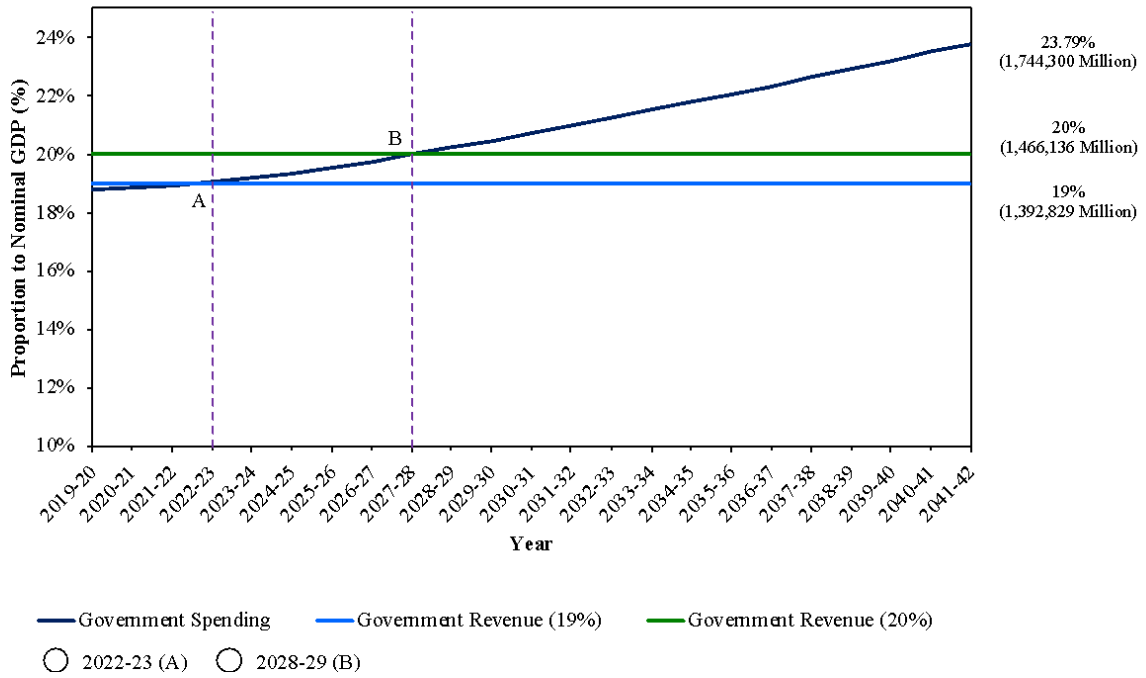


Figure 3.5
Projected Government Revenue and Expenditure Under
1% Annual Service Enhancement Scenario by the Working Group

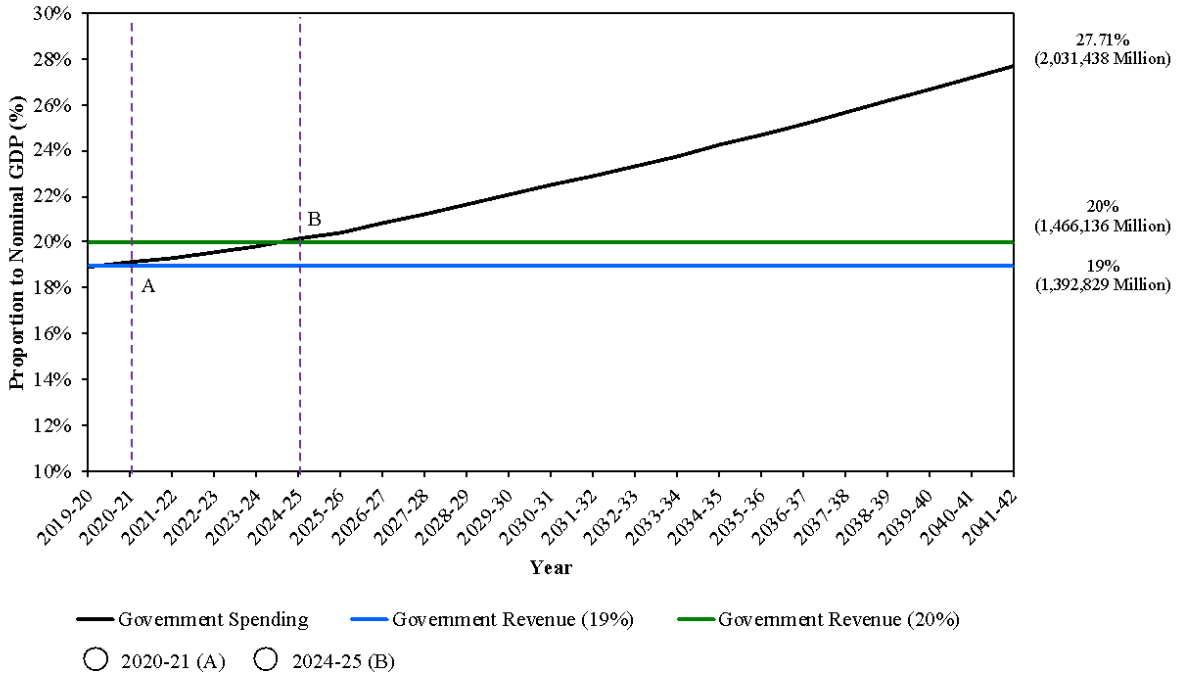


Figure 3.6
Projected Government Revenue and Expenditure Under 2% Annual Service Enhancement Scenario by the Working Group

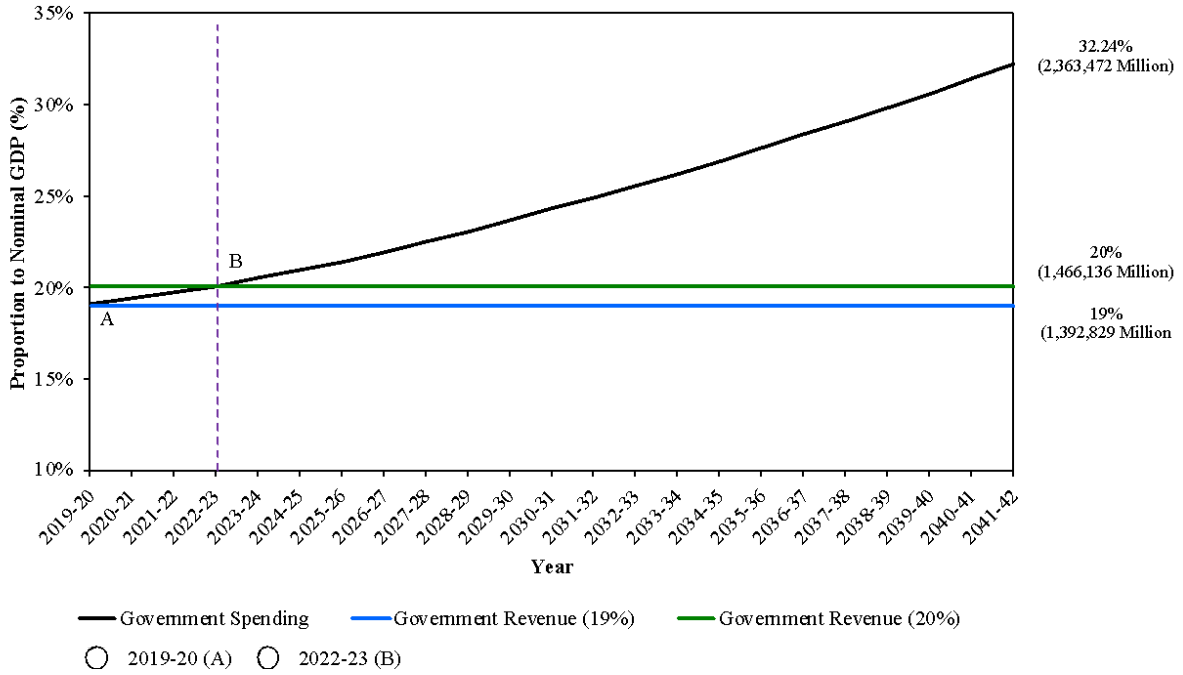
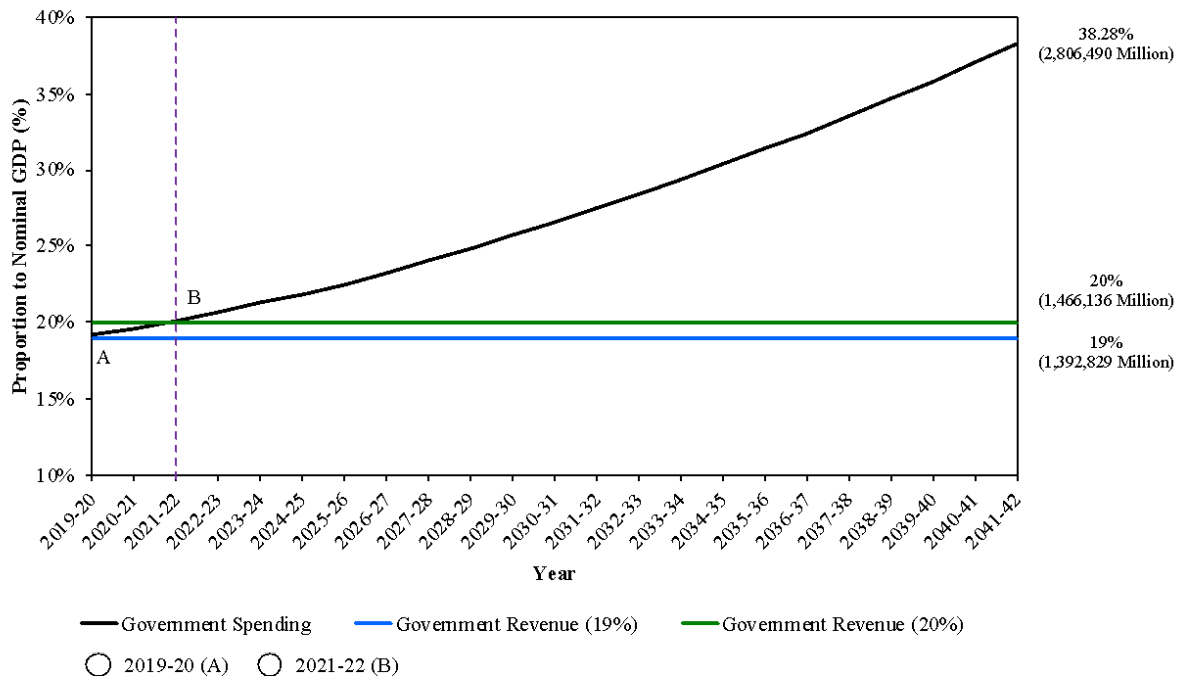


Figure 3.7
Projected Government Revenue and Expenditure Under the Service Enhancement at Historical Trend Scenario by the Working Group



Using the Exponential Trend Model to estimate future economic growth, the HKSAR government's public finance will deteriorate faster than that of the assumptions used by the Working Group (Table 3.3). If we consider expenditure scenario 1 and government revenue as a proportion of 20% of nominal GDP for analysis, the structural fiscal deficit will appear as early as in 2023-2024, which is 5 years earlier than the assumption utilized by the Working Group (Figure 3.8 to Figure 3.11). The main reason is that the Exponential Trend Model projects the pace of slowing down of the Hong Kong economy will be faster than which the government expected, and this will drag down government revenue and push forward the time of occurrence of the structural fiscal deficit.

Table 3.3
Projected Fiscal Deficits Based on Real GDP Growth Rate by
Exponential Trend Model

		First Occurrence of Fiscal Deficit	Fiscal Deficit as at 2041 (in Millions)
Expenditure Scenario 1	Government Revenue (19%)	2020-2021	-583,117
	Government Revenue (20%)	2023-2024	-522,002
Expenditure Scenario 2	Government Revenue (19%)	2019-2020	-870,255
	Government Revenue (20%)	2022-2023	-809,140
Expenditure Scenario 3	Government Revenue (19%)	2019-2020	-1,202,288
	Government Revenue (20%)	2021-2022	-1,141,173
Expenditure Scenario 4	Government Revenue (19%)	2019-2020	-1,645,306
	Government Revenue (20%)	2020-2021	-1,584,191

Figure 3.8
Projected Government Revenue and Expenditure Under the
No Service Enhancement Scenario by Exponential Trend Model

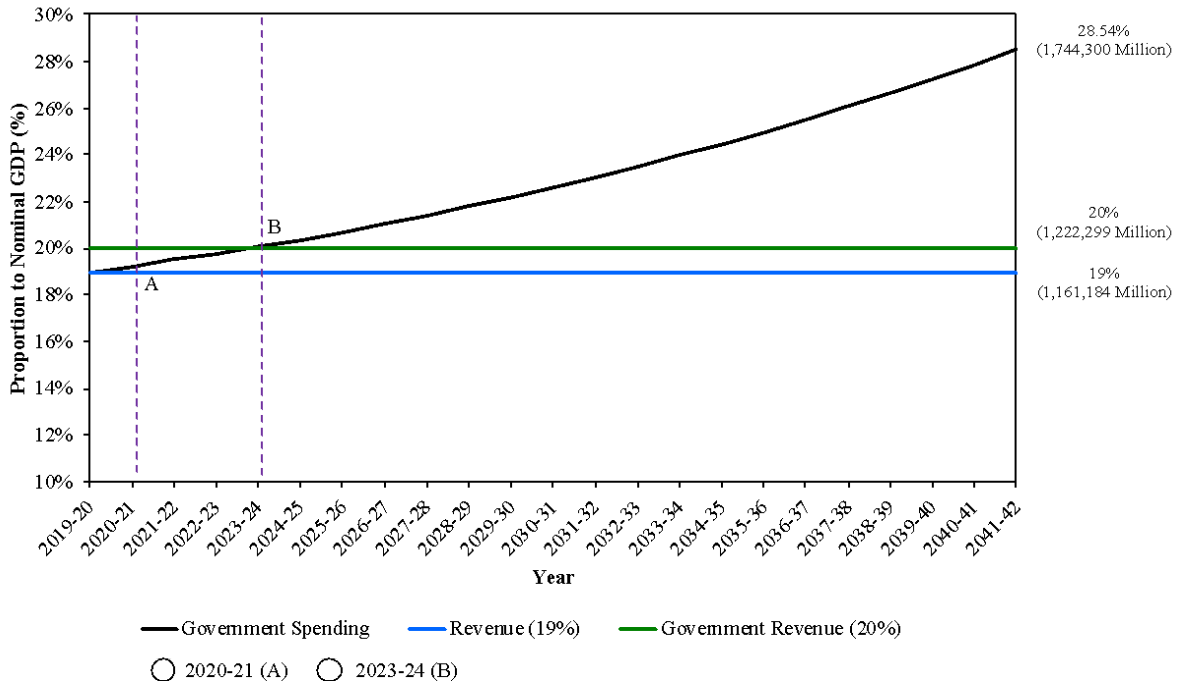


Figure 3.9
Projected Government Revenue and Expenditure Under
1% Annual Service Enhancement Scenario by Exponential Trend Model

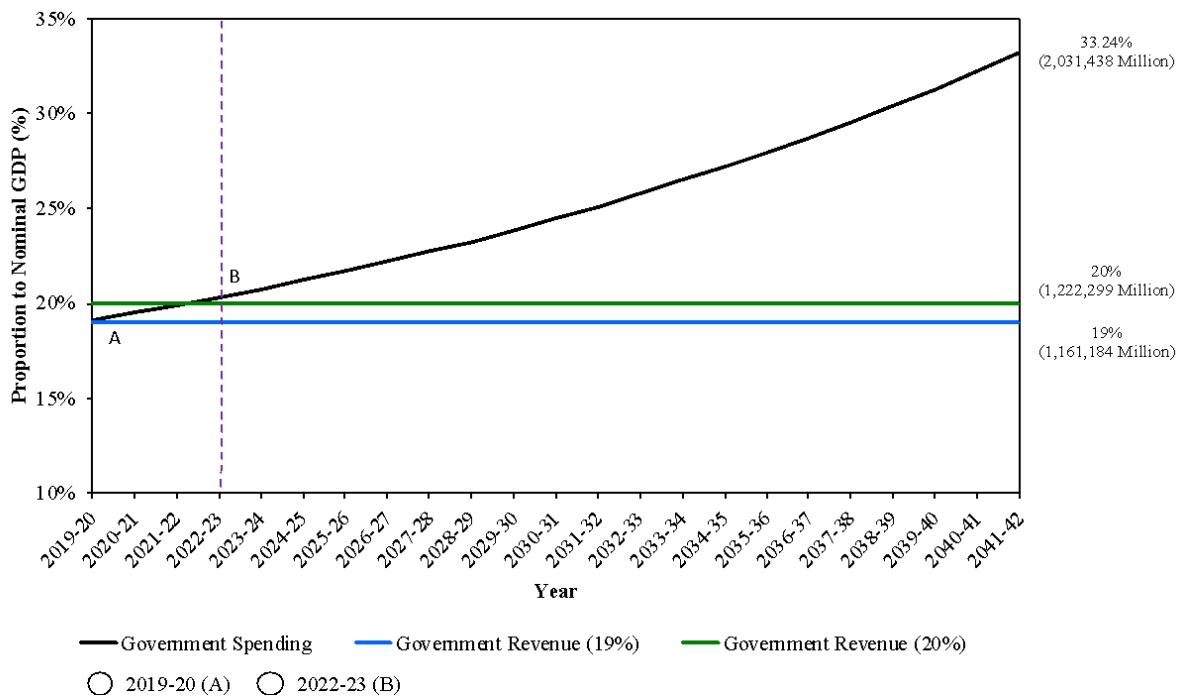


Figure 3.10
Projected Government Revenue and Expenditure Under
2% Annual Service Enhancement Scenario by Exponential Trend Model

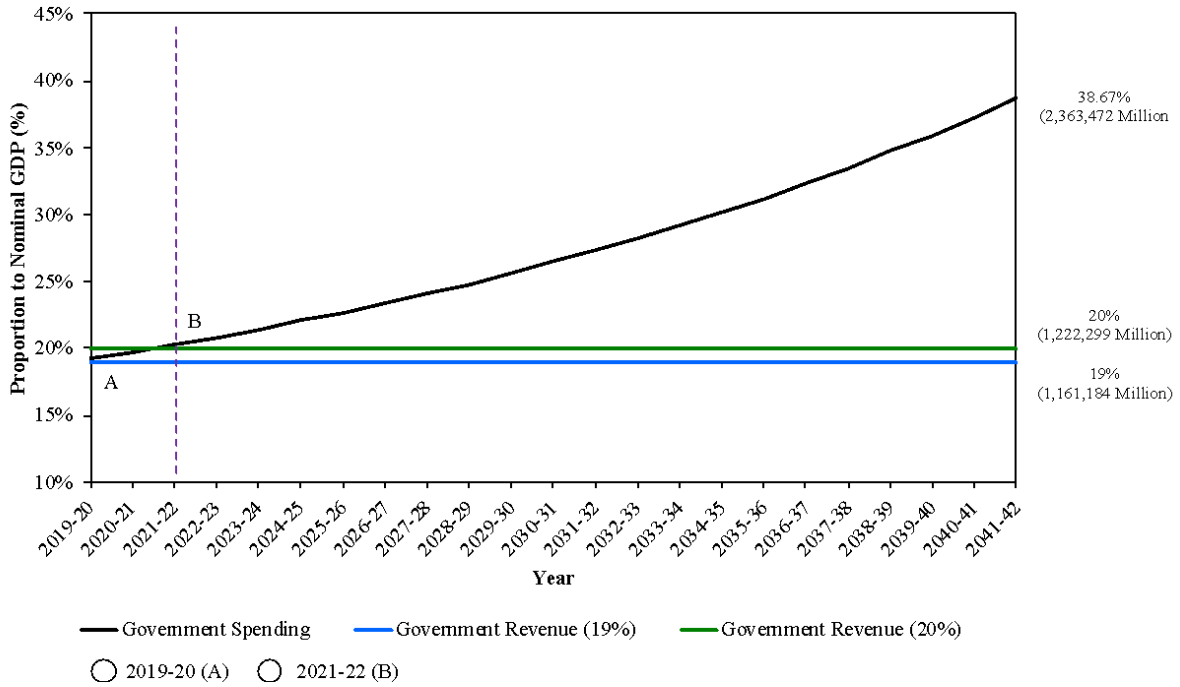
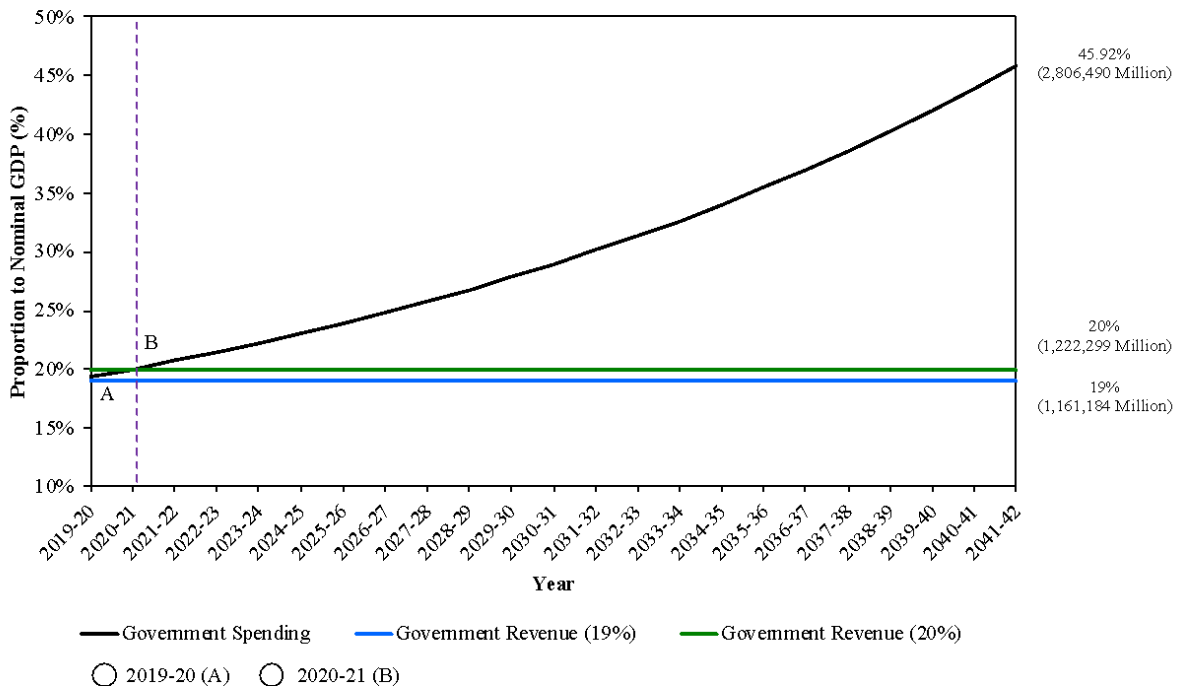


Figure 3.11
Projected Government Revenue and Expenditure Under the Service
Enhancement at Historical Trend Scenario by Exponential Trend Model



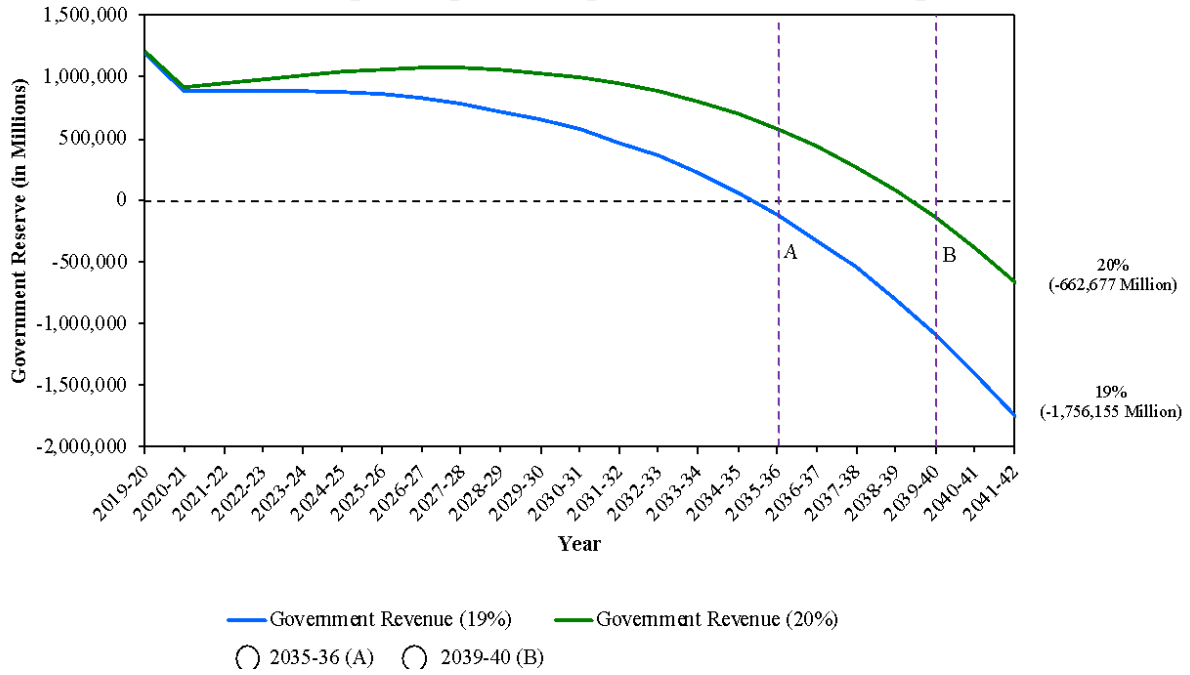
Persistent fiscal deficit impeding current fiscal reserves remains a critical issue. This foreseeable trend is expected to emerge in Hong Kong in a few years. From Table 3.4 and Table 3.5, Hong Kong's fiscal reserves will be exhausted in 2027-28 at the earliest, and no later than 2039-2040 (Figure 3.12 to Figure 3.19). In any case, the HKSAR government will have to borrow money to fund its deficit spending due to depletion of the fiscal reserves.

If the HKSAR government's expenditure exceeds its income, there will be a growing problem of indebtedness for the society. Under the assumption of the service level is increasing according to the historical trend and the annual fiscal revenue accounts for 19% of GDP, based on the Exponential Trend Model, the debt level of the HKSAR government will rise to HK\$12,360.2 billion in 2041-42 (Table 3.5). With debts reaching unprecedented heights, this situation can pose a great challenge for a city with a population of a few millions.

Table 3.4
Projected Fiscal Reserves Based on Real GDP Growth Rate by
Working Group on Long-Term Fiscal Planning

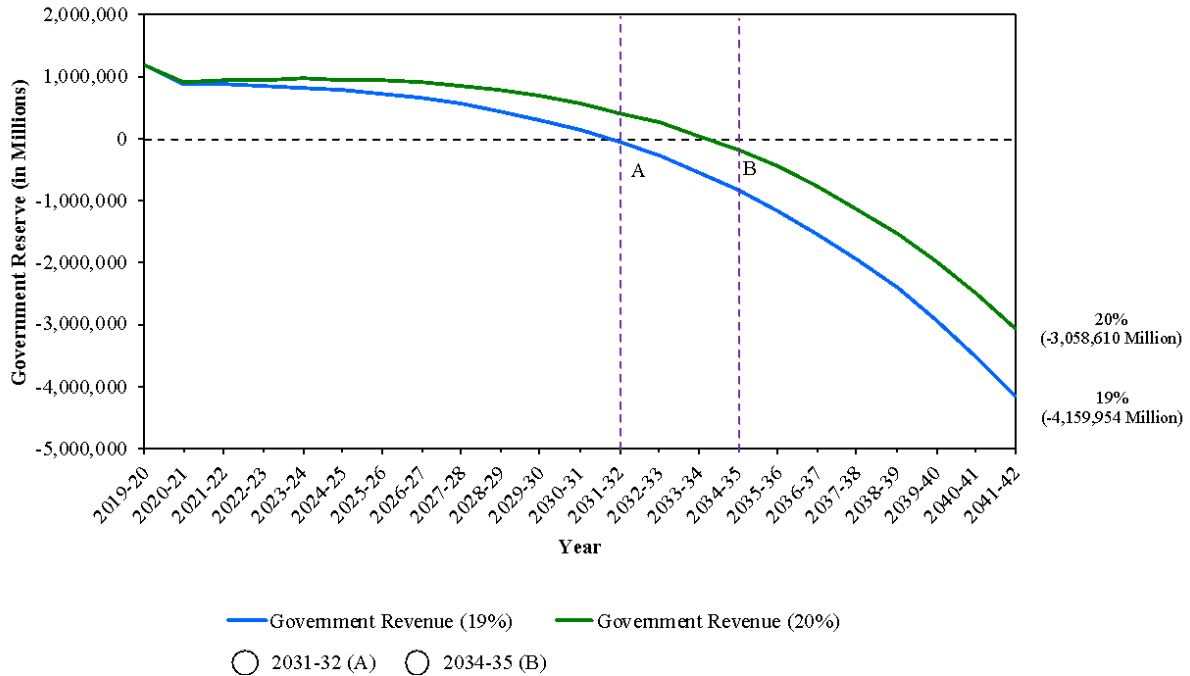
		First Occurrence of Neg. Fiscal Reserves	Fiscal Reserves as at 2041 (in Millions)
Expenditure Scenario 1	Government Revenue (19%)	2035-2036	-1,756,155
	Government Revenue (20%)	2039-2040	-662,677
Expenditure Scenario 2	Government Revenue (19%)	2031-2032	-4,159,954
	Government Revenue (20%)	2034-2035	-3,058,610
Expenditure Scenario 3	Government Revenue (19%)	2029-2030	-6,836,441
	Government Revenue (20%)	2031-2032	-5,727,178
Expenditure Scenario 4	Government Revenue (19%)	2028-2029	-10,270,309
	Government Revenue (20%)	2029-2030	-9,151,934

Figure 3.12
Projected Fiscal Reserves Under the
No Service Enhancement Scenario by the Working Group



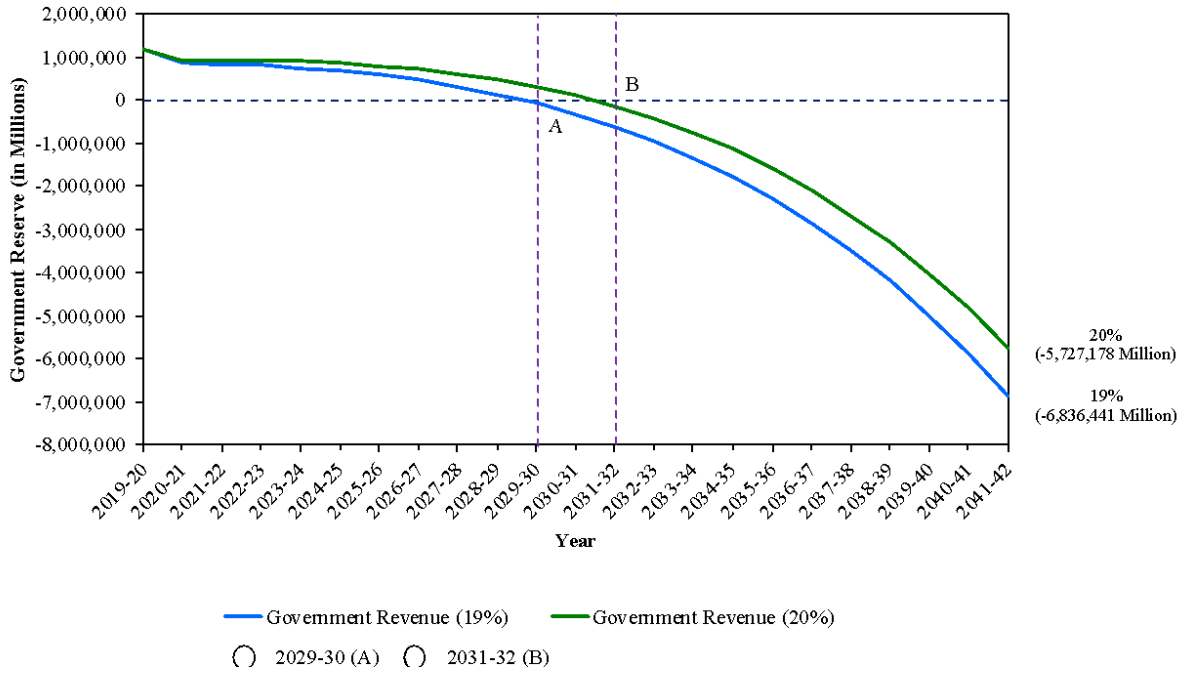
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.13
Projected Fiscal Reserves Under
1% Annual Service Enhancement Scenario by the Working Group



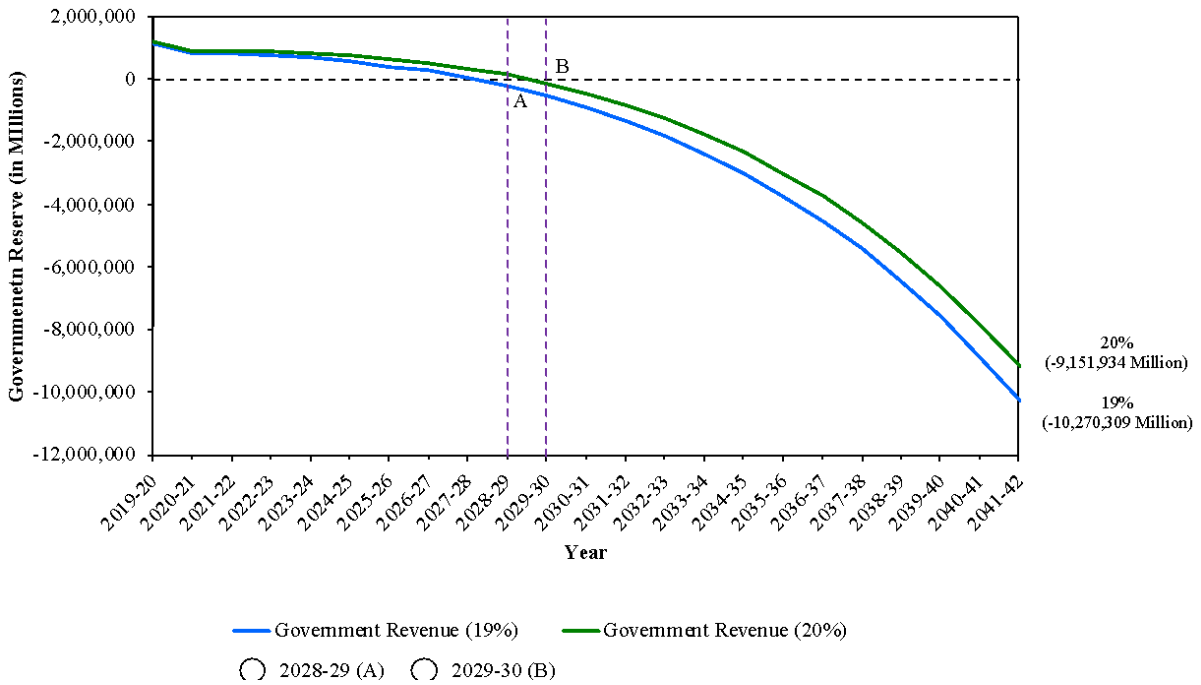
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.14
Projected Fiscal Reserves Under
2% Annual Service Enhancement Scenario by the Working Group



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.15
Projected Fiscal Reserves Under the Service Enhancement
at Historical Trend Scenario by the Working Group

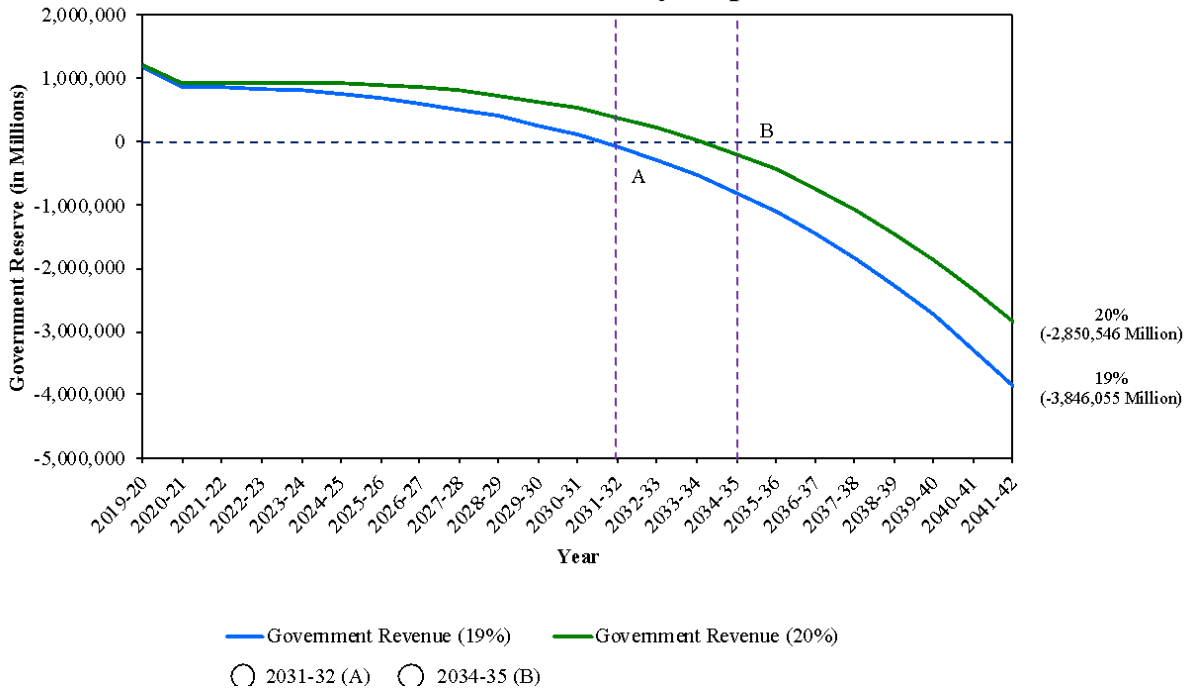


*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Table 3.5
Projected Fiscal Reserves Based on Real GDP Growth Rate by
Exponential Trend Model

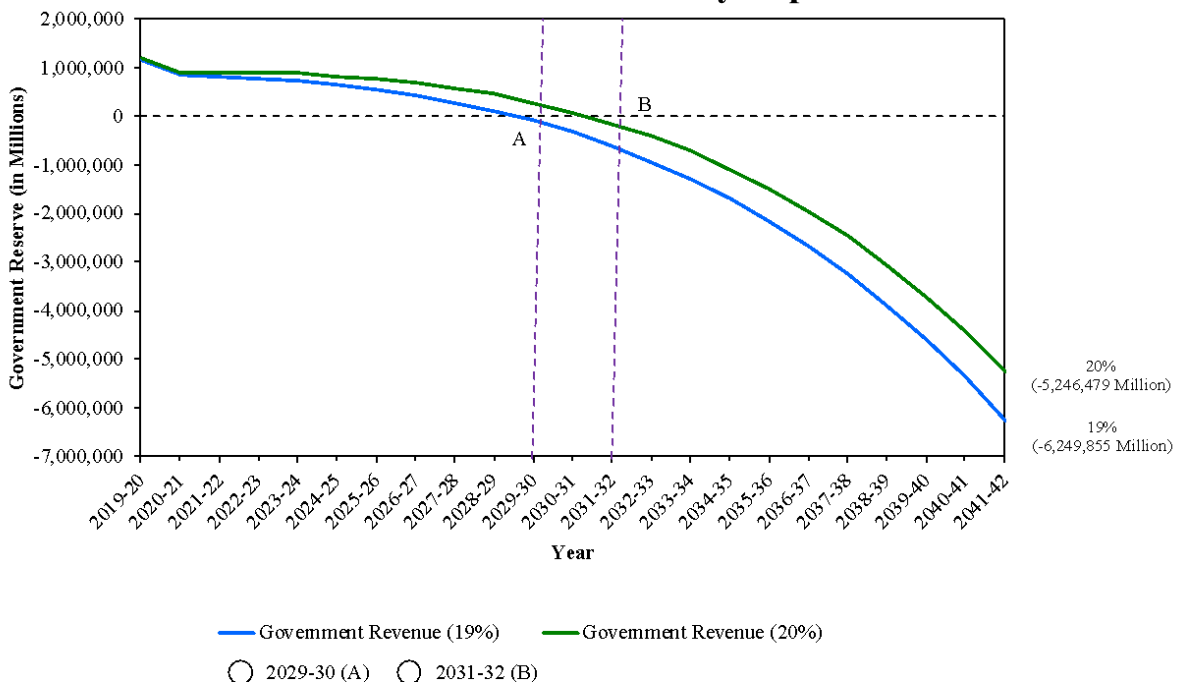
		First Occurrence of Neg. Fiscal Reserves	Fiscal Reserves as at 2041 (in Millions)
Expenditure	Government Revenue (19%)	2031-2032	-3,846,055
Scenario 1	Government Revenue (20%)	2034-2035	-2,850,546
Expenditure	Government Revenue (19%)	2029-2030	-6,249,855
Scenario 2	Government Revenue (20%)	2031-2032	-5,246,479
Expenditure	Government Revenue (19%)	2028-2029	-8,926,341
Scenario 3	Government Revenue (20%)	2029-2030	-7,915,048
Expenditure	Government Revenue (19%)	2027-2028	-12,360,210
Scenario 4	Government Revenue (20%)	2028-2029	-11,339,803

Figure 3.16
Projected Fiscal Reserves Under the
No Service Enhancement Scenario by Exponential Trend Model



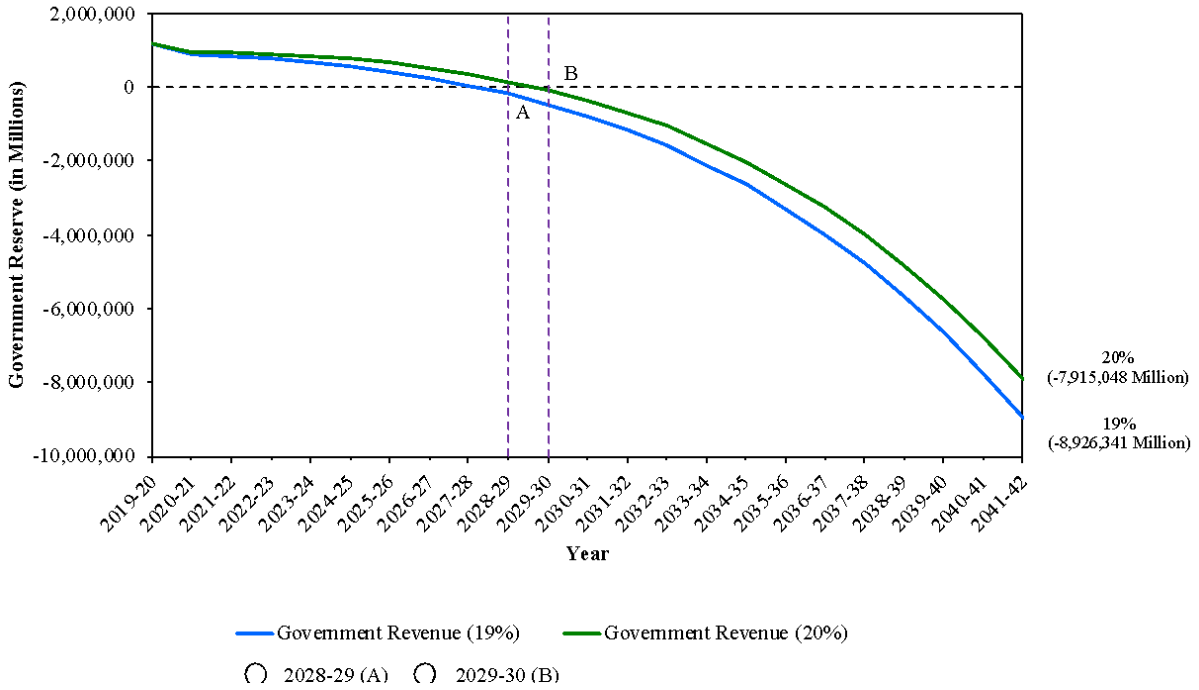
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.17
Projected Fiscal Reserves Under
1% Annual Service Enhancement Scenario by Exponential Trend Model



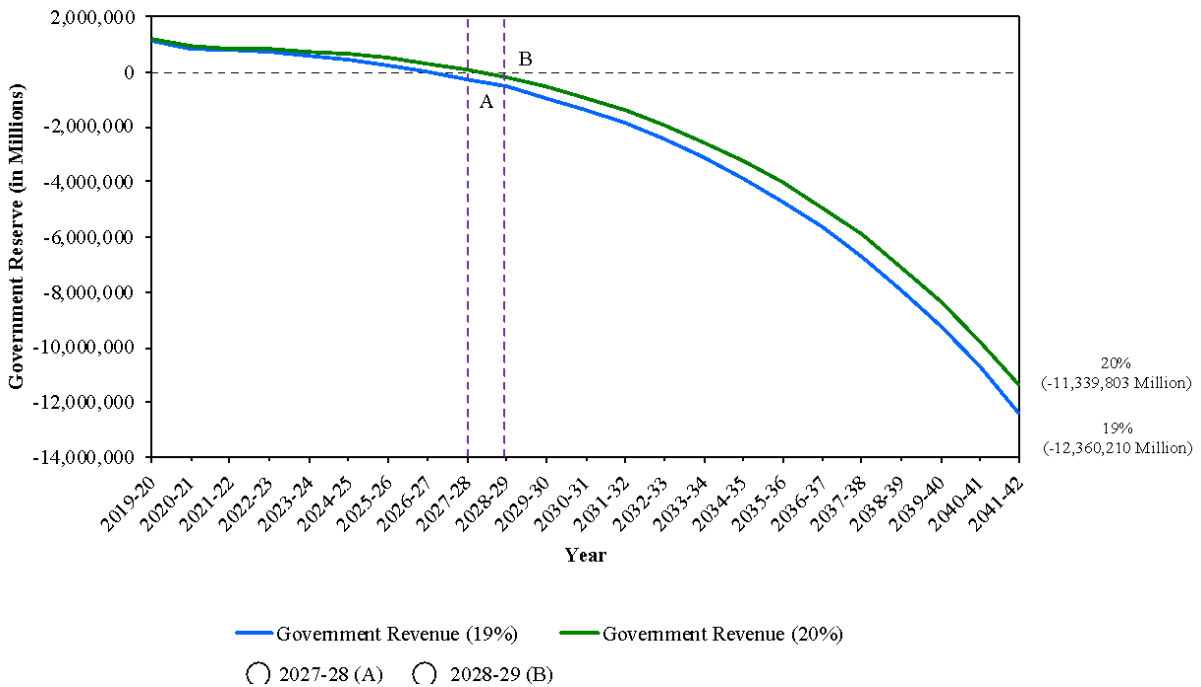
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.18
Projected Fiscal Reserves Under
2% Annual Service Enhancement Scenario by the Working Group



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.19
Projected Fiscal Reserves Under the Service Enhancement
at Historical Trend Scenario by Exponential Trend Model



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

3.3.2 Projections of Government Revenue Based on Cointegration Theory

Aforementioned GDP projections are based on the Working Group on Long-Term Fiscal Planning and the Exponential Trend Model respectively. These projections are used for projecting the government spending. The projection results of fiscal deficit and negative fiscal reserves are obtained under the assumption of fixed proportions of government revenue to nominal GDP (19% and 20% respectively). However, in the actual situation, the proportion of government revenue to nominal GDP is not fixed. The projection of government revenue obtained based on the cointegration theory does not limit the proportion of government revenue to nominal GDP.

According to the cointegration theory, the projection results of structural fiscal deficit or negative fiscal reserves also show similar results. Table 3.6 shows that Hong Kong will have structural fiscal deficit from 2023-2024 to 2025-2026, while Table 3.7 shows fiscal reserves will be exhausted from 2029- 2030 to 2033-2034, These results indicate that the fiscal sustainability of the HKSAR government will be exhausted and cannot be guaranteed (see Figure 3.20 to Figure 3.27).

From Figure 3.20 to Figure 3.23, the proportion of government revenue to nominal GDP projected by cointegration theory shows a long-term downward trend. Although the result is calculated based on past statistics using the statistical method of cointegration theory, the phenomenon can also be constructed as follows; despite government revenue and nominal GDP share a common factor (they have a cointegration relationship), the common factor has different driving forces for the two time series. In particular, the common factor has a weaker driving force on government revenue than it has on nominal GDP.

Table 3.6
Projected Fiscal Deficits Based on Cointegration Theory

		First Occurrence of Fiscal Deficit	Fiscal Deficit as at 2041 (in Millions)
Expenditure Scenario 1	Government Revenue (Cointegration)	2025-2026	-943,434
Expenditure Scenario 2	Government Revenue (Cointegration)	2024-2025	-1,230,572
Expenditure Scenario 3	Government Revenue (Cointegration)	2023-2024	-1,562,605
Expenditure Scenario 4	Government Revenue (Cointegration)	2023-2024	-2,005,623

Figure 3.20
Projected Government Revenue and Expenditure Under the
No Service Enhancement Scenario Based on Cointegration Theory

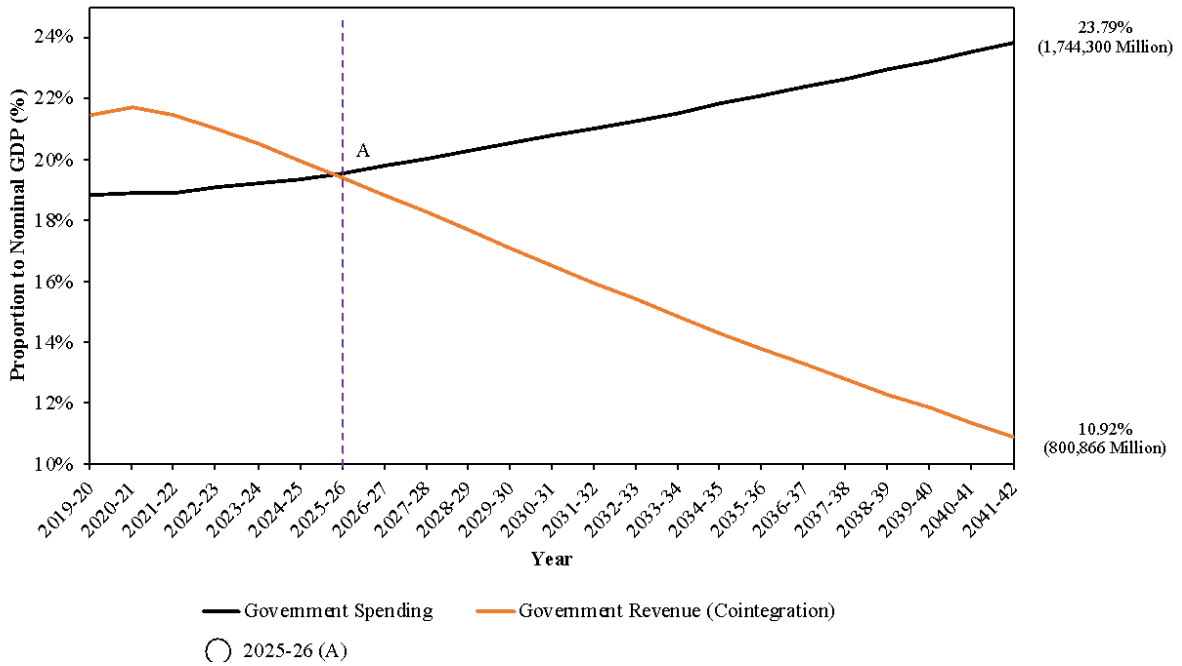


Figure 3.21
Projected Government Revenue and Expenditure Under 1% Annual
Service Enhancement Scenario Based on Cointegration Theory

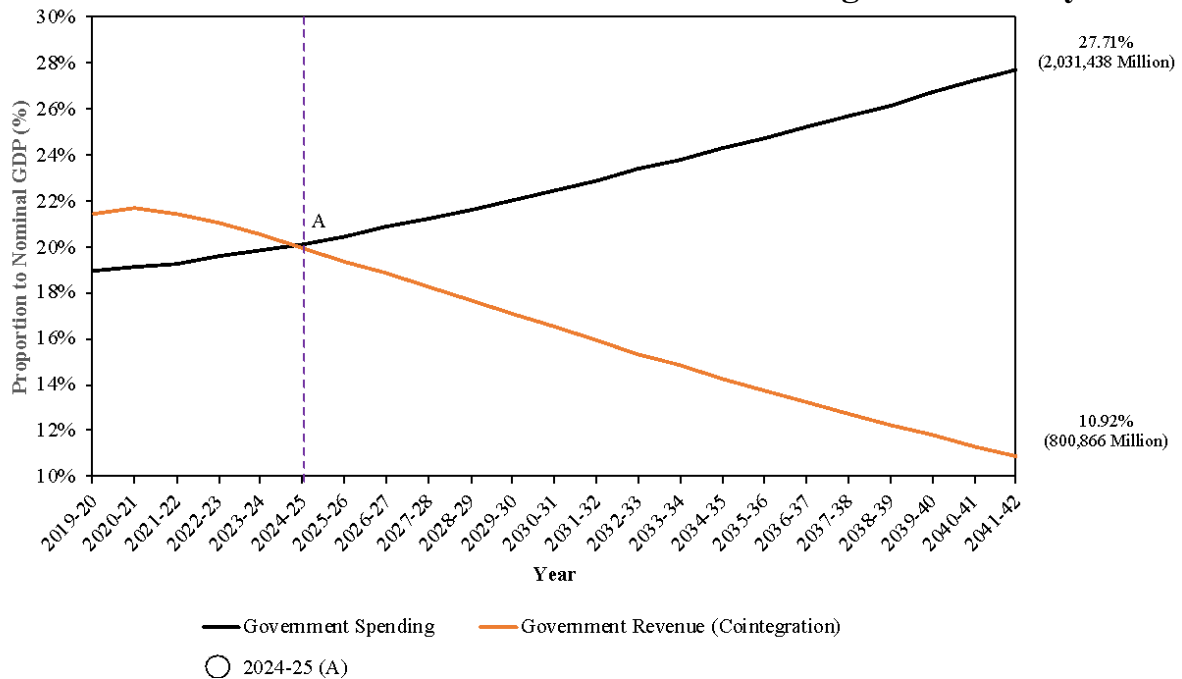


Figure 3.22
Projected Government Revenue and Expenditure Under 2% Annual Service Enhancement Scenario Based on Cointegration Theory

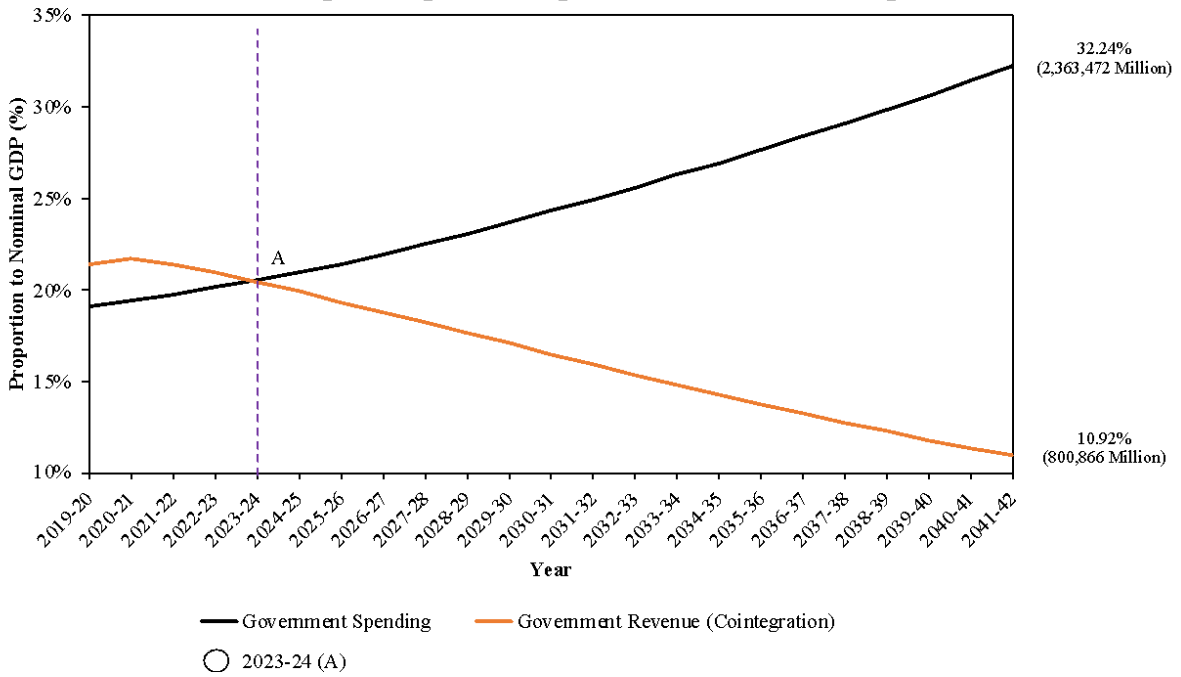


Figure 3.23
Projected Government Revenue and Expenditure Under the Service Enhancement at Historical Trend Scenario Based on Cointegration Theory

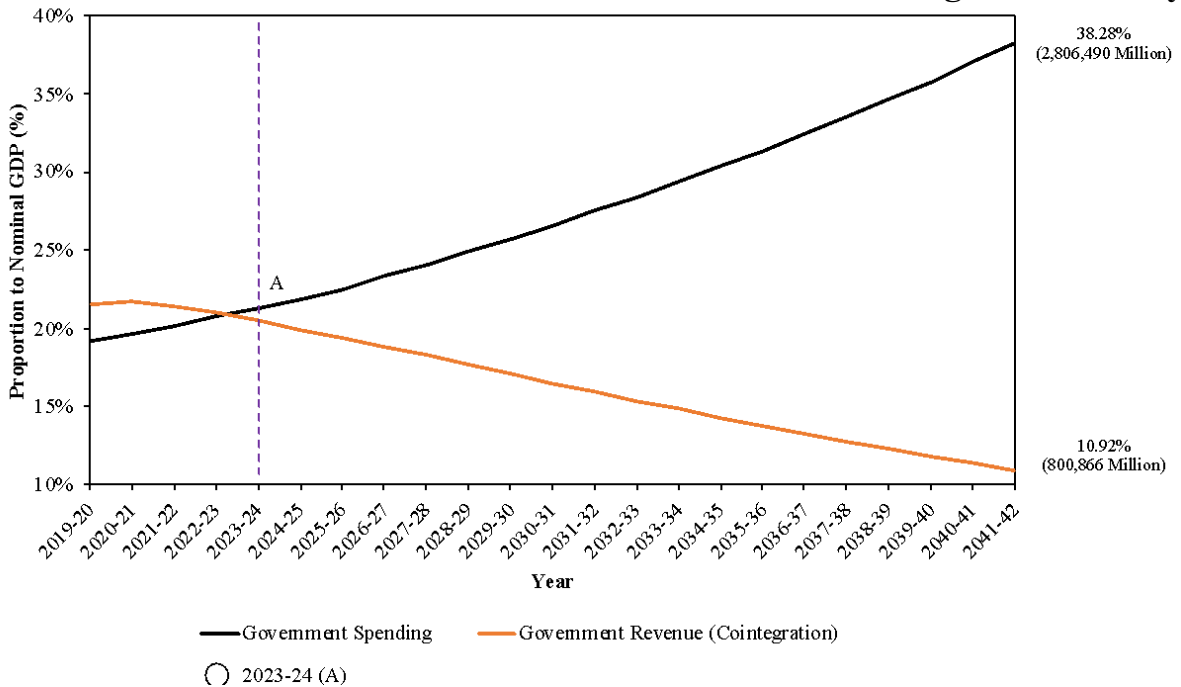
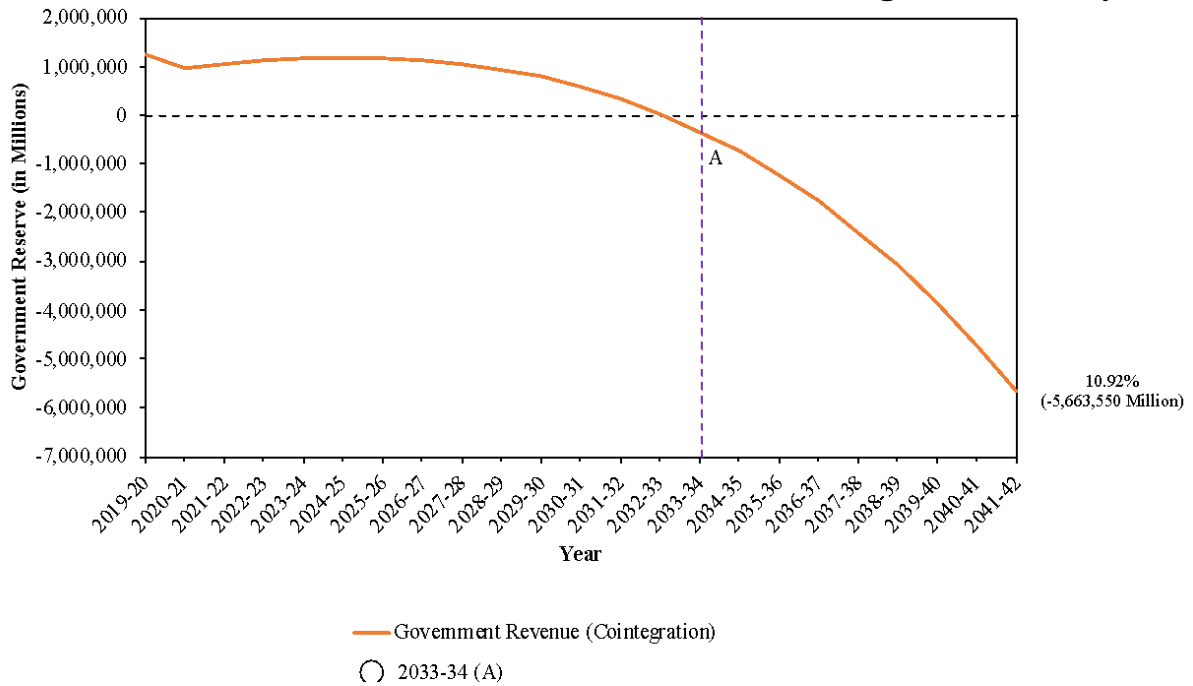


Table 3.7
Projected Fiscal Reserves Based on Cointegration Theory

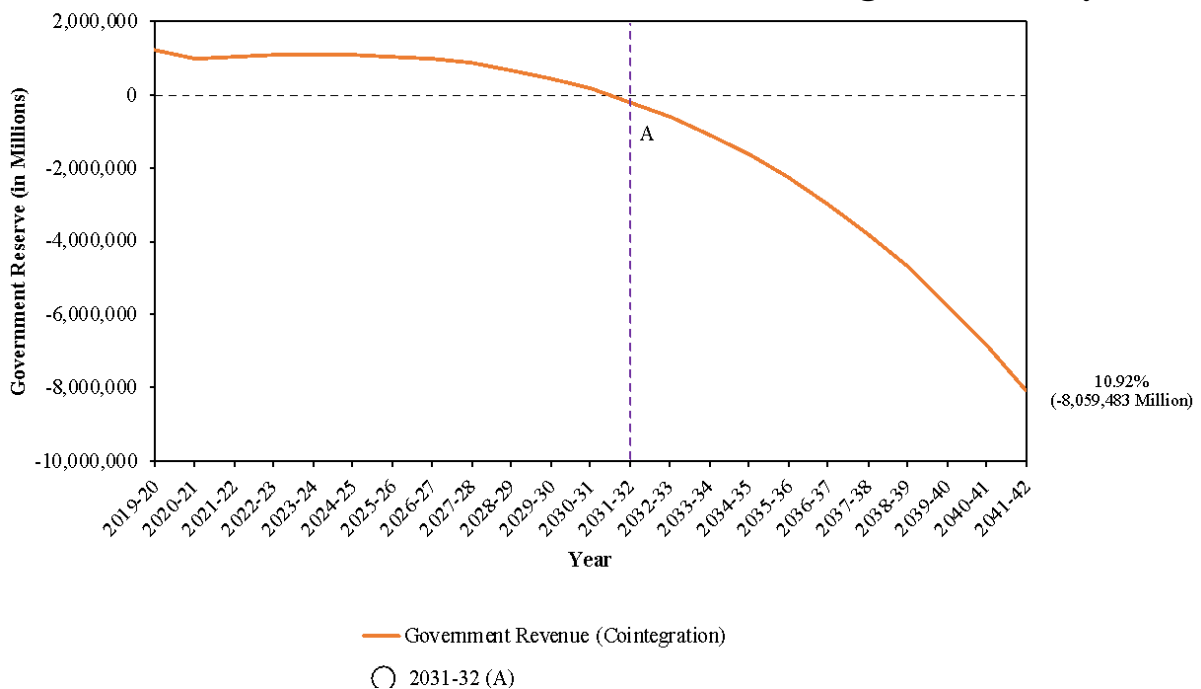
		First Occurrence of Neg. Fiscal Reserves	Fiscal Reserves as at 2041 (in Millions)
Expenditure	Government Revenue	2033-2034	-5,663,550
Scenario 1	(Cointegration)		
Expenditure	Government Revenue	2031-2032	-8,059,483
Scenario 2	(Cointegration)		
Expenditure	Government Revenue	2030-2031	-10,728,051
Scenario 3	(Cointegration)		
Expenditure	Government Revenue	2029-2030	-14,152,806
Scenario 4	(Cointegration)		

Figure 3.24
Projected Fiscal Reserves Under the
No Service Enhancement Scenario Based on Cointegration Theory



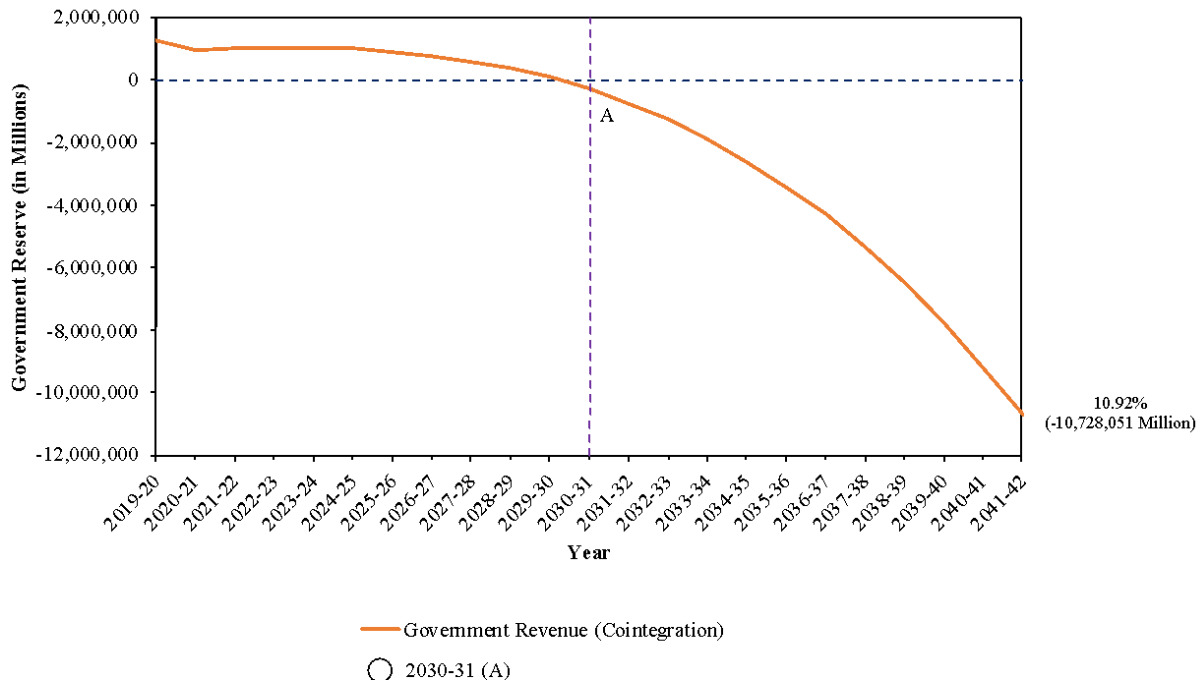
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.25
Projected Fiscal Reserves Under 1% Annual
Service Enhancement Scenario Based on Cointegration Theory



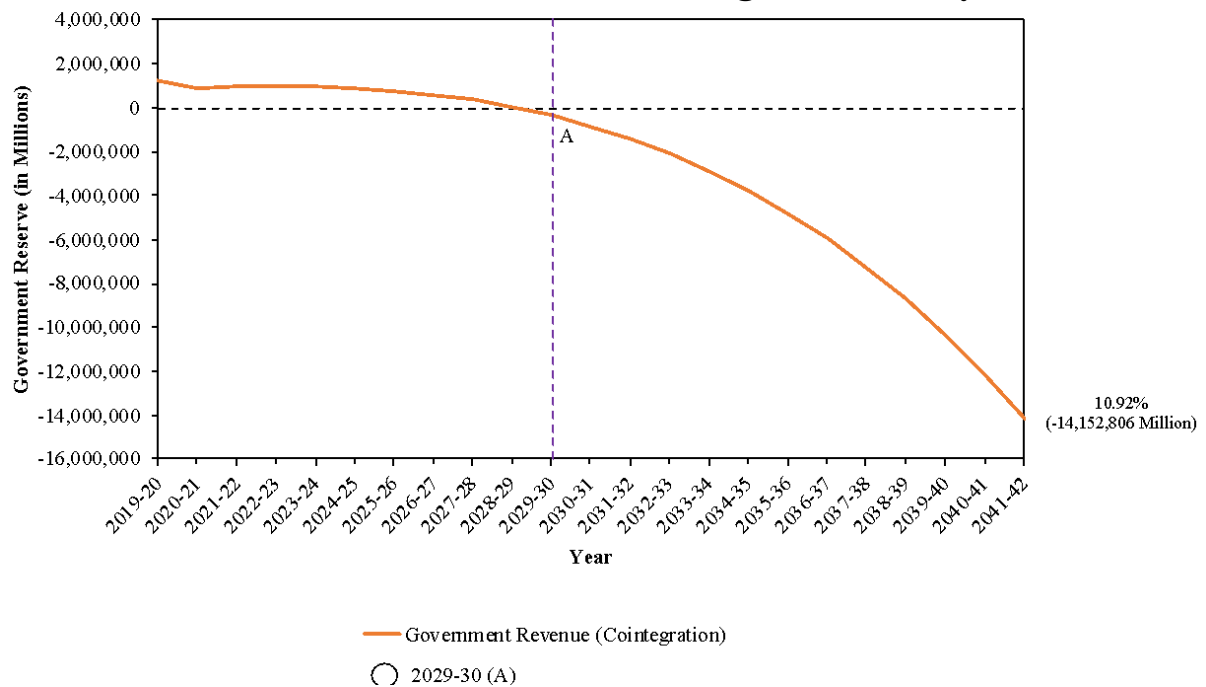
*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.26
Projected Fiscal Reserves Under 2% Annual
Service Enhancement Scenario Based on Cointegration Theory



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 3.27
Projected Fiscal Reserves Under the Service Enhancement at Historical
Trend Scenario Based on Cointegration Theory



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

The above calculation results show that Hong Kong will face the problem of structural fiscal deficit and depletion of fiscal reserves. It is disappointed with the HKSAR government's measures to increase recurrent expenditure in the past three years, without acting proactively by preparing appropriate measures for potential crisis. This reflects the Chief Executive and senior officials lack a sense of crisis in handling public finance.

The novel coronavirus broke out last year in Wuhan City, Hubei Province of China, and it has since spread across the world. At present, the third wave of coronavirus has broken out in Hong Kong, which halts recovery for the local economy. Under the current global economic recession, the future of Hong Kong definitely raises concern. In order to alleviate the impact of local economic contraction, the Financial Secretary Chan Mo-po introduced a one-off HK\$120 billion relief deal in this year's Budget, plus two rounds of measures from the "Anti-epidemic Fund". The HKSAR government spent a total of HK\$287.5 billion to deal with the epidemic of the century, which accounted for about 10% of the nominal GDP in 2019. The move made by Carrie Lam's government at this time is indeed extremely powerful. However, considering that the government has substantially increased public expenditure in recent years, this epidemic is likely to accelerate the exposure of how fragile the

HKSAR government's public finance is. Even if the government has abundant fiscal reserves, it is still difficult to resist the black swan events like the new coronavirus crisis.

To conclude, the HKSAR government must improve their approach in dealing with public finance. Holding on to deficiencies will only make the problem more difficult to handle. If the Chief Executive and senior officials in charge of public finance are willing to better understand the obstacles of population aging and fiscal sustainability, and take action to achieve practical solutions, we remain hopeful and confident for the future of Hong Kong.

Chapter 4 Impacts of Lantau Tomorrow on Public Finance

4.1 Lantau Tomorrow Causes Structural Fiscal Deficit to Occur Earlier

In recent years, large-scale government infrastructure projects have been experiencing cost overruns, including the Hong Kong-Zhuhai-Macao Bridge, Shatin to Central Link, Guangzhou–Shenzhen–Hong Kong Express Rail Link Hong Kong section, etc. As over budget in infrastructure has gradually become the norm, citizens are concerned about the supervisory ability of the HKSAR government. Along with increasing public expenditure related to the elderly, since Hong Kong has entered a stage of aging population. Despite the HKSAR government supported by financial reserves, it is responsible to control public spending and reduce unnecessary waste to achieve a good fiscal discipline.

The Development Bureau suddenly applied for funding for studies related to Lantau Tomorrow in the last meeting of the LegCo Finance Committee in July of this year. This reflects the government insists on land reclamation. In light of a number of cost overruns and delays in mega projects in recent years, there are concerns over the government's supervisory ability on infrastructure projects, and cause a negative impact on public finance. Furthermore, to combat the

epidemic, the HKSAR government has spent HK\$287.5 billion which has consumed a considerable amount of fiscal reserves. Therefore, the HKSAR government must carefully study whether the infrastructure is affordable, so as to prevent fiscal problems in the future.

The HKSAR government initially estimated the cost of this infrastructure project to be HK\$624 billion. If the cost is divided into ten years, the average cost is HK\$62.4 billion per year. According to the news released by the HKSAR government, Lantau Tomorrow is scheduled to start in 2025-2026. If we include the cost of this infrastructure in our projections of government revenue and expenditure, according to the no service enhancement scenario by the Working Group, provided that government revenue accounts for 19% of GDP, our result obtained in Chapter 3 points out that there is no change in the occurrence time when this mega infrastructure is taken into consideration. The reason is that our result reveals the structural fiscal deficit is expected to occur before 2025-2026. But the fiscal reserves will be depleted earlier in 2032-2033. When the government revenue accounts for 20% of GDP, the structural fiscal deficit will occur by 2025, which is 3 years earlier (Figure 4.1). As regards the fiscal reserves, this land reclamation project will make the depletion happen earlier to 2035-2036 respectively (Figure 4.2).

When the long-term economic growth trend is projected by the Exponential Trend Model, the projection obtained in Chapter 3 points out that the structural fiscal deficit will occur before 2025-2026 (Figure 4.3), the inclusion of Lantau Tomorrow will not change the result. The exhaustion time of fiscal reserves will be pushed to happen sooner in 2029-2030 and 2031-2032 respectively (Figure 4.4).

Finally, according to the results of the cointegration theory, the inclusion of this large-scale infrastructure does not change the occurrence time of the structural fiscal deficit (Figure 4.5), while the time for fiscal reserves to drop to zero will be pushed forward to 2031-2032 (Figure 4.6).

Figure 4.1
Impact of LTV on Projected Government Revenue and Expenditure Under the No Service Enhancement Scenario by the Working Group

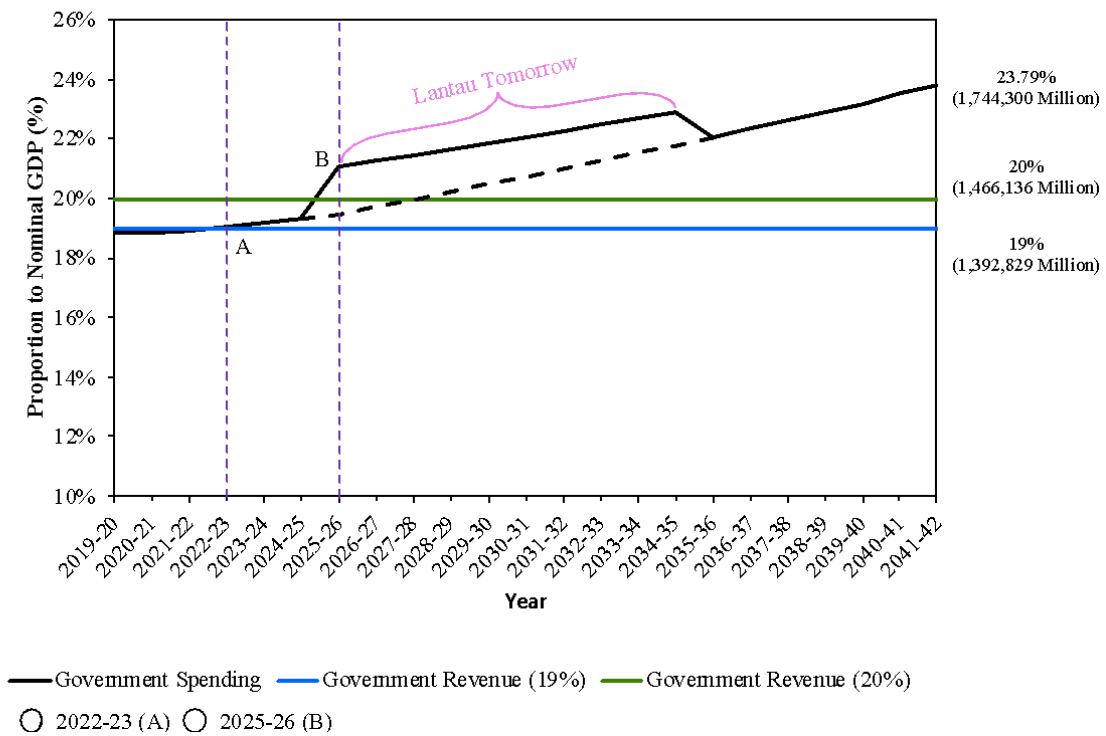
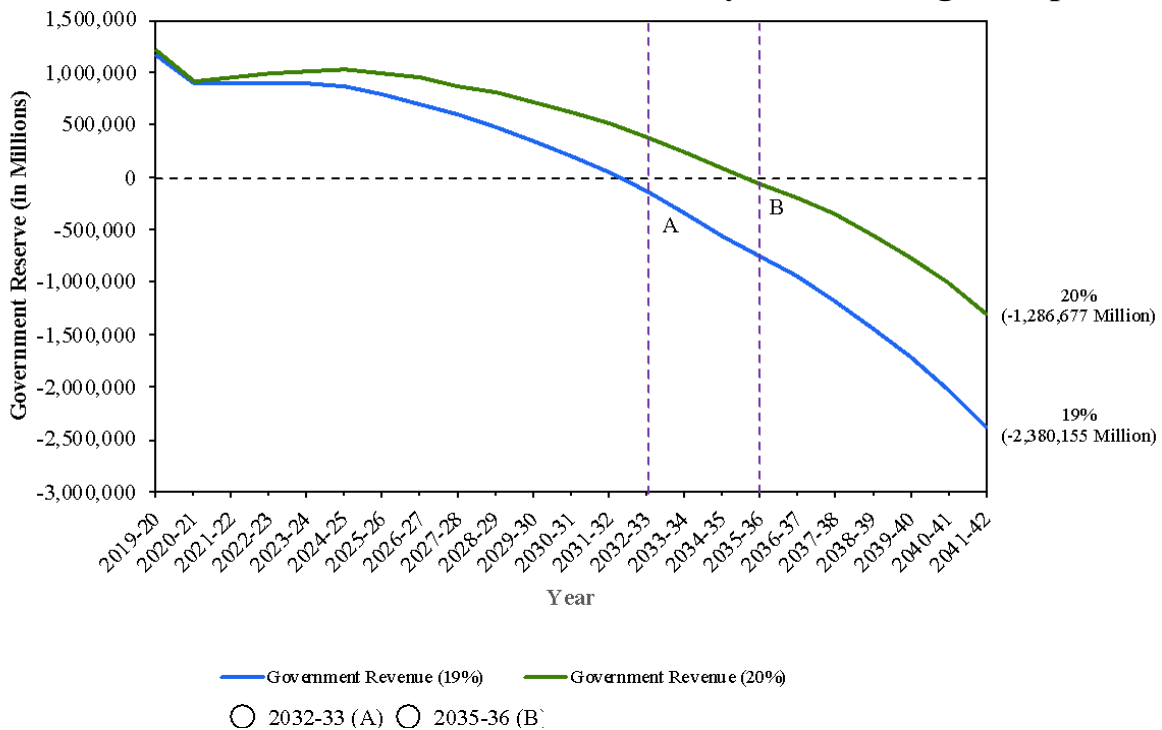


Figure 4.2
Impact of LTV on Projected Fiscal Reserves Under the No Service Enhancement Scenario by the Working Group



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 4.3
Impact of LTV on Projected Government Revenue and Expenditure
Under the No Service Enhancement Scenario by Exponential Trend Model

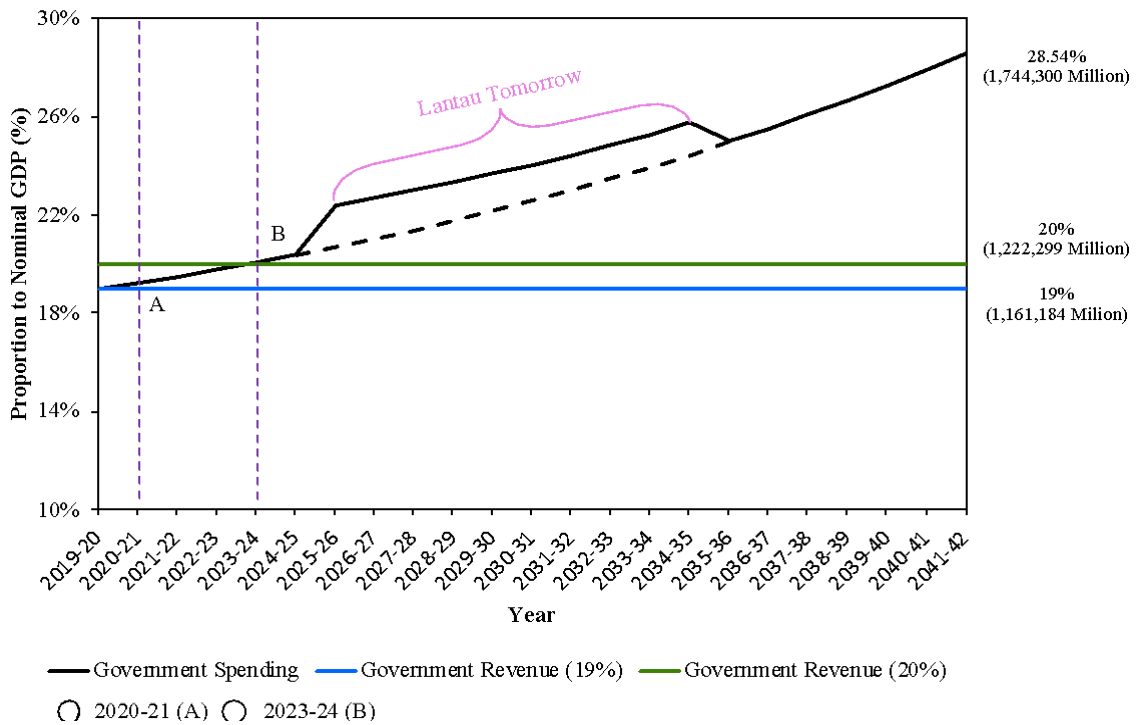
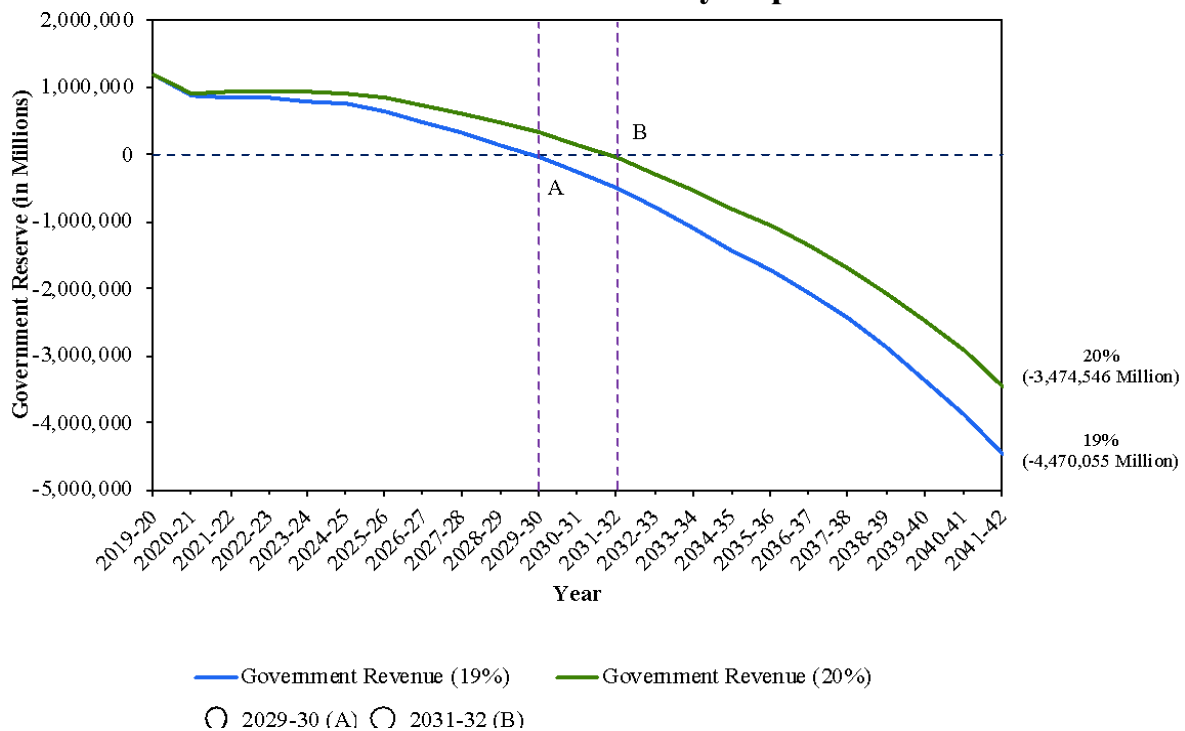


Figure 4.4
Impact of LTV on Projected Fiscal Reserves Under
the No Service Enhancement Scenario by Exponential Trend Model

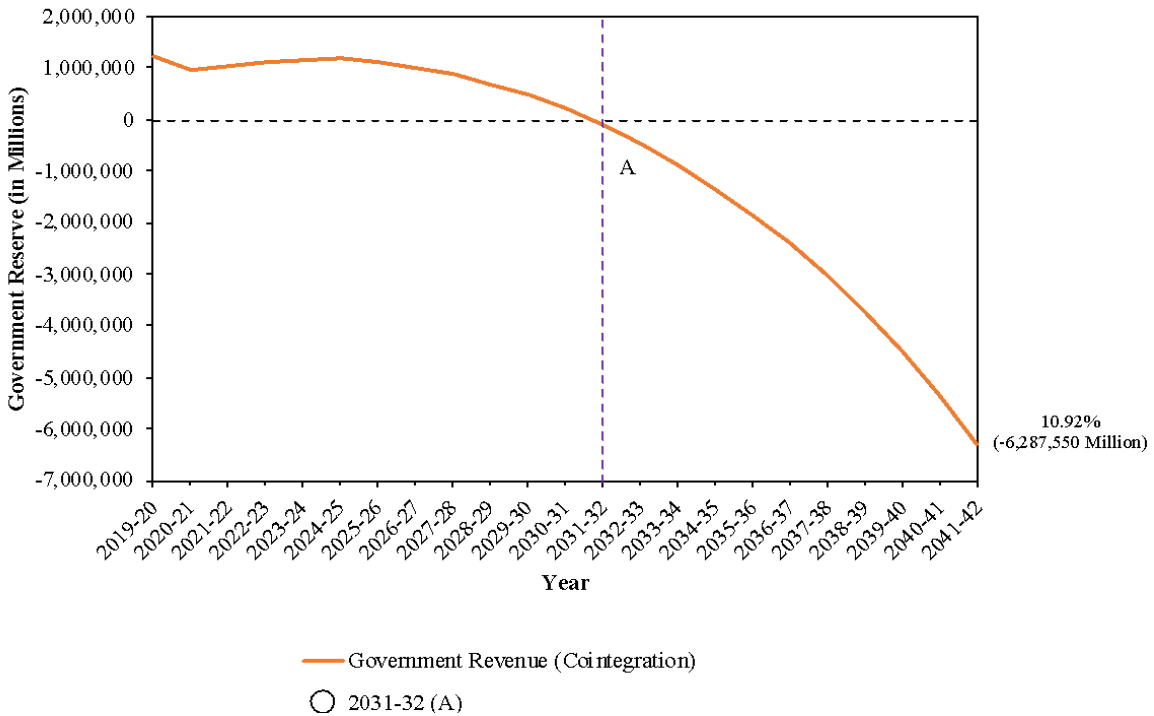


*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Figure 4.5
Impact of LTV on Projected Government Revenue and Expenditure
Under the No Service Enhancement Scenario Based on Cointegration Theory



Figure 4.6
Impact of LTV on Projected Fiscal Reserves Under
the No Service Enhancement Scenario Based on Cointegration Theory



*A response further to the relief package in the Budget and the two rounds of the anti-epidemic expenditure are included.

Chapter 5 Long-term Housing Demand

5.1 Crisis in Demand for the Property Market

Truly speaking, it is comprehensible that the HKSAR government tries to build up land reserves as high property prices tend to be caused by the imbalance of supply and demand. If there is a property bubble, the increase in land supply, thus the housing supply can help to stabilize property prices and enable the healthy development of the property market. While creating land reserves involves the use of public funds, it is advised that the HKSAR government should consider cost-effectiveness in order to avoid putting unnecessary pressure on public finance.

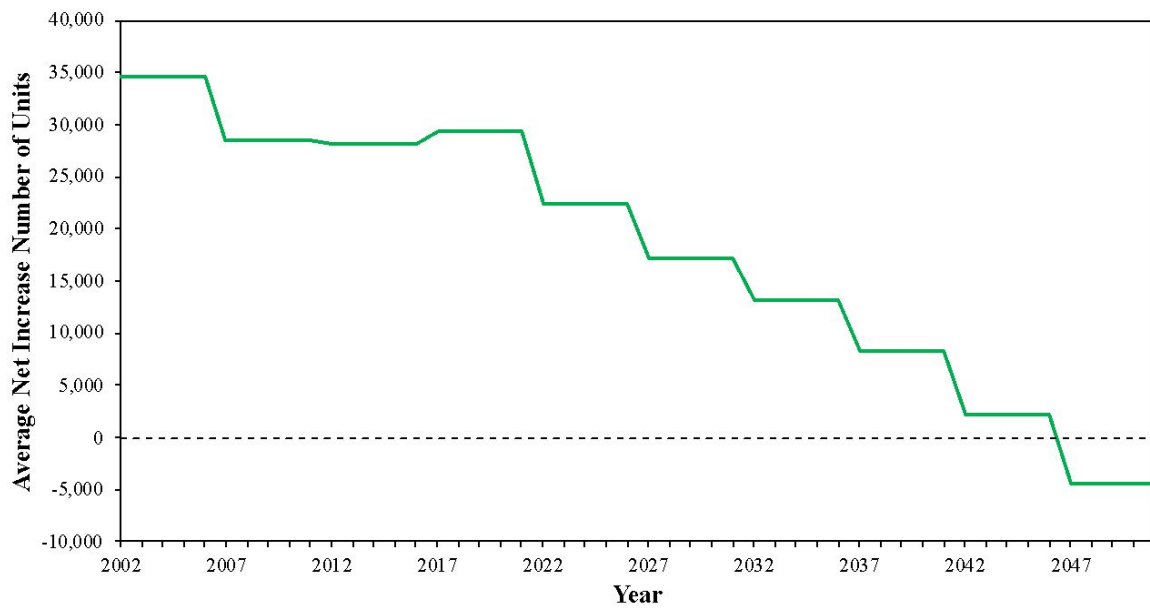
According to the latest “Ranking of International Housing Affordability” by the survey agency Demographia, Hong Kong has been ranked first for ten consecutive years. Until effective housing measures are found, solutions to improve the livelihoods for citizens remain unknown. Hong Kong's property market is infamous for its high prices and it has outperformed other international cities by a large margin, reflecting how housing policy is failing over the past few years.

However, the risk of property bubble may lessen from the perspective of population aging. The reason is the population aging will hinder economic growth in the medium- and long-term as it has a depressing effect on internal asset prices, such as property prices. With reference to the situations in Japan, the rapid aging of population causes shrinking in population. It has reduced labour productivity and dragged down the economy. Moreover, many Japanese elderly with poor health who lack self-care skills may move to nursing homes for assistance. Subsequently, this has led to a high number of vacant flats in Japan. Since the aging population drives a significant increase in housing supply, it is difficult for Japanese property prices to rebound from low levels.

Although Hong Kong population has not yet entered the shrinking stage, the medium- and long-term economic performance are negatively affected by the impact of aging population. In the long run, local housing demand will be suppressed as the gradual slowdown in population growth will drive the growth of the number of households to decline significantly. According to the “Hong Kong Domestic Household Projections up to 2051” published by the Census and Statistics Department, the net increase in the number of households will begin to slow down starting from 2022 (see Figure 5.1), and start to show

negative growth in 2047, contributing to a negative outlook for the medium- and long-term housing demand.

Figure 5.1
Projected Net Increase of Residential Units (2002-2051)



5.2 Long-term Housing Demand Estimated by LTHSSC

From the long-term housing demand formulated by the Long Term Housing Strategy Steering Committee (LTHSSC), there are four main demand factors:

- I. Net increase in the number of households;
- II. Households affected by redevelopment;
- III. Households with poor living conditions; and
- IV. Miscellaneous factors.

I. Net increase in the number of households

From the latest “Hong Kong Domestic Household Projections up to 2051” published by the Census and Statistics Department in 2017, the net increase in the number of domestic households is expected to drop from 29,400 in 2021 to a decrease of 4,500 in 2047. In the latest “Long Term Housing Strategy Annual Progress Report”, the net increase of households in the next 10 years (2020-2021 to 2029-2030) is 209,800. From the fact that the net increase in the number of households will continue to decrease or even shrink in the coming 20 years, the demand for this part of housing will decrease significantly over time.

II. Households affected by redevelopment

This part of the demand includes the redevelopment of public and private housing units.

III. Households with poor living conditions

LTHSSC considers 4 cases of poor living environment:

- (a) Whether the relevant housing unit is a temporary structure;
- (b) Whether the relevant unit is located in a non-residential building;
- (c) Whether the relevant unit is shared with other households; and
- (d) Whether the relevant unit is a subdivided unit.

IV. Miscellaneous factors

Other factors include households living in private permanent housing units occupied by only mobile residents, including non-local students who may purchase local housing units, non-local buyers who have purchased units without channelling them back to the market, and so on.

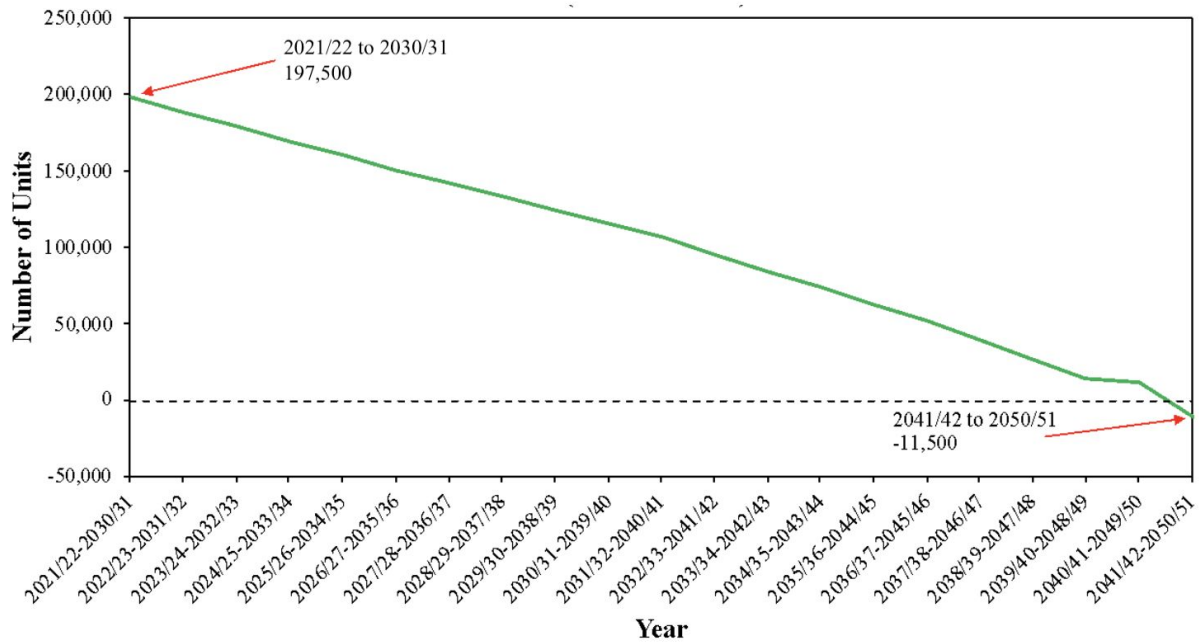
Table 5.1 shows the housing demand in the next ten years as calculated by the LTHSSC in the past six years. A very interesting phenomenon is that the local long-term housing demand shows a downward trend. This calculation is obviously different from the belief that most people in Hong Kong have a keen demand for home ownership. Meanwhile, the net growth of households will enter a steady decline in the next 30 years due to the aging population. According to the net increase in the number of households estimated by the Census and Statistics Department, the demand in this area has dropped from 197,500 units in 2021-2022 to 2030-2031 to a decrease of 11,500 units in 2041-2042 to 2050-2051 (Figure 5.2). Since this part of demand accounts for the heaviest proportion of the total housing demand, therefore, this gradually weakening demand factor will suppress the overall local housing demand.

Table 5.1

Forecasting of 10-Year Housing Demand by LTHSSC in the Past 6 Years

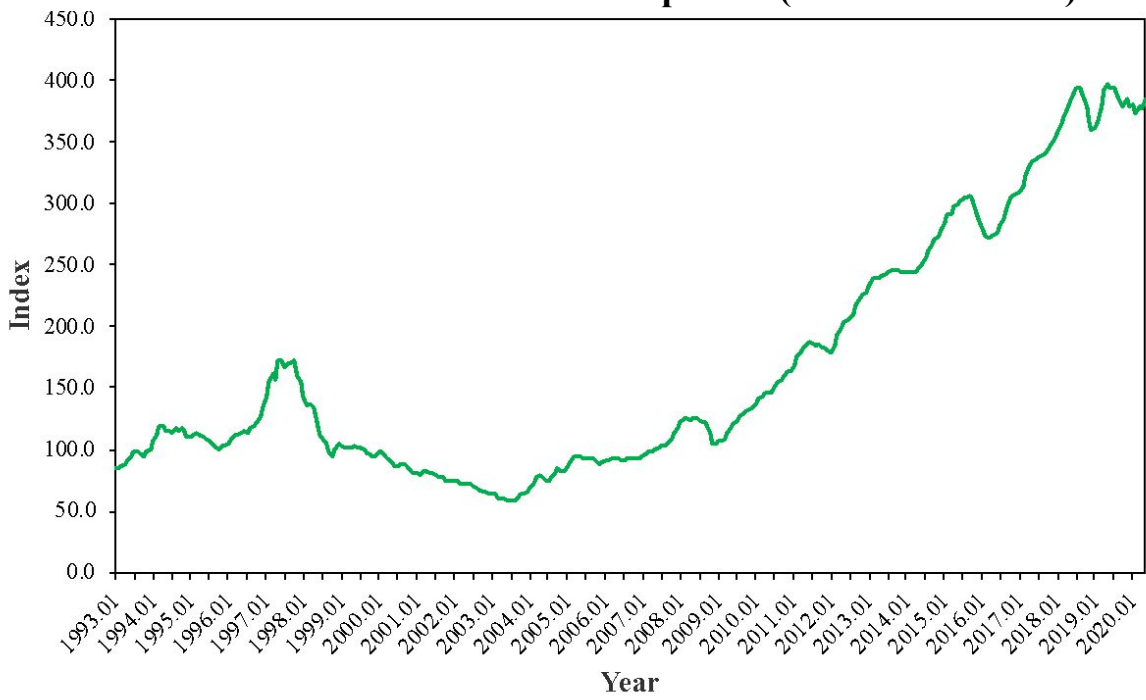
Year	Net Increase in Number of Domestic Households (a)	Number of Households Affected by Redevelopment (b)	Inadequately Housed Households (c)	Other Factors (d)	Total Housing Demand (a)+(b)+(c)+(d)
2015-16 to 2024-25	282,800	39,100	105,600	36,000	463,500
2016-17 to 2025-26	247,800	45,400	106,600	36,700	436,500
2017-18 to 2026-27	237,000	62,900	105,000	33,400	439,500
2018-19 to 2027-28	234,000	60,400	115,100	31,200	441,000
2019-20 to 2028-29	222,100	63,500	116,600	30,200	432,400
2020-21 to 2029-30	209,800	64,000	119,100	30,200	423,100

Figure 5.2
Projected Demand of the Number of Household (2021-2051)



After the SARS epidemic in 2003, the Hong Kong's property market entered a bull market that was beyond expectations. According to the property market information released by the Rating and Valuation Department, the price index of private domestic homes rose to a historical high of 396.9 points in May 2019 after bottoming out in July 2003 at 58.4 points, reflecting a significant increase of 5.8 times (Figure 5.3). Such an increase is rare in other major international cities. The sharp rise in property prices has brought a series of livelihood problems to the society, but the government did not have adequate solutions. The signs of real estate mania are everywhere in the city, whether the property prices will fall remains to be seen.

Figure 5.3
Price Index for Private Domestic Properties (1993.01 - 2020.06)



5.3 Insufficient Land Supply

A consultation document issued by the Task Force on Land Supply in April 2018 pointed out that “the shortage of land supply directly leads to a shortage of housing land, which has significantly reduced the number of housing completions in Hong Kong, both public and private. There was a long period of insufficient land supply. In the end, the housing supply is insufficient.” Therefore, the current high property prices are not only caused by demand, but also related to the housing policy of the HKSAR government. It is essential to consider the land supply as a determining factor in order to solve the local housing imbalance.

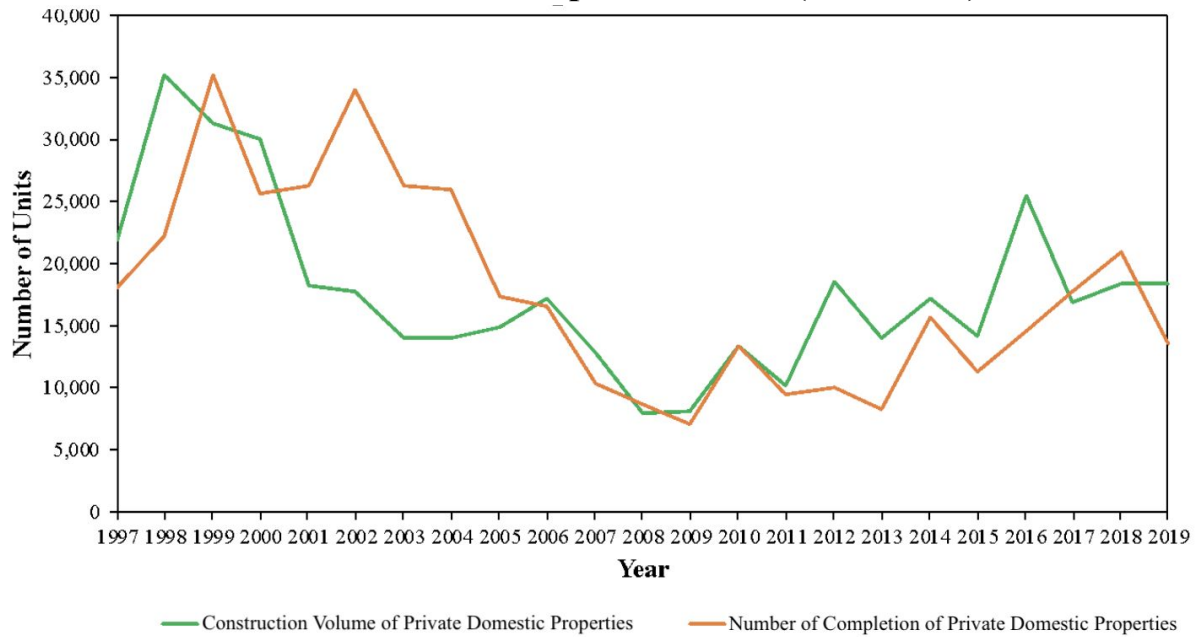
Judging from the two data in terms of the construction volume and number of completion of private housing, the housing policy of the HKSAR government has a significant impact on the supply of private housing. For example, the first Chief Executive Tung Chee-hwa launched the “85,000 policy” shortly after taking office in July 1997, with the objective to suppress soaring property prices by increasing housing supply. Unfortunately, the Asian currency crisis broke out in mid-1997 that dragged Hong Kong’s economy into a severe recession, and eventually caused local property prices to plunge. Although it is a good

thing for property prices to drop significantly from high levels, Tung Chee-hwa's decision to implement the "85,000 policy" had continued to worsen the imbalance between supply and demand in the property market. Following the bursting of the dot-com bubble in 2000 and the terrorist attacks of September 11 in 2001, the global economy deteriorated sharply, and Hong Kong economy also experienced another recession under these circumstances. Although "85,000 Policy" had not been fully executed, the continuing high supply of residential housing caused the property prices to continue to test the bottom. It was only after SARS in 2003 that Hong Kong property prices finally bottomed.

To support property prices, the second Chief Executive, Tsang Yam-kuen, Donald, drastically reduced land production after taking office, resulting in a drastic reduction in land supply and a drag on the construction volume and number of completion of private housing. Figure 5.4 shows that the residential construction volume in 2008 and 2009 fell to 8,000 and 8,200 units respectively, representing a drop of 70% as compared to the 35,300 units in the 1998 peak period. Fortunately, when Leung Chun-ying took office in July 2012, he accelerated land supply with the purpose of increasing the number of residential completions. Despite increasing land supply, it still lagged behind the backlog

of housing demand. Therefore, property prices continued to rise until the recent two years that they consolidated at a high level and no longer rose significantly.

Figure 5.4
Construction Volume and Number of Completion of Private Domestic Properties in HK (1997-2019)



According to information of private housing supply in primary market from the Transport and Housing Bureau, 93,000 private residential units will be supplied to the market in three to four years. Such supply, when calculated on an annual average, is much higher than the past few years. However, the HKSAR government still has to maintain a stable and sufficient land supply to support ample housing supply to resolve this property bubble. This will definitely have a positive effect on controlling property prices to return to a healthy level.

The Task Force on Land Supply issued a report in December 2018, stating that the lack of local land supply is not a cliché, but definitely a critical social problem. According to the Task Force's estimation, the short-term land shortage is the most serious, so land reserves should be established as soon as possible to meet the needs of society.

The Task Force on Land Supply has proposed several options of land supply:

Short to medium term options include:

- Development of Brownfield,
- Use private agricultural land reserves in the New Territories, and
- Alternative uses of sites under private recreational leases

Medium to long term options include:

- Nearshore reclamation outside Victoria Harbour;
- Development of the East Lantau Metropolis;
- Use of caverns and underground space;
- More new development areas in the New Territories; and
- Development of the River Trade Terminal site in Hong Kong.

The HKSAR government should take account of the above suggestions in ensuring sound decision-making to ease the land supply shortage. Meanwhile, the government should address the huge cost from land development which may drag the government revenue and expenditure. As mentioned in Chapter 3, the fiscal sustainability of the HKSAR government may be in danger now. Once the government insists on launching large-scale land developments, it will only cause Hong Kong to fall into a debt swirl, and it will be difficult to rebound.

Chapter 6 Conclusions

According to calculations made by the government, one-third of Hong Kong population will be aged 65 or above in 2047. With the continuous advancement of medical technology and the gradual improvement of the quality of services for the elderly, the life expectancy of Hong Kong citizens has become longer. However, the low birth rate and rising in elderly population will aggravate the problem of population aging in Hong Kong.

From the economic perspective, under a population aging stage, not only the labour force will shrink, but also the productivity will decline, which will eventually impose pressure on medium- and long-term economic growth. The worst possible scenario of population aging is to push a country with sound public finance into a debt swirl, and its long-term economic development will face strong headwinds.

Although the HKSAR government has continuously recorded huge fiscal surpluses in the past few years, and drove its fiscal reserves to increase significantly. However, ample fiscal reserves does not imply that there will be no fiscal problems in the future. Recently, the HKSAR government has spent a

lot of money to combat the epidemic, which has caused the fiscal reserves to decline significantly. In addition, the government should exercise prudence on controlling public spendings given the rapidly aging population and increasing fiscal burden by the continuous surge in expenditure. According to the calculations of this study, there is a strong possibility that Hong Kong has already started a structural fiscal deficit. If the HKSAR government continues to fail to manage its fiscal reserves properly, it will be eventually used up. By then, Hong Kong can only borrow money to survive, and economic development will be compromised.

According to the calculations of the Long-term Housing Strategy, the housing demand will continue to fall in the next 10 years. The main reason is that the aging population has gradually slowed down the net increase in the number of households, thus weakening the housing demand. Furthermore, economic literature (Yoon and Kwon (2019)) has found that when the elderly population (or the ratio of elderly to the total population) continues to rise, the number of vacant units (or unit vacancy rate) will also increase, which will help increasing the housing supply in the medium- and long- term. In this respect, it will have a positive influence on improving the imbalance between supply and demand in the property market.

Finally, this research report points out that the development of large-scale land projects, such as Lantau Tomorrow, will not only involve large outlays, but also bring huge financial pressure to the HKSAR government, which has already experienced fiscal concerns. Additionally, reclamation greatly destroys the precious marine ecology. Therefore, the HKSAR government must carefully consider how to replenish its land reserves, for example, choose brownfields as a more cost-effective alternative than reclamation, so as to avoid damaging fiscal sustainability by one careless move. It is important for the government to reach a cost-effective measure, balancing the demand for sustainable development and fiscal sustainability, along with the objective to improve quality of life for citizens by deploying valuable government contributions.

Annex 1 Projection of Government Revenue by Vector Autoregressive Model

1. In this study, the Vector Autoregressive (VAR) model is implemented to project the government revenue. Actually, VAR is a typical econometric model which was proposed by Christopher Sims, an economist and econometrician. The advantage of this model is it can handle the autoregression feature of more than one time series. In the following, the nominal GDP (x_t) and government revenue (y_t) are considered as the time series data to establish the VAR:

$$X_t = \Phi_0 + \Phi_1 X_{t-1} + \dots + \Phi_p X_{t-p} + u_t,$$

$X_t = [x_t, y_t]^T$ indicates the collection of nominal GDP and government revenue at time t .

2. The stationarity of the nominal GDP and government revenue allow their VAR model to produce stable projection results. Therefore, it is necessary to apply an unit root test to check the stationarity of these time series individually. A typical version of unit root test is Augmented Dickey-Fuller Test. This test considers the linear regression of the following model:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \dots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

y_t represents the observed value of the nominal GDP or the government revenue at time t , Δy_t equals $y_t - y_{t-1}$. Then, the hypothesis testing of $H_0 : \gamma = 0$ (i.e., unit root exists) vs $H_1 : \gamma < 0$ (i.e., unit root does not exist) can help to decide whether the time series is stationary or not. The parameter p can be determined by the minimization of Akaike Information Criterion (AIC) value.

3. If the null hypothesis H_0 in the above cannot be rejected, they are said to be integrated of order 1, i.e., they are not stationary. Then, they are required to perform the cointegration test. Cointegration test indeed is used to analyze the long-run equilibrium relationships among multiple time series. During the process of cointegration analysis of time series, if the time series are cointegrated, there exist long-run equilibrium relationships among the time series. In this study, the Engle-Granger's (EG's in-short) two-step cointegration test was implemented to decide whether the nominal GDP and government revenue possess a long-run equilibrium relationship.

4. Basically, the EG's two-step cointegration test can be proceeded as follows: (1) Apply the linear regression of y_t (government revenue) on x_t (nominal GDP) to obtain the residual z_t ,

$$z_t = y_t - \hat{\beta}_0 - \hat{\beta}_1 x_t.$$

Then, (2) Apply the Augmented Dickey-Fuller Test to check whether the residual z_t is stationary or not. When the residual z_t is stationary (i.e., the null hypothesis H_0 is rejected), y_t and x_t are cointegrated (i.e., nominal GDP and government revenue would possess a long-run equilibrium relationship).

5. If there exists a long-run equilibrium relationship between the nominal GDP and government revenue, their VAR model can be re-written in the form of Vector Error Correction Model (VECM) :

$$\Delta X_t = \Phi_0 + \Pi X_{t-1} + \Psi_1 \Delta X_{t-1} + \dots + \Psi_{p-1} \Delta X_{t-p+1} + u_t,$$

where the coefficients $\Pi, \Psi_1, \dots, \Psi_{p-1}$ are computed based on the coefficients Φ_1, \dots, Φ_p in the VAR model. Note that, each term in the VECM is stationary, so this model can be applied to predict the government revenue directly.

6. The data used for the model estimation is selected from the sampling period 1991-2018.

7. Results of augmented Dickey-Fuller test

Nominal GDP:

$$\hat{\Delta y}_t = -0.0002 + 0.1618y_{t-1} - 0.4362\Delta y_{t-1} - 0.4905\Delta y_{t-2}$$

Government Revenue:

$$\hat{\Delta x}_t = -0.0002 + 0.1414x_{t-1} + 0.0812\Delta x_{t-1} - 0.4440\Delta x_{t-2}$$

Time Series	Test Statistics
Nominal GDP	3.5952
Government Revenue	1.6988

Since both test statistics are smaller than 5% critical value, both nominal GDP and government revenue are non-stationary.

8. EG's two-step cointegration test

Residual z_t can be obtained by the following expression

$$z_t = y_t - 94849.05 + 0.254x_t.$$

The computed test statistic in EG's two-step cointegration test is

-3.4171 which is less than the critical value at 5%. Thus, there exists a long-run equilibrium relationship between nominal GDP and government revenue.

9. Estimation results of VECM model

(1) Based on the data, the error correction term is defined by

$$z_t = y_t - 94849.05 + 0.254x_t$$

(2) Error correction formula for government revenue is given by

$$\Delta y_t = -1.0463z_{t-1} + 0.3629\Delta y_{t-1} + 0.1103\Delta x_{t-1}$$

(3) Error correction formula for nominal GDP is given by

$$\Delta x_t = -0.4113\Delta z_{t-1} + 0.7224\Delta y_{t-1} + 0.6298\Delta x_{t-1}$$

The projection of government revenue is generated by the recursive application of the above three expressions.

Annex 2 Exponential Trend Model

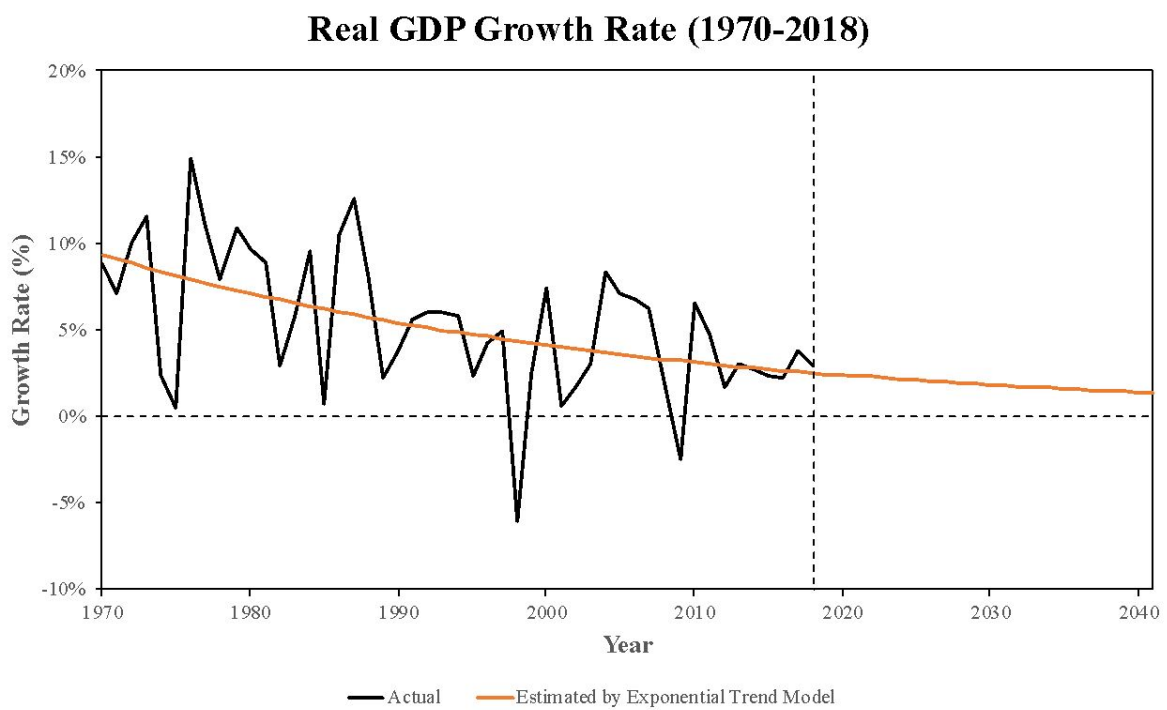
Projection of Real GDP Growth Rate

1. In addition to the real GDP growth rates suggested in the Report of the Working Group on Long-Term Fiscal Planning in 2014, i.e., 3.5% in 2019-2021, 3% in 2022-25 and 2.5% in 2026-2042, the Exponential Trend Model is also suggested to project the long-term trend of real GDP growth rate.
2. As the name suggests, the Exponential Trend Model generates real GDP growth rates by a nonlinear function over time. Nevertheless, the real GDP growth rates are produced at a constant rate annually.
3. In this study, the observations in the sampling period 1991-2018 are considered to estimate all model parameters by the method of nonlinear least squares. Indeed, the estimated Exponential Trend Model generates the real GDP growth rate by the following formula:

$$\text{Exponential Trend Model: } \hat{r}_t = \hat{\alpha}e^{\hat{\beta}t}$$

where \hat{r}_t indicates the estimated real GDP growth rate at time, $\hat{\alpha}$ and $\hat{\beta}$ are the estimated values of model parameters as shown in the following table:

Estimated Parameters	Exponential Trend Model
$\hat{\alpha}$	0.0960
$\hat{\beta}$	-0.0273



References

- Cox, W. and H.P. Pavletich (2020), 16th Annual Demographia International Housing Affordability Survey: Rating Middle-Income Housing Affordability. Demographia.
- Dickey, D.A. and Fuller, W.A. (1979). "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association*, **74**, 427–431.
- Engle, R.F. and C.W.J. Granger (1987), "Cointegration and error correction: Representation, estimation and testing," *Econometrica*, **55**, 251-276.
- Said, S.E. and D.A. Dickey (1984), "Testing for Unit Roots in Autoregressive-Moving Average Models of Unknown Order," *Biometrika*, **71**, 599–607.
- Sims, C.A. (1980), "Macroeconomics and Reality," *Econometrica*, **48**, 1-48.
- United Nations (2019), World Population Prospects 2019. United Nations: Department of Economic and Social Affairs, Population Division.
- Yoo, H. and Y. Kwon (2019), "Different Factors Affecting Vacant Housing According to Regional Characteristics in South Korea," *Sustainability*, **11**, 6913.
- Census and Statistics Department (2017). *Hong Kong Population Projections 2017-2066*. Hong Kong: Census and Statistics Department.

Census and Statistics Department (2017). *Hong Kong Labour Force Projections for 2017 to 2066*. Hong Kong: Census and Statistics Department.

Census and Statistics Department (2017). *Hong Kong Domestic Household Projections up to 2051*. Hong Kong: Census and Statistics Department - Demographic Statistics Section (2).

Financial Services and the Treasury Bureau (2014). *Working Group on Long-Term Fiscal Planning*. Hong Kong: Financial Services and the Treasury Bureau.

Task Force on Land Supply (2018). *Report of the Task Force on Land Supply*. Hong Kong: Task Force on Land Supply.

Transport and Housing Bureau (2019). *Long Term Housing Strategy Annual Progress Report 2019*. Hong Kong: Transport and Housing Bureau.

Wong, K. and M. Yeung (2019). *Population Aging Trend of Hong Kong*. Hong Kong: Office of the Government Economist.