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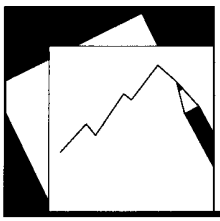

IMF Working Paper

Guarding Against Fiscal Risks in Hong Kong SAR

Nathan Porter

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Guarding Against Fiscal Risks in Hong Kong SAR[1]

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Abstract

Hong Kong SAR's government faces the dual challenges of volatile revenue and medium term spending pressures arising from a rapidly aging population. Age-related spending pressures raise long-run sustainability concerns, while revenue volatility creates risks to service provision, possibly entailing sudden tax changes, or even requiring new borrowing. After describing the risks associated with aging, the paper applies value at risk techniques to measure the value of the unanticipated risks posed by volatile revenue. The paper also describes the self-insurance value of Hong Kong SAR's traditionally high fiscal savings (reserves), and the impact alternate policy choices could have on revenue volatility.

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I. INTRODUCTION

Hong Kong SAR has amongst the most volatile fiscal revenues in the world, and faces significant spending pressures due to population aging. Age-related spending pressures raise long-run sustainability concerns, while underlying revenue volatility creates risks to government service provision, and can make government planning difficult, as revenue falls short of expenditure needs both frequently and unexpectedly, even if revenues cover spending on average. Such sudden or short-term changes in expenditure plans can be costly and make expenditure (execution) less efficient. Sudden falls in revenue may also require governments to draw down accumulated savings or borrow, which in turn can threaten sustainability given the uncertainty surrounding the duration of the fall in revenue. Aware of these challenges, the government has commenced, and plans further, public discussions on how to reform the healthcare financing systems, and on ways to broaden the revenue base.[2]

This paper describes the nature and size of the fiscal risks posed by these challenges. After a brief review of age-related fiscal pressures, we document the extent of revenue volatility and measure the associated fiscal risks. The paper applies value at risk methodology as a way to measure these risks. Although this methodology is typically applied to the valuation of risks to financial portfolios, its elements provide a way to value the risks posed by extreme fiscal events. By providing numerical estimates of potential losses over various horizons and probability levels, it allows policy makers to assess a government's vulnerability to sudden swings in revenue (and expenditure). Moreover, value at risk techniques provide enough flexibility to undertake sensitivity analysis to assess how measured risks change under alternate policies. Specifically, we study the possible impact of two alternative policies: (i) the introduction of a broad-based goods and services tax; and (ii) smoothing the return the government receives on its financial assets.

Reflecting the volatility of revenue, the Hong Kong SAR government has traditionally operated prudent fiscal policy, with significant fiscal savings (known as fiscal reserves)—currently over 20 percent of GDP—playing an integral role. These savings have limited the amount the government has needed to borrow to cover unanticipated revenue fluctuations and spending pressures. Moreover, by limiting the government's need to borrow, reserves have supported Hong Kong SAR's currency board. The implicit market value of the self-insurance provided by Hong Kong SAR's large accumulated fiscal savings (and a way to measure their optimal amount) is also discussed.

The broad conclusion of this paper is that fiscal reserves will likely remain an important feature of future fiscal policy, reflecting the desirability of anticipating age-related spending pressures, and providing a sufficient buffer against fiscal shocks.[3] Based on these

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[2] See the public consultation documents: *Building a Healthy Tomorrow - Discussion Paper on the Future Service Delivery* (issued by the Health and Medical Development Advisory Committee in July 2005); and *Broadening the Tax Base, Ensuring Our Future Prosperity: What's the Best Option for Hong Kong?* (issued by the Hong Kong SAR government in July 2006).

[3] Although unanticipated revenue fluctuations can be accommodated through borrowing, Hong Kong SAR's currency board raises the cost (and risk) of such borrowing, especially if shocks initially thought transitory are

(continued…)

considerations, and in the absence of any policy change or reforms, reserves aimed at anticipating age-related fiscal pressures could be up to 30 percent of GDP by 2030, while estimates of "prudential" reserves reflecting historical volatility could be around 30–50 percent of GDP. However, the extent of fiscal risks will change with tax and non-tax revenue policies, and the particular features (as well as impact) of healthcare reforms. Much will depend on how the structure of revenue changes. For example, by limiting revenue volatility, smoother investment returns would reduce fiscal risks. Similarly a broad-based consumption tax would limit risks also through lower revenue volatility, as well as shore up the tax base as the aging population limits income tax revenue. In addition to changing policies and volatility, the estimates presented, of course, depend on the government's risk tolerance: the more risk the government is willing to tolerate, the less its desired fiscal reserves.

II. Anticipated Risks: Age-Related Fiscal Pressures

Hong Kong SAR faces significant age-related fiscal pressures. Leigh (2006) investigated these, showing that rapidly increasing old-age dependency (which is expected to double by 2030) is likely to place pressure on fiscal accounts through slower growth in income-based taxes, and increases in age-related spending. However, the ultimate impact will depend upon the government's policy choices about future health and welfare policy.

Given current policies, most of these pressures are likely to reflect health care spending. The government provides a relatively limited pension, with the Mandatory Provident Fund (MPF) providing an increasing source of retirement income over time. Although in the transition there could be pension-related spending, it is unlikely to cumulatively amount to more than 5 percent of GDP by 2030–2035, when it stabilizes and begins declining as the MPF becomes a growing source of retirement income. Consequently, holding reserves to cover transitional spending could require some temporary savings. However, as much of healthcare is publicly provided, the rise in these costs could place significant potential pressure on the fiscal accounts over coming decades.

Without any changes in the financing of healthcare, or other fiscal policies, Leigh (2006) finds that healthcare costs could result in cumulative deficits of almost 20 percent of GDP by 2030 and 50 percent of GDP by 2050. However, if these costs are mostly covered by individuals, possibly by raising the current contribution to the MPF by about 5 percentage points and earmarking it purely to finance the rise in healthcare due to aging, then the fiscal impact of the ageing population could be limited. Nonetheless, private savings (or voluntary insurance) alone cannot solve the problem as without some universal catastrophic coverage the least healthy could remain uninsured, exposing the government to remaining fiscal risks.[4] Moreover, it is unlikely that these costs can be completely passed to private individuals, leaving potentially significant pressure on public finances. As an example, a 2½ percentage

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longer-lived. Theoretical work on fiscal policy highlights the important role played by a government's net asset position when the fiscal environment is volatile (Box 1).

[4] Hsiao, William, 2006, "What Should Macroeconomists Know About Health Care Policy? A Primer," forthcoming IMF Working Paper (Revised 21 May, 2006).

point rise in the MPF contribution rate could account for only half of these average age-related costs. Nonetheless, timely policy action can significantly reduce the consequences of an aging population for the tax burden faced by future generations, fiscal sustainability, and possibly the LERS.[5]

III. UNANTICIPATED RISKS: REVENUE VOLATILITY

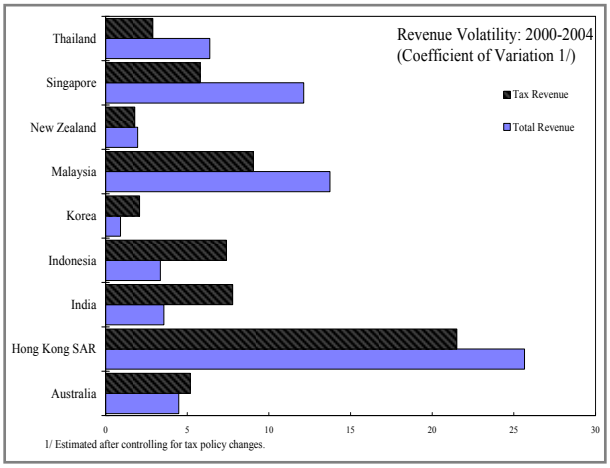
A. How Volatile is Hong Kong SAR's Revenue?

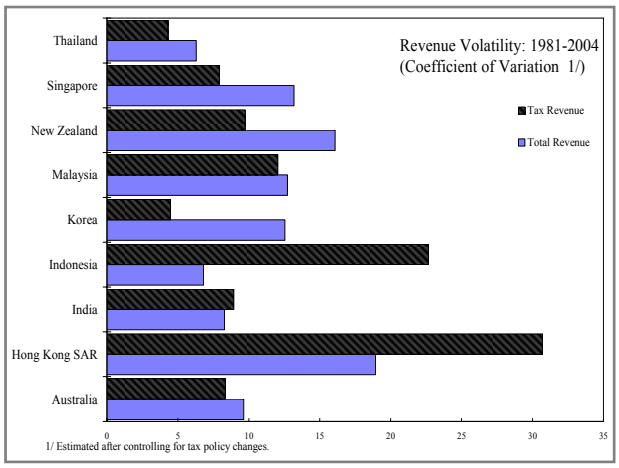
Hong Kong SAR has amongst the most volatile revenue bases in Asia. Since 1981, shares of Hong Kong SAR's total and tax revenue in GDP have varied between 13½ percent and 20¾ percent, and 8½ percent and 12¼ percent, respectively. Measured by the coefficient of variation, the volatility of tax and total revenue (as shares of GDP) have each been around 11 percent of their average levels since 1981.[6] However, this measure of volatility reflects, in part, changes in tax policy, including increases in tax rates following the SARS outbreak. Even after controlling for tax policies changes, thereby highlighting the underlying volatility in the revenue base, Hong Kong SAR still has considerably more volatile revenue than other Asian countries, even if volatility has fallen more recently.[7]

[5] Hong Kong SAR's Basic Law, akin to its constitution, also places constraints on the extent to which future fiscal pressures can be anticipated through savings. It provides that the government "... strive to achieve a fiscal balance, ... and keep the budget commensurate with the growth rate of its gross domestic product."

[6] The coefficient of variation of a series is the ratio of its standard deviation to its mean.

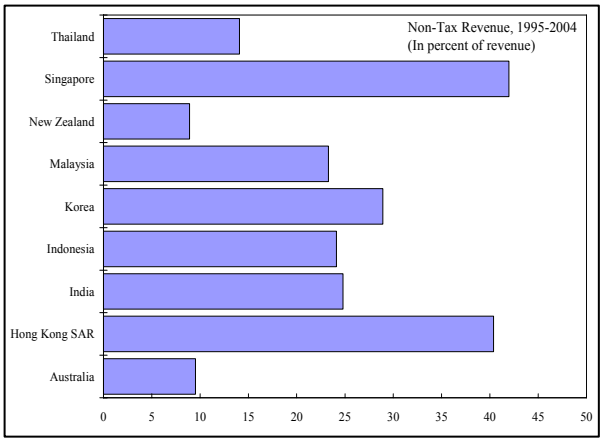
[7] Tax policy changes are proxied by changes in corporate and individual tax rates and the introduction of a VAT, and changes in the VAT rates.

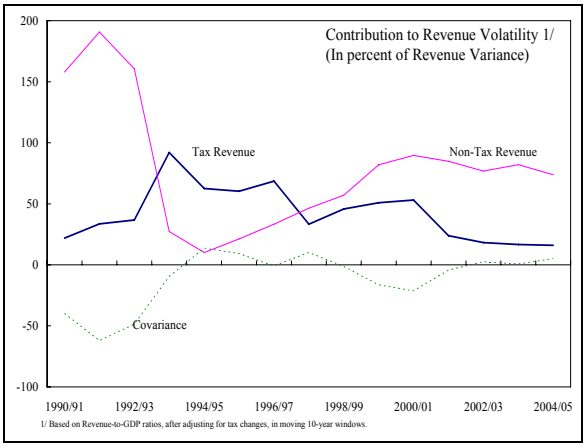




Sources: IMF, *Government Finance Statistics*, CEIC Database, and author's estimates.

Hong Kong SAR's revenue volatility principally reflects the importance of volatile non-tax revenue. When compared across the region, Hong Kong SAR (and Singapore) rely considerably more heavily on non-tax revenue, with non-tax revenue accounting for over 90 percent of the variance of the SAR's total revenue since FY1981/82. Although the relative importance has fluctuated throughout the period, non-tax revenue has typically driven overall revenue volatility, even though the most volatile non-tax revenue items—investment income and the land premium—make sustainable contributions to revenue (Gruenwald, 2005).[8]





[8] Tax revenue contributed more to revenue volatility during the period (up to April, 1998) when fiscal reserves were treated as a time deposit with the Exchange Fund.

Box 1: Fiscal Policy in Volatile Environments

Volatile economic and fiscal environments complicate fiscal policy. This box discusses some relevant theoretical aspects of fiscal policy in volatile environments. This first theoretical approach discussed is optimal fiscal policy when taxes are distortionary, spending pressures fluctuate, and markets are incomplete. The second approach takes revenue volatility as given and asks how an optimizing government would choose spending to "insure" the private sector. Each of these approaches suggest an important role for the government's net asset position when the fiscal environment is volatile.

Optimal Fiscal Policy

Optimal fiscal policy seeks to minimize distortions over time in the face of economic and government spending shocks. When markets are complete and the government can finance any deficits through state contingent bonds, then distortions are minimized by keeping tax rates relatively stable and allowing net assets to fluctuate (Chari, et. al., 1994). When markets are incomplete—the government only issues risk free bonds as is done in most countries—then under some (relatively stringent) conditions, the government's problem for setting taxes can be recast in the form of a permanent income problem (Aiyagari, et. al, 2002). The government will choose taxes to be less volatile than (the exogenous but volatile) spending, allowing (net) assets to fluctuate. If the government can accumulate assets up to its "natural" limit, then the government will accumulate assets to this limit and reduce taxes to zero, financing spending from the (fixed) return on assets.[1] The intuition for this reflects that financing spending through (fixed) investment income is less distortionary than tax revenue. Although a conjecture, if asset income is sufficiently volatile, then it may be optimal to maintain low taxes. If assets cannot reach the "natural" limit, then distortionary taxes remain positive and net assets fluctuate.

Government Spending and Insurance when Revenue is Volatile

When asset markets are incomplete and the economy and revenue are volatile, then the government can play the role of a "tormented" insurer—maintaining relatively smooth spending and transfers for the private sector. Mendoza and Oviedo (2005) study such a situation with a model calibrated to Mexican data. They assume the government cannot hold net assets, and is constrained by the natural debt limit, meaning governments with more volatile revenue cannot borrow as much as those with more stable revenue. They find that government spending absorbs much of the volatility in the economy, with spending being more volatile than in the fully efficient (complete markets) equilibrium. In addition, they find the assumption that governments cannot hold net assets sometimes binding in the long-run, suggesting that holding net asset can be optimal. Finally, they argue a consumption tax should ease governmental borrowing constraints, by stabilizing revenues.

[1] To recast the optimal tax problem as a permanent income one it is necessary that agents be risk neutral. The "natural" asset limit is the one sufficient to finance government spending indefinitely, while the "natural" debt limit is such that debt can be repaid no matter how long exogenous spending remains high. Under more general preferences, if government spending can enter an absorbing state, then tax rates are likely to converge to a positive constant and the allocation reflects the complete markets case. Besides these special results, little can be said about the long-run efficient allocation when markets are incomplete (Aiyagari, et. al., 2002).

B. How Large Are Fiscal Risks?

The volatility of Hong Kong SAR's fiscal accounts poses potentially significant risks and underlies the case for maintaining prudential balances. A measure of fiscal risks would provide a basis for estimating the desirable level of prudential reserves. This section presents estimates of fiscal risks using value at risk techniques that account for the volatility of fiscal variables, as well as the likelihood of extreme negative events and the government's risk aversion (tolerance for risk). Based on historical patterns of volatility, these exercises suggest prudential reserve holding of around 30–50 percent of GDP, although if the government is concerned to avoid even the most extreme losses, then higher reserves may be needed. While these estimates reflect historical volatility and policy choices, desired prudential reserves should be a forward looking concept, reflecting the expected structure of economic and fiscal volatility and setting of policy. Nonetheless, the methodology described below, and possibly even the range of estimates, may provide a reasonable frame of reference for the government to begin considering the choice of reserves. Desired self insurance arising from the insurance provided by reserves is also discussed, with high levels of self insurance optimal over the estimated ranges of prudential reserves, especially as the prospect of obtaining market based insurance is limited.

Value at Risk Estimates

Value at risk (VaR) measures the maximum expected loss over a target horizon for a given level of confidence (Jorion, 2001). Although this technique has traditionally been applied to financial portfolios, it provides a way to measure the potential downside risk associated with government fiscal accounts. Two recent papers have applied VaR techniques to fiscal sustainability issues, by looking at the VaR of the public sector balance sheet (Barnhill and Kopits, 2003) and public debt (Adrogué, 2005). In contrast, this paper uses VaR techniques to provide a probability based measure of the value of a series of weak fiscal outcomes, and therefore desired reserve holdings. Technical details of this exercise are more completely outlined in the related paper by Porter (2007).

To calculate the VaR, simulation techniques—Monte Carlo and bootstrap—are applied to Hong Kong SAR's fiscal data.[9] Simulation methods revalue the consolidated fiscal balance for a series of simulated realizations, possibly reflecting the realization of underlying risk factors. Based on a large number of these valuations, the probability distribution of fiscal outcomes can be estimated and the worst loss for a given confidence level calculated. The confidence level implicitly reflects the amount of risk the government is willing to accept when choosing desired reserves. Specifically, the confidence level reflects the likelihood that chosen reserves will be sufficient to cover the deficits arising from adverse shocks.[10] Since both of these methods have their own strength and weaknesses, the results of each technique

[9] Data availability is limited to FY1981/82–FY2004/05. To check for robustness, two bootstrap methodologies designed for time series applications—moving block and stationary—are used in this paper.

[10] For example, a 99 percent confidence interval implies the level of reserves that would be insufficient to cover fiscal outcomes one percent of the time.

is compared. Monte Carlo methods rely on an underlying economic model, and so are subject to specification errors, but are more flexible to conduct counterfactual exercises. Although bootstrap methods are less flexible, they do not depend on specific modeling assumptions.[11]

The VaR (fiscal risks) measure discussed in this paper is based on cumulative fiscal balances over a number of years.[12] This measure reflects the persistence of deficits; the fiscal outcome for one year does not fully reflect the risk that the government may wish to maintain prudential reserves against. For example, Hong Kong SAR had five consecutive deficits from FY2000/01–FY2004/05, and only a small surplus in FY1999/00 following a deficit in FY1998/99. This suggest accumulated deficits over a 5–7 year period may be reasonable choices for estimating extreme outcomes, although results for 2–7 year periods are reported. The length of time over which balances are accumulated provides another dimension of risk aversion that the government may base its desired reserves decision on.

Based on cumulative balances, the bootstrap estimates suggest reserves within the range of 25–50 percent of GDP for consecutive balances over 5–7 years and confidence levels between 92.5 and 97.5 percent.[13] Figure 1 shows this by displaying the VaR against two factors reflecting government risk aversion, the confidence level and the number of balances included in the measure of fiscal risk (T). The VaR increases with both the confidence level and T, and at an increasing rate. The Monte Carlo estimates are distinctly larger, varying between 40 and 80 percent of GDP over the same range of parameters, although the broad pattern is similar.

The Monte Carlo method produces larger VaR estimates because the large majority of cumulative balances are negative (see the density function in Figure 2). Consequently, it seems likely that the Brownian motion model of risk factors maybe too simple. The bootstrap estimates, on the other hand, do not involve model choice, reflecting only historical volatility.[14]

[11] Further methodological details can be found in Porter (2007).

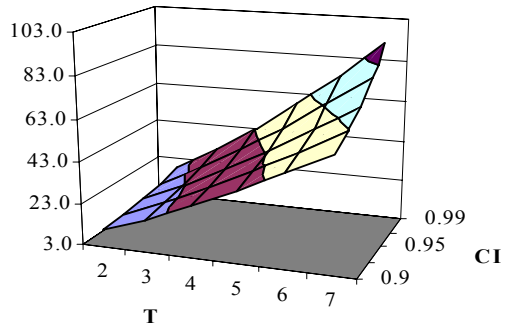
[12] More specifically, the measure reflects the sum of overall consolidated fiscal balances as a share of the final period GDP.

[13] The VaR estimates are calculated for a variety of confidence levels from 90 to 99 percent, based on 20,000 simulations.

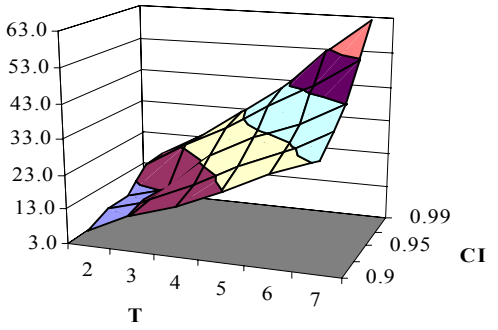
[14] As discussed in the appendix, a generalized Brownian motion model is chosen for the Monte Carlo simulations as it is standard in the VaR literature and used in the previous fiscal VaR studies. The Monte Carlo exercise could be repeated with a richer model of economic shocks. However, since the bootstrap estimates are independent of model choice, this would be unlikely to significantly change the VaR estimates. If the growth in expenditure were half of its historical average, then the Monte Carlo method with this model produces results closer to the bootstrap techniques. Both estimates are affected by the limited historical fiscal data available.

Figure 1. Cumulative Fiscal Value at Risk Estimates
(In percent of GDP)

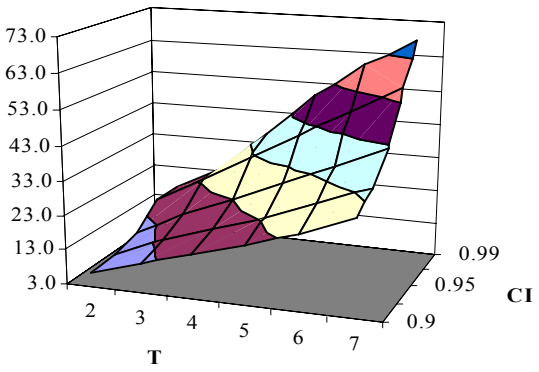
Monte Carlo Simulation



Moving Block Bootstrap

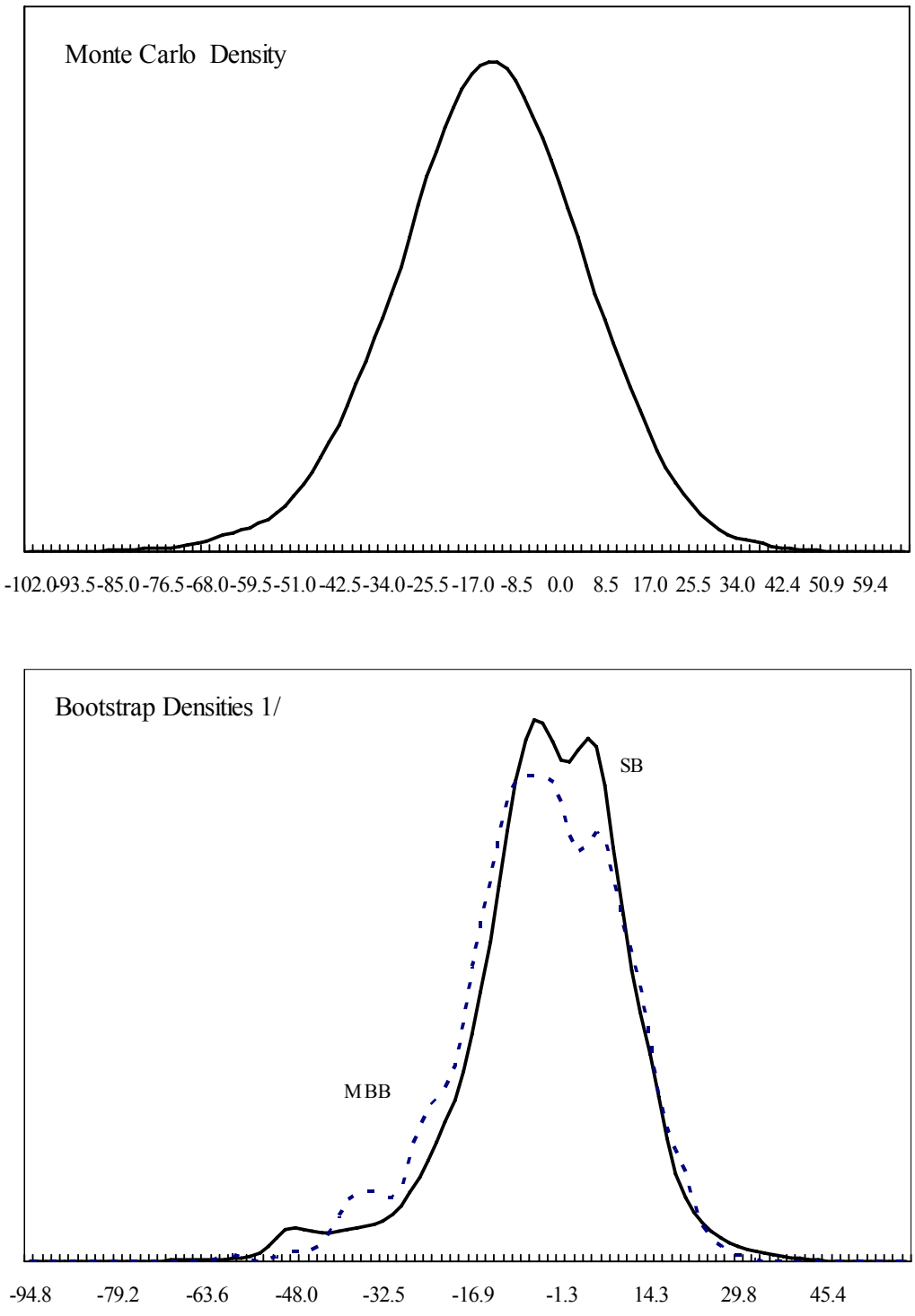


Stationary Bootstrap



Source: Author's estimates.

Figure 2. Fiscal Value at Risk Density Functions



Source: Author's estimates.
All destity estimates assume a case of T =5, and the number of simulations is 20,000.
1/ SB refers to Stationary Bootstrap; MB refers to Moving Block Bootstrap.

The Insurance Value of Fiscal Reserves

Hong Kong SAR's fiscal reserves have clearly played an important self-insurance role. This section attempts to place an implicit market value on this insurance for two purposes: to provide an insight into the cost-effectiveness of current reserves; and to assess the desirable split between self- and market-based insurance (if available). The implicit market value of insurance is calculated by relying on the equivalence between the market value of insurance and the value of a put option designed to ensure the same outcome, and therefore assumes efficient market pricing.[15] This equivalence was first exploited by Merton (1971) to value deposit insurance and, more recently, was used by Lee (2004) to value the insurance provided by foreign reserve holdings.

Market Value and Cost Effectiveness

To exploit this equivalence, we make a number of simplifying assumptions. First, we take the "asset" value (V_t) insured against to be annual revenue (as a share of GDP). Second, we assume that the European option pricing formula provides an approximate value of the equivalent option.[16] Reflecting historical patterns of revenue-to-GDP, the per unit insurance value is calculated for desired insurance (*D)* based on various values for current revenue. Specifically, we take values of *D* equal to 15, 20, and 23 percent of GDP, reflecting current reserve holdings (around 23 percent of GDP) as well a alternative lower levels of coverage,[17] and against various values for revenue (V_t) (the minimum (13.5), average (16.5), and maximum (20.7) values in our sample, and the FY2004/05 outcome (18.4)).[18]

Based on revenue and reserve holdings in FY2004/05 the average annual implicit market price of insurance would be around 0.17, implying the cost of insurance equivalent to the self-insurance provided by fiscal reserves of 23 percent of GDP would be around 3¾ percent of GDP annually.

Average Unit Insurance Value of Reserves

	Asset Value (V) 1/			
	13.5	16.5	18.4	20.7
D = 23	0.381	0.250	0.168	0.081
D = 20	0.296	0.148	0.070	0.017
D = 15	0.084	0.006	0.001	0.000

Source: Author's calculations based on Lee (2004).
1/ The minimum, average, FY2004/05, and maximum revenue-to-GDP ratios, FY1981/82-FY2004/05.

[15] The equivalence reflects the fact that a given cash flow can be guaranteed through a put option, just as it could by insurance. A put option guarantees a sales price of an asset with a volatile value. More specifically, suppose an asset has a payoff of V_t against a desired liquidity of D, then insurance against a shortfall $D - V_t > 0$ is equivalent to guaranteeing a sale price of D, through a put option, when $D > V_t$. Consequently, the average insurance value per unit of coverage can simply be estimated through the value of a put option with exercise price D. Technical details may be found in Lee (2004).

[16] Although this may not be the most appropriate assumption, it allows a simple indicative estimate of the insurance value; more sophisticated approaches could be taken up elsewhere.

[17] For example, 20 percent of GDP was proposed as an expenditure target in the FY2003/04 budget.

[18] This exercise assumes a risk free interest rate of 3 percent.

Given the high rate of return historically made by the Exchange Fund (averaging 6.3 percent over 1994–2005), it is unlikely that market insurance, even if available, would have been a cost effective alternative to self-insurance of the order held by Hong Kong SAR. However, average implicit insurance prices fall rapidly as desired insurance falls and revenue increases.

Self Insurance

This method for valuing the insurance provided by fiscal reserves can be used to examine the optimal share of self insurance where, for a *given level of desired insurance*, the marginal benefit of additional reserves equals their marginal cost. The marginal cost of additional reserves reflects the lower return from holding more liquid assets, while the marginal benefit comes from the reduction in the (implicit) per unit market cost from purchasing less. Lee (2004) shows that the optimal share of self insurance decreases monotonically with the spread over of a less liquid portfolio over the reserves portfolio.

High levels of self insurance can be optimal. Given the high average rate of return earned by the Exchange Fund, it is unlikely that there is a significant liquidity premium applicable to these assets. Optimal self insurance is calculated (for a series of low liquidity premia) for desired insurance at around current levels (20 percent of GDP or slightly more than FY2004/05 revenue), 30 percent of GDP (1.6 times FY2004/05 revenue), and 50 percent of GDP (2.7 times FY2004/05 revenue). For desired reserves and volatility around current levels, these results suggest less than complete self insurance is optimal, although as revenue volatility increases so does the share self insured as the implicit price of market insurance rises. Nonetheless, if desired insurance increases in line with the estimates based on fiscal risks discussed above, then complete self-insurance quickly becomes optimal. Moreover, it is not clear how easy market insurance is to obtain, especially based on the "efficient" market price assumed in this exercise. The assumption that the insurance value can be priced though an equivalent European option may also understate the cost of obtaining the insurance even at "efficient" prices. Borrowing remains the likeliest avenue of obtaining a market buffer against shocks. However, even borrowing is not equivalent to insurance as its cost is not fixed ex ante, and is likely to be highest when it is needed most.

Share Optimally Self-Insured
(In percent)

Liquidity Premium	Revenue Volatility 1/ 0.05	0.1	0.15	0.2
	Desired Insurance/Revenue = 1.1			
0.000	27.7	47.6	63.0	72.3
0.005	17.5	32.1	44.6	55.1
0.01	15.5	28.8	40.5	50.6
0.02	13.2	24.9	35.5	45.0
	Desired Insurance/Revenue = 1.6			
0.000	99.9	100.0	100.0	100.0
0.005	99.0	100.0	100.0	100.0
0.01	43.6	52.6	60.3	67.1
0.02	42.1	50.0	57.0	63.4
	Desired Insurance/Revenue = 2.7			
0.000	100.0	100.0	100.0	100.0
0.005	100.0	100.0	100.0	100.0
0.01	100.0	100.0	100.0	100.0
0.02	65.3	70.0	74.2	78.0

Source: Author's calculations based on Lee (2004).
1/ Revenue reflects the FY2004/05 level and volatility over the FY1981/82–FY2004/05 period is around 0.1 percent.

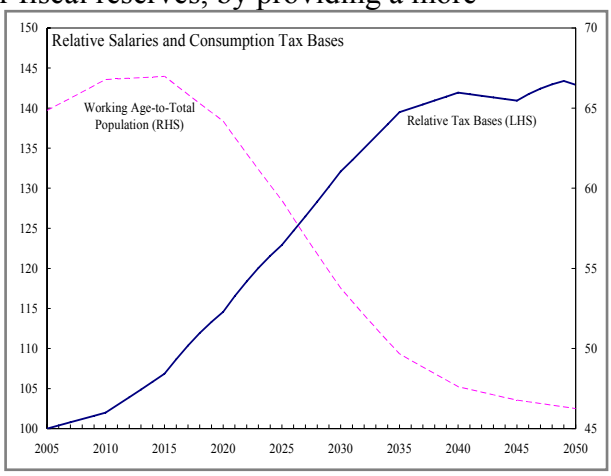
IV. Can Policy Choices Limit Fiscal Risks?

Changes in either policy or the structure of the economy will change the extent of fiscal risks. The estimates of desired reserve holdings described above are based on historical patterns of economic and fiscal volatility, as well as the structure of the economy and policy. This section provides some preliminary assessment of the sensitivity of desired reserves to two

changes: the introduction of a goods and services tax (GST); and a move to fixed returns on fiscal reserves. The results suggest that moving to a fixed rate of return on reserves could significantly reduce fiscal risks and desired reserves, but that the impact from the introduction of a low-rate GST is likely to be more moderate. This is unsurprising given the highly volatile nature of investment returns, and the extent of revenue possible from a low-rate GST.

A. Introduction of a GST

The introduction of a GST should limit the need for fiscal reserves, by providing a more stable revenue base as the population ages and by limiting revenue volatility. The first of these channels is likely to become increasingly significant with both the size of the working population, as well as overall labor productivity growth, likely to fall with the aging of the population during coming decades. In addition, the more stable the revenue base, the less the need to hold reserves, which would also reduce the relative importance of volatile investment income. The consumption tax base could grow by 40 percent more than the salaries tax base as the aging population increasingly lives off previous savings, even assuming moderate and declining real per capita consumption grow and moderate real wage growth.[19]

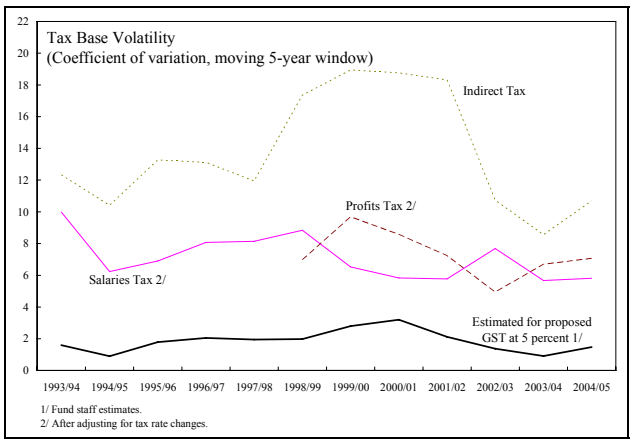


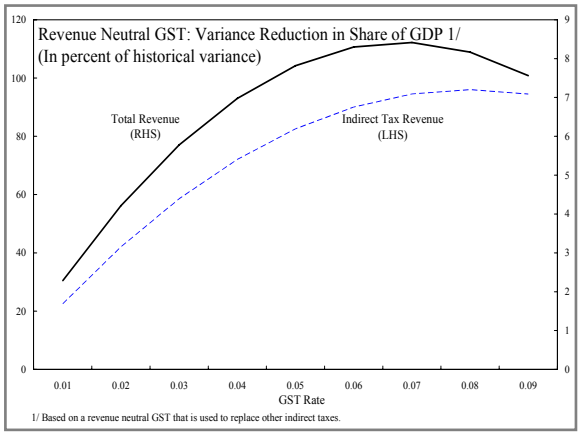
A GST will reduce the volatility of the revenue base, although the extent will depend on how it is implemented. One way is reduce other taxes to offset the revenue from a new GST. Estimating the impact on revenue volatility of such a change in tax policy is fraught with difficulties. In particular, a different tax policy could change the underlying structure of the economy. However, to provide a first-order guide, one could consider the effect of replacing some historical revenue with an equal amount (on average) of revenue from a GST given a historical estimate of its base. Such an estimate suggests a revenue neutral move from historical indirect taxes (the most volatile tax revenue) to a GST could reduce the variance of indirect taxes-to-GDP by 60–83 percent at rates of 3–5 percent.[20] The impact of such a change on overall revenue volatility would be more muted, with the variance of total

[19] Real per capita consumption growth is assumed to decline but average less than 1 percent per annum between 2005 and 2050, while real wages are assumed to grow at 1 percent during this period.

[20] It is assumed that the GST is introduced from FY1981/82, and other indirect taxes are reduced so that indirect taxes make up the same average share of GDP over the FY1981/82-FY2004/05 period. The tax base is estimated from National Accounts data, where only household-related (including rent) spending are exempt, and there is a 25 percent leakage rate. Such a tax base would imply that each percentage point in GST rate would yield around ½ percent of GDP revenue in FY2004/05, with a rate of 8–9 percent being able to completely replace historical indirect tax revenue.

revenue-to-GDP possibly falling by 6–8 percent. The impact of changes is considerably non-linear, with most of the variance reduction occurring at lower GST rates.





A low rate GST could bring about a modest reduction in fiscal risks, and thereby the desired level of prudential reserves. Using the Monte Carlo VaR method described above, a GST introduced at rates of 3–5 percent, and offsetting indirect tax revenue, could reduce fiscal risks by around 2–4 percentage points of GDP depending on the length of consecutive deficits considered.[21] The reduction in VaR is smaller than the direct impact on the variance of revenue, reflecting the interaction of risk factors with the GST base. Although the estimated reduction in risk is modest, this reduction in fiscal risks is a side-benefit of a policy worth pursuing for a more stable and broader tax base over the longer-run as well as the efficiency benefits of a GST.[22]

VaR Reduction by GST (Percentage point of GDP reduction)			
Confidence Interval (In Percent)	GST Rate		
	0.01	0.03	0.05
	T = 5 Years		
95	0.11	1.41	2.44
99	0.11	2.09	2.65
	T = 7 Years		
95	0.10	2.17	3.86
99	0.48	2.35	4.08

B. Fixed Investment Returns

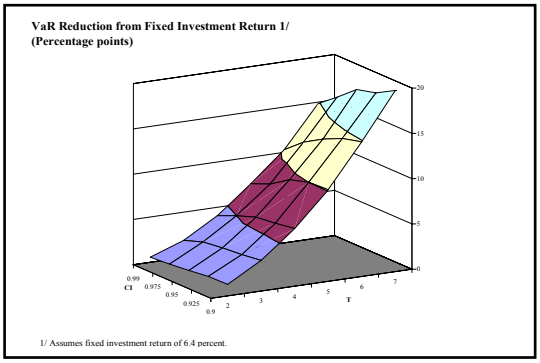
Fixing investment returns should reduce revenue volatility but would also involve costs. During the period prior to 1998, when the government's fiscal reserves received a fixed return, the volatility of overall revenue was much smaller, with the relative contribution of non-tax revenue to overall volatility at its smallest. Nonetheless, such a change in policy is unlikely to be costless. Fixing returns removes the possibility of very high investment

[21] Estimates are based on the Monte Carlo method as this method is more amenable to scenario analysis.

[22] See Baylor (2005) and Botman (2006) for a discussion of the relative efficiency benefits of a GST.

income. Moreover, the party—probably the Exchange Fund—carrying the return risk would implicitly charge for this by offering a lower rate of return.

Nonetheless, moving to a fixed (or smoother) investment return could bring about a significant reduction in fiscal risks. To provide a preliminary assessment of the impact, the VaR is calculated for a fixed investment return, assuming investment income equals income from fiscal reserves earning a fixed annual return equal to the historical average.[23] Such a change in policy could reduce reserves required to withstand a string of five deficits by around 7–10 percentage points of GDP, but by even as much as 20 percentage points over a 7 year horizon. The reduction in reserves increases significantly with the number of balance accumulated, but decreases with the confidence level. Other policies to smooth investment returns, such as a moving average of historical returns, should (given historical patterns of volatility) reduce the fiscal VaR by some fraction of the above fixed returns estimate.



V. CONCLUSION

This paper has argued that significant reserves could continue playing an essential role in Hong Kong SAR's fiscal policy as a buffer against fiscal risks. While these fiscal risks are potentially very large, their size depends on policy choices, future volatility, and the extent of the government's risk aversion. Consequently, timely policy action, such as moving towards less volatile revenue sources, could significantly reduce the need for sizable reserves.

[23] As with the GST exercise, this counter-factual is undertaken using the Monte Carlo model.

APPENDIX: METHODOLOGICAL ISSUES

This appendix briefly discusses methodological issues associated with the VaR estimates discussed in the paper. VaR estimates provide a probability based measure of potential financing needs associated with several weak fiscal balance outcomes. With VaR techniques dependent on modeling assumptions, and having their own advantages and disadvantages, this paper presented estimates from two commonly used full-valuation VaR techniques:[24]

- **Monte Carlo simulations** rely on model-based assumptions about the behavior of the valuation of fiscal variables, and underlying risk factors. Specifically, in this exercise the risk factors assumed to affect fiscal outcome include direct revenue and expenditure risks, interest rates, Hong Kong's GDP and private consumption, CPI inflation, and equity and residential property prices in Hong Kong. For the purpose of this note, the Monte Carlo simulations assume that interest rates follow a mean-reverting process, and that other economic and financial risk factors follow geometric Brownian motion processes. Although this is a very simple model, it captures the correlation structure of risk factors, and is the same as used in previous fiscal VaR applications (Barnhill and Kopits, 2003; Adrogué, 2005). Realizations of the various financial and economic risk factors impact directly on the simulation outcome. Although Monte Carlo techniques are fairly flexible, their biggest weakness is a dependence on an assumed model structure.

- **Bootstrapping** estimates the VaR based on many alternative histories built by directly resampling from observed historical data. Two bootstrap approaches are used: the moving block bootstrap (MBB) that captures persistence in time series data (Li and Maddala, 1996); and the stationary bootstrap (SB) that prevents any nonstationary issues flowing from applying the bootstrap to time series data (Li and Maddala, 1996; Politis and Romano, 1994). A large number of new realizations of fiscal outcomes are then calculated based on this these sampling realizations. Although simple and free of modeling assumptions, it is less amenable to sensitivity analysis that Monte Carlo methods. Moreover, bootstrapping reflects the extent of available data—with only 24 independent values of fiscal outcomes available. However, the method accounts for data with non-Gaussian properties.

[24] Further details can be found in Jorion (2001) and Porter (2007).

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