HONG KONG MONETARY AUTHORITY

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THE MACROECONOMIC IMPACT ON HONG KONG OF HYPOTHETICAL MAINLAND SHOCKS

Key points:

- *As the Hong Kong economy became increasingly integrated with that of Mainland China, it has benefited tremendously from the strong performance of the Mainland economy. At the same time, skilful macroeconomic management and sustained structural reforms on the Mainland have engendered a virtuous cycle, which reduces risks to Hong Kong from any potential adverse developments on the Mainland. Nevertheless, questions have been raised how Hong Kong will fare in the unlikely event that the Mainland is hit by economic shocks, which could cause the economy to deviate from its envisaged robust medium-term growth path.*

- *Shocks could be transmitted from the Mainland to Hong Kong through two main channels. First, Hong Kong's exports and imports are likely to be affected by sharp fluctuations in Mainland macroeconomic variables. Reduced export earnings and changes in terms of trade will then spill over to the Hong Kong domestic economy. Second, monetary and financial conditions in Hong Kong may be altered by changes in investor confidence and in fund flows as a result of Mainland shocks. The resulting change in Hong Kong dollar interest rates will impact asset prices and domestic demand.*

- *We use an econometric model to quantify the impact on Hong Kong of a range of Mainland macroeconomic shocks. Seven* ***hypothetical*** *scenarios are considered: external shocks include a large renminbi revaluation, a significant US economic slowdown, a trade war, and an oil price hike; domestic shocks include an investment retrenchment, a credit crunch, and financial instability. The magnitudes of the shocks are deliberately set to be large—typically taken as two standard deviations of the shock variable based on historical observations over a ten year period.*

- *Our simulation analysis suggests that Hong Kong is resilient against the shocks:*

- *Most of the shocks have relatively moderate impacts on Hong Kong, reducing economic growth by less than 1.5 percentage points cumulatively in the two years following a shock.*

- *The financial instability and trade war shocks inflict larger losses. In the former scenario, growth can decline by around 4.4 percentage points, reflecting primarily the contractionary impact on domestic demand of a sharp rise in Hong Kong's interest rates. In the latter scenario, growth can be reduced by a cumulative 6.2 percentage points over two years, resulting primarily from a sharp reduction in Hong Kong's total trade volume.*

- *Nevertheless, the size of output losses pales in comparison with that experienced by Hong Kong during the Asian crisis. Even in that case, the Hong Kong economy endured without major defaults by the corporate sector and the household sector.*

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1. INTRODUCTION

Hong Kong has enjoyed an economic boom in the past two years, registering growth of 8.6% in 2004 and 7.3% in 2005. Apart from a generally conducive global economic environment, the Mainland factor has played an important role. Hong Kong's external trade has grown strongly as the Mainland steadily expands its export market, while growing financial linkages between the two economies have opened up business opportunities in other sectors. Supportive policies to Hong Kong such as the 'individual visit' scheme and the Closer Economic Partnership Arrangement (CEPA) not only directly bring in tangible economic benefits, but also boost confidence of Hong Kong residents and the international investor community.

However, the increasing links between the two economies also raise concerns about how Hong Kong will fare if the Mainland is hit by economic shocks, which could cause the economy to deviate from its envisaged strong medium-term growth path. In the case of a positive shock, Hong Kong can expect even stronger growth. But the economy is likely to be adversely affected if there are unfavourable developments in Mainland China. Risks originated from the external sector include a possible further renminbi revaluation, an economic slowdown in the US, trade wars and further oil price hikes, while an investment retrenchment and financial instability are risk factors from the domestic economy.

This study uses a model to describe macroeconomic linkages between the two economies and assesses the impact on Hong Kong of shocks emanated from the Mainland economy. The remainder of the paper is arranged as follows. Section 2 documents the Mainland's contributions to Hong Kong's growth, and outlines a medium-term outlook for the Mainland economy as a baseline scenario for examining downside risks. Section 3 suggests some scenarios of macroeconomic shocks on the Mainland, while Section 4 briefly explains the modelling approach to quantifying the impact of these risks. Sections 5 and 6 discuss the shock transmission mechanisms in the Mainland and Hong Kong, and present the simulation results on assessing the impact on the two economies respectively. Section 7 puts the simulation results in historical perspective by comparing them with a few episodes of severe economic downturns in the past. Section 8 concludes.

2. THE MAINLAND FACTOR IN HONG KONG'S ECONOMIC GROWTH

The Mainland has a dominant status in Hong Kong's external trade arising from Hong Kong's status as an entrepôt intermediating goods between the Mainland and the rest of the world. In merchandise trade, the Mainland is Hong Kong's largest partner, accounting for close to 50% of the total. About 60% of Hong Kong's imports for re-exports are sourced in the Mainland, and about half of the re-exports go to the Mainland market. Connected with the merchandise trade, Hong Kong provides a range of trade-related services to the Mainland including transportation, merchanting and merchandising.[1] The Mainland is the largest destination for goods sold through offshore trade in Hong Kong, amounting to around 40% of the total value. Mainland China is also the key factor driving a boom in Hong Kong's inbound tourism. The number of Mainland tourists has been rising particularly fast since the introduction of the 'individual visit' scheme in 2003, generating around half of the tourist earnings in 2004.

In terms of financial linkages, Hong Kong is a major source of investment funding for the Mainland, with the cumulative direct investment accounting for around 40% of the total at end-June 2005. In return, Hong Kong derives HK$ 80 billion from these investments, or about 6.3% of the Gross National Product. At the same time, the Mainland is Hong Kong's largest source of direct investment, investing close to 30% of the total. Hong Kong also helps channelling foreign funds efficiently into China. Activities related to arrangements of syndicated loans and issuances of securities for Mainland entities generate strong demand for Hong Kong's financial, legal, accounting and other professional services.

With ongoing economic reforms and liberalisation of the Mainland economy, as well as the further impetus provided by the Mainland's entry into the World Trade Organisation and the implementation of the CEPA, the economic relations between the two economies will grow ever closer and stronger. The close linkages between the two imply that developments in the Mainland economy will have increasingly significant impacts on Hong Kong.

Both economies are envisaged to grow strongly in the medium term. Among the factors supporting potential growth in the Mainland economy, capital accumulation is occuring at a rapid speed, and labour supply continues to be plentiful, with projected increases in the working age population and continuing substantial migration from rural to urban areas. More importantly, ongoing structural reforms

[1] Offshore trade comprises merchanting and merchandising services which intermediate trade flows without the goods involved passing through Hong Kong. In the former case, Hong Kong companies take ownership of the goods involved, while in the latter, purchases/sales of goods are arranged on behalf of buyers/sellers outside Hong Kong.

should help maintain fast productivity growth. Hong Kong has increasingly become a service-based economy offering a range of high value-added services to the Mainland. As such, Hong Kong can maintain robust growth by taking full advantages of the fast rising Mainland economy.

Overall, the Mainland economy is envisaged to grow at a speed of around 7.5% to 8.5% a year in the medium term, while vigilant demand management by the central bank should be able to keep inflation stable at low levels. There could also be positive shocks to the economy such as faster-than-expected productivity growth. Strong and stable economic developments in the Mainland will provide a conducive environment for Hong Kong's economic growth. Table 1 provides historical data of a set of key macroeconomic variables as well as a baseline medium-term projection for the two economies by the *Oxford Economic Forecasting* Model, which will be discussed further in Section 4.

Table 1. Economic developments in Mainland China and Hong Kong: historical performance vs. medium-term projections

	Mainland		Hong Kong	
	Historical	Projection	Historical	Projection
GDP *(%, yoy)*	8.6	8.1	3.6	5.7
Consumption *(%, yoy)*	6.9	10.4	2.1	4.8
Investment *(%, yoy)*	12.3	10.3	2.3	7.4
Exports *(%, yoy)*	17.7	13.9	7.3	9.2
Imports *(%, yoy)*	17.5	14.8	6.5	9.3
Inflation *(%, yoy)*	3.1	2.8	1.0	2.1
Unemployment Rate *(%, per annum)*	3.4	4.0	5.1	5.2
Current account *(% of GDP)*	2.4	2.2	3.2	9.3
Fiscal balance *(% of GDP)*	-2.2	-1.1	-0.4	1.3

Note: The figures are year-on-year changes unless stated otherwise. The historical performance refers to the averages for the period of 1995-2004, while the projection are averages of the forecasts made by the Oxford Economic Forecasting for 2006-2010.

3. SHOCK SCENARIOS

There exist, however, risks to this benign picture, which have low probabilities of occurring but could cause short-term deviations from the baseline medium-term projection. As Mainland China becomes increasingly integrated into the world economy, its economic growth is more closely aligned with global trade cycles,

and thus can be affected by adverse external developments such as unfavourable exchange rate movements, a surge in protectionism, a weakening in world demand and oil price volatility. Risks of a domestic origin also exist, including swings in investment spending and instability in the financial system.

To assess how these risk factors will affect the Mainland and Hong Kong economies, we run simulations on a global macroeconomic model developed by the Oxford Economic Forecasting. The types of risks suggested above are based on the economic characteristics of the Mainland and uncertainties present in the global economy. In quantifying the shocks, the magnitudes of the shocks are deliberately set to be large—typically taken as two standard deviations of the shock variable based on historical observations over a ten year period—in order to assess Hong Kong's resilience even under unusual circumstances (Table 2).[2] It needs to be emphasised that these risk scenarios are highly hypothetical. Given the Mainland's continued strong economic performance and sustained structural reforms, domestic shocks of such large magnitudes are very unlikely to occur.

Table 2. Shock Scenarios

Scenarios	Assumption
External shocks	
1 Renminbi revaluation	10% renminbi revaluation in one step
2 Trade war	Export growth declines by 20ppt for 1 year
3 US economic slowdown	US private consumption growth declines by 2 ppt for 1 year
4 Oil price hike	Oil price rises permanently by US$20 per barrel
Domestic shocks	
5 Investment retrenchment	Investment growth declines by 15ppt for 1 year
6 Credit crunch	Credit growth declines by 20ppt for 1 year
7 Banking and currency instability	Interest rate rises by 10ppt, exchange rate depreciates by 50% and credit growth declines by 20ppt for 1 year

[2] Under the assumption of a normal distribution, a two-standard-deviation shock has a small probability of occurring (less than 5%).

3.1 External shocks

Renminbi revaluation

Despite the recent revaluation and a move to a managed float, the renminbi may continue to face upward pressures. Domestic problems of overheating may deteriorate, constituting macroeconomic imperatives for further appreciation from a domestic viewpoint. Externally, should the Mainland continue to run large current account surpluses, trade frictions will rise again, and political pressures from the trading partner countries will periodically intensify. The combined forces of domestic and external needs may lead to a re-run of the situation before the latest exchange rate reform took place. In assessing the impact of a possible further move, we assume that the renminbi will be revalued by a further 10% in one step, which is likely to be larger than what the authorities would like to see but can be considered plausible. This magnitude of revaluation is close to two standard deviations of changes in the renminbi nominal effective exchange rate in the past decade.

Trade shocks

Merchandise trade has become an increasingly significant part of the Mainland economy in recent years with exports quadrupling in the last decade and continuing to expand at a year-on-year rate around of 30% (in value terms) on a monthly basis in the last couple of years. However, the heavy reliance on external trade has made the economy more vulnerable to external shocks such as an economic slowdown in major trading partner countries and other shocks to exports such as a rise in trade frictions. Among the major trading partners, the US can have a particularly large influence as it is the Mainland's biggest market as well as a key engine driving global growth. Separately, trade frictions with a number of major trading partners have risen considerably this year as the Mainland's strong trade performance triggered a rise in protectionist sentiment in those regions.

In this light, we consider two specific trade shocks. In the first case, Mainland China's export growth is trimmed by 20 percentage points (in volume terms) due to, for example, a rise in protectionism and ensuing trade wars. The second scenario assumes that there is a setback in the US economic growth caused by a decline of 2 percentage points in the US private consumption growth for one year, which averaged at 3.7% in the past 10 years.

Oil price hike

Oil prices have been climbing steadily in the past two years. Since mid-June 2005, the price of Brent crude oil has been fluctuating around $60 per barrel, almost twice the level in the spring of 2004, and, after discounting inflation, higher than the levels seen in the first oil crisis of 1973-74, albeit still lower than the oil prices during the second oil crisis in the late 1970s. Amidst strong energy demand and concerns over disruptions to supply, oil prices are expected to remain high and volatile in the near term. In our later assessments, we assume a further $20 increase in oil prices.

3.2 Domestic shocks

Investment retrenchment

With a share of 45% in GDP, investment spending has been a key driver of the Mainland's recent business cycles. In the current cycle, for example, real investment spending expanded by 13% in 2004 alone, contributing about a half to GDP growth. In the downswing of the cycle, developments in investment will also be crucial in determining the pace of an economic slowdown. Here we assess the impact of a decline of 15 percentage points in real investment growth as a result of, for example, a sharp reduction in FDI, a fall in firms' profitability, or lower expected returns on investment.

Credit crunch

Although progress has been made in the Mainland's banking reforms, the banking sector remains weak. Nonperforming loans remain a long-standing issue within the system. While it is generally expected that the situation will improve, there could be a new spout of bad loans which might trigger a large reduction in bank liquidity. The most immediate risk is that banks cut back lending sharply over a short period of time. We consider a case of 20 percentage point reduction in real credit growth.

Banking and currency instability

Another major shock could be a system-wide problem of financial instability, particularly when the capital account is being increasingly liberalised. This could result in capital flight, large currency devaluations and higher domestic interest rates. In simulating this risk scenario, we assume that credit growth will fall by 20

percentage points, interest rates will rise by 10 percentage points and the renminbi will depreciate by 50% -- a set of conditions close to those faced by Korea at the height of the Asian financial crisis in 1997-8.

4. MODELLING APPROACH

In order to assess the impacts of these scenarios, we run simulations on a global macroeconomic model developed by the *Oxford Economic Forecasting*. This model is widely used for a range of purposes by central banks, international organisations such as the International Monetary Fund, other policy-making institutions and analysts in the financial markets. The model contains detailed specifications for eight most important economies including Mainland China with more than 250 equations for each. Another 36 economies are also modelled with varying degrees of details. There are also blocks of equations to describe variables for the world as a whole, as well as for different geographic regions and different types of economies such as the OECD and emerging markets.

Each country model follows a similar structure, which has neoclassical long-run properties, but exhibits 'Keynesian' features in the short to medium term. On the supply side, an individual country block is modelled as a one-sector economy with a Cobb-Douglas production function in the long run. The economies have a natural growth rate, which is determined by population and productivity growth. As to the price behaviour, the Phillips curve is vertical, and inflation is a monetary phenomenon in the long run. The employment, wage and price equations can jointly solve for the equilibrium levels of real unit labour costs and unemployment consistent with the given labour's share in the production function. In the short run, there are nominal and real wage rigidities, which result in 'involuntary' unemployment and monetary effects on the real economy.

The demand side is modelled based on the income-expenditure accounting framework. Consumption is a function of real income, financial wealth and interest rates, while investment is determined by funding costs. Exports are a function of world demand and competitiveness, and real domestic demand and competitiveness are the key determinants of imports. Most of the behavioural equations for the demand side are estimated using the error correction model.

While the country blocks have many shared features, individual characteristics are also reflected. For example, parameters are different across countries for the same equations, bearing out differences in countries' responses to shocks. Coverage of non-core variables, such as disaggregated expenditure components,

important indicator variables such as retail sales, also depends on data availability and features of individual economies. [3]

5. MACROECONOMIC IMPACTS ON THE MAINLAND

Assessing the macroeconomic impacts of the shocks described above is a challenging task, since the transmission of these shocks involves multiple channels and interactions among the channels. The use of a macroeconomic model allows such channels to be simplified and tractable. This section discusses the transmission channels based on the structure of the *Oxford Economic Forecasting* model.

5.1 Shock transmission channels

The most direct impact of external shocks is a reduction in the growth rate of exports from the Mainland. Export growth slows due to weaker growth in foreign income and/or a loss of competitiveness. The terms of trade may also change. These developments spill over the domestic economy through a reduction in earnings and changes in prices. In the case of a renminbi revaluation, slower activity and a fall in import prices exert downward pressures on domestic prices. Real interest rates rise due to lower inflation, and, combined with reduced earnings from the export sector, dampen investment and consumption. Imports often fall, partly reflecting weak domestic demand, and partly reflecting the 40% share of imports relating to processing trade.

The impulses of domestic shocks, such as an investment retrenchment and a credit crunch, run from the domestic economy to the external sector. The sharp slowdown in investment growth will result in a marked contraction in aggregate demand, and a fall in prices. Real interest rates rise as the decline in nominal interest rates is smaller than the fall in prices. Consumption will be restrained by the resulting decline in earnings and higher real interest rates. The drop in domestic demand leads to a marked fall in imports, but exports will be largely unaffected.

A permanent oil price hike depresses both domestic and foreign demand. It pushes up import prices which will lead to higher production costs and consumer prices. However, as utility and petrol prices are controlled by the Mainland authorities, headline inflation will probably not rise significantly. Although domestic demand is somewhat dampened by higher prices, the more significant impact is still on exports as higher oil prices lead to a global slowdown, reducing demand for Mainland goods. Such a fall in export demand will also lower domestic demand through the multiplier effect.

[3] See the Technical Appendix for details of the Mainland China and Hong Kong blocks of the model.

Financial instability will cause a sharp reduction in domestic demand, but provide a boost to external competitiveness. Investment spending, which is sensitive to funding costs and credit availability, will fall. Consumption spending, although less affected, will be weak as a result of job losses and lower earnings. Higher import prices brought about by the sharp exchange rate depreciation will lead to some increases in prices. The pick-up in inflation will be relatively mild, however, in large part reflecting the weakness of domestic demand. As the increase in inflation cannot fully offset that in nominal interest rates, real interest rates rise and depress domestic demand even further.

In the meantime, although the exchange rate depreciation leads to significant gains in competitiveness, exports may not expand immediately, reflecting the disruption on economic activity brought about by the credit crunch. Even when exports start to accelerate, the support from export earnings is not sufficient to offset the contractionary effect of the credit crunch and interest rate rises on consumption and investment. Imports slow significantly initially partly due to sluggish domestic demand, and partly due to higher import prices, but pick up subsequently along with buoyant processing trade. The current account improves, first because imports contract more sharply than exports, and later because growth of exports outpaces that of imports.

5.2 Magnitudes of impacts

In order to gauge the magnitude of impacts as described above, this sub-section presents simulation results, showing the quantitative effects of the specified shocks on Mainland GDP and its components, inflation, unemployment rate, the current account balance, and the fiscal balance. The effects are described as deviations from the baseline scenarios in the two years following a shock (Tables 3-5).

In terms of the overall impact on GDP growth, the most severe shocks are the investment retrenchment, the trade war, and financial instability scenarios where overall growth declines by 7.9, 8.9 and 11.0 percentage points accumulatively in the first two years. By comparison, the renminbi revaluation and the US slowdown have the smallest impact. The effect of an oil price hike and a credit crunch is in the middle range, lowering GDP growth by around two percentage points cumulatively in two years after the shocks.

Among the components of GDP, investment spending always reacts more strongly than consumption spending. The financial instability shock has the most drastic impact on domestic demand, driving investment growth down by as much as 28 percentage points in two years. In the more contained situation of a credit crunch,

investment growth slows by a cumulative 4.7 percentage points in the first two years. While external shocks tend to have only a small effect on domestic demand, the strong negative impact of trade wars on the trade sector reduces investment by around 10 percentage points in the second year after a relatively modest decline in the first. The contraction of consumption growth is milder, mostly around 3 percentage points in two years.

In terms of the impact on exports, a two-percentage-point slowdown in the US consumption growth has the biggest effect, resulting in a fall of export growth by 2.3 percentage points in a year. A 10% renminbi appreciation does not have as severe an impact as many feared as export growth slows by a cumulative 2.1 percentage points in the first two years following the currency move, reflecting low price elasticity of export demand.

Import growth declines in all the cases due to weaker domestic demand and/or a fall in processing trade as the result of a slowdown in exports. The largest declines are seen in the scenarios of financial instability, investment retrenchment, and trade wars. The trade balance changes little in many cases. However, the trade surplus narrows by 3% of GDP when export growth slows by 20 percentage points due to trade wars, while widening by around 10% of GDP in the scenarios of an investment retrenchment and financial instability, since domestic demand is severely dented.

Inflation falls as a result of weak aggregate demand in the majority of the shock scenarios. In the investment retrenchment and trade war scenarios, the inflation rate declines by more than two percentage points in two years. It falls by 1.7 percentage points in the event of a 10% renminbi revaluation, reflecting the combined effect of weak demand and lower import prices. A credit crunch and a US slowdown result in small reductions in inflation.

Inflation rises in the cases of an oil price hike and financial instability. Oil prices push up inflation, but only mildly, by less than one percentage point over two years. In the financial instability scenario, the effect of the sharp depreciation more than offsets that of weak demand, resulting in a 2.2-percentage-point rise in inflation in the first year, but a decline in the second.

The impact on the unemployment rate is small for most of the shock scenarios. Nevertheless, when a trade war breaks out, the unemployment rate will increase by 1.7 percentage points in the first two years. If investment spending experiences a sharp retrenchment, the unemployment rate rises by a cumulative 1.3 percentage points in two years.

Among the different scenarios, the trade war has the largest impact on the fiscal position, leading to a cumulative rise of 1.0 percentage point in fiscal deficits as a proportion of GDP over two years. Fiscal deficits also rise by 0.4 percentage point of GDP in the investment retrenchment case, but narrow subsequently as the economy improves. The fiscal position is largely little affected in other cases. One exception is the financial instability scenario where fiscal deficits are shown to decline by 1% of GDP in the first year of the shock. This is due to marked increases from two revenue sources. The sharp depreciation of the exchange rate will lead to a significant rise in exports and imports in the renminbi terms, and the interest rate hike will result in a surge in interest earnings. If taxes on trade and on interest earnings are maintained as, for example, the authorities are constrained to take any stimulative measures, the two enlarged tax bases will lead to a significant increase in government revenues. This more than offsets the rises in government expenditure due to higher social transfers and interest payments on government debt, resulting in an improvement in the fiscal position.

6. MACROECONOMIC IMPACTS ON HONG KONG

6.1 Shock transmission channels

The Hong Kong economy will be affected by Mainland shocks through two main channels. First, re-exports originated from the Mainland through Hong Kong to the rest of the world, re-exports via Hong Kong from the rest of the world to the Mainland and offshore trade organised by Hong Kong firms are likely to be affected by Mainland shocks. Reduced export earnings and changes in terms of trade will then spill over to the domestic economy. Second, monetary and financial conditions in Hong Kong may be altered by changes in investor confidence and in fund flows. The resulting change in Hong Kong dollar interest rates will impact asset prices and domestic demand.

Comparing the two transmission mechanisms, the trade channel is more direct and easier to quantify. As Hong Kong is the major *entrepôt* for the Mainland's trade, the territory's trade performance will be affected by shocks that have a large impact on the Mainland's external sector. Conversely, shocks that have limited impacts on the Mainland's exports will have little influence on Hong Kong's trade. Furthermore, since shocks to the Mainland economy are transmitted to Hong Kong mainly from the external sector to the domestic economy, those that do not have much of an impact on trade also tend to have limited effects on domestic demand.

Among the external shock scenarios, the trade channel transmission is particularly interesting in the case of a further renminbi revaluation where there are

offsetting trade flows. Because of Hong Kong's position as an *entrepôt*, a renminbi appreciation does not mean a gain in the territory's external competitiveness. Re-exports originated from Mainland China to the rest of the world will fall along with the Mainland's exports. Nevertheless, a positive terms-of-trade effect for the Mainland will stimulate re-exports via Hong Kong from the rest of the world. Although not modelled explicitly, inbound tourism might increase as the renminbi appreciation boosts the purchasing power of Mainland visitors. The largely offsetting movements in different types of trade result in relatively minor impacts on Hong Kong's external sector initially. However, when the Mainland's imports begin to decline along with falling exports, Hong Kong's trade will also be negatively affected.

Shocks emanated from the Mainland also impinge on Hong Kong's domestic demand through the financial market linkages. Hong Kong's interest rates equal to their US counterparts plus a risk premium. Under the Linked Exchange Rate system, local interest rates will follow the movements of the US rates, which can alleviate or exacerbate the impact of the original shocks. In the case of the oil shock, for example, local interest rates will rise following their US counterparts if the Federal Reserve is compelled to raise policy rates in order to keep inflation in check, imparting a further contractionary impulse on the domestic economy.

Hong Kong's risk premium are affected by the current account and fiscal positions, levels of foreign reserves as well as the Mainland's growth prospect and general emerging market risk. Shocks to the Mainland economy may lead to a sharp rise in the risk premium for emerging markets in general, and that for Hong Kong in particular due to its close geographical proximity and economic linkages with the Mainland. The resulting rate hike will severely depress domestic demand. Property prices in Hong Kong are particularly procyclical and sensitive to interest rate movements. As housing wealth accounts for a large part of wealth in Hong Kong, a decline in property prices will severely impact private consumption directly through the wealth effect as well as by undermining consumer sentiment. Higher interest rates and falling property prices also deter investment, particularly spending on buildings and constructions.

6.2 Magnitudes of impacts

In terms of the overall impact on GDP, the trade war would inflict the largest loss on the Hong Kong economy, by 6.2 percentage points over two years, amidst an abrupt shrinkage in the trade volume of the Mainland. In the investment retrenchment and financial instability scenarios, Hong Kong's growth will decline by a cumulative 3.3 and 4.4 percentage points respectively in the two years following the shocks.

Specifically, in the case of financial instability, growth will fall by around 4.1 percentage points in the first year, but the decline will moderate in the second year as the trade sector starts to recover.

In contrast, a renminbi revaluation has little impact on Hong Kong's GDP growth. Upon a US slowdown, the rate of economic expansion will slow by close to 1 percentage point, but the economy will quickly return to its baseline growth path. The declines in growth caused by a credit crunch on the Mainland and an oil price hike are around 1.5 percentage points over two years.

On Hong Kong's exports, the trade war shock will have the largest impact, reducing its growth by around 16 percentage points over two years. An investment retrenchment will also lead to a relatively large decline in Hong Kong's export growth, by a cumulative 6 percentage points. In the majority of the other shock scenarios, the decline in export growth is in the order of 1-2 percentage points. Imports usually decline by a similar magnitude as exports, reflecting the large weight of Mainland-related re-exports.

Reflecting the impact on exports and imports, the trade war shock will slash Hong Kong's trade surplus by 8.7% of GDP. The oil price hike also has a large impact on the current account, reducing the surplus by 4.1% of GDP. In other shock scenarios, the trade balance is not much affected, and there is a small improvement in the current account position in some cases, *e.g.* financial instability.

The largest impact on domestic demand in Hong Kong comes from financial instability on the Mainland, with both consumption and investment growth falling by 5-6 percentage points in the first year before stabilising in the second, reflecting a sharp increase in interest rates of 9 percentage points brought about by a surge in risk premium. In the trade war and the investment retrenchment scenarios, interest rates rise by around 2 percentage points. Consequently the impacts on the domestic economy are milder, with consumption and investment growth declining by 2-4 percentage points in the first two years.

Hong Kong's inflation will be significantly affected by the trade war and financial instability, declining by 1.5-2 percentage points in two years. Other shocks have little effects on inflation in Hong Kong.

Reflecting their impacts on economic growth, the trade war and financial instability shocks will raise the unemployment rate by 2-3 percentage points in two years. Other shocks have milder effects on unemployment in Hong Kong.

Government deficits will rise by close to 1% of GDP in two years in the case of the trade war, and around 0.3-0.5% in the financial instability and oil price hikes scenarios as declines in government revenues from taxes on income and profits were larger than declines in government consumption and investment. The fiscal position is not much affected in other cases.

Table 3. External Shocks

Scenario 1: Renminbi revaluation

Assumption: 10% renminbi revaluation in one step

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-0.9	-0.9	0.0	-0.2
Consumption *(%, yoy)*	-0.1	-0.3	0.0	0.0
Investment *(%, yoy)*	-0.6	-1.1	0.0	-0.1
Exports *(%, yoy)*	-0.7	-1.4	0.0	-0.8
Imports *(%, yoy)*	0.8	-1.2	0.0	-0.8
Inflation *(%, yoy)*	-0.7	-1.0	0.0	0.0
Unemployment Rate *(%, per annum)*	0.0	0.2	0.0	0.0
Current account *(% of GDP)*	-0.5	-0.4	0.2	0.0
Fiscal balance *(% of GDP)*	-0.2	-0.1	0.0	0.0

Note: Figures are deviations in percentage points from the baseline.

Scenario 2: Trade war

Assumption: Export growth declines by 20ppt for 1 year

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP (%, yoy)	-5.8	-3.1	-3.2	-3.0
Consumption (%, yoy)	-1.3	-1.9	-1.6	-2.6
Investment (%, yoy)	-2.8	-9.9	-1.7	-2.4
Exports (%, yoy)	-20.0	0.0	-10.4	-5.7
Imports (%, yoy)	-12.2	-9.5	-10.3	-5.6
Inflation (%, yoy)	-0.6	-1.9	-0.5	-1.5
Unemployment Rate (%, per annum)	0.8	0.9	0.8	2.0
Current account (% of GDP)	-3.1	0.1	-3.7	-5.0
Fiscal balance (% of GDP)	-0.6	-0.4	-0.1	-0.8

Note: Figures are deviations in percentage points from the baseline.

Scenario 3: US economic slowdown

Assumption: US private consumption growth declines by 2ppt for 1 year

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-0.6	0.2	-0.9	0.2
Consumption *(%, yoy)*	-0.1	-0.1	-0.8	-0.1
Investment *(%, yoy)*	-0.3	-1.1	-1.0	0.0
Exports *(%, yoy)*	-2.3	3.0	-1.3	1.1
Imports *(%, yoy)*	-1.5	1.1	-1.3	1.0
Inflation *(%, yoy)*	-0.1	-0.1	-0.1	-0.1
Unemployment Rate *(%, per annum)*	0.1	0.0	0.2	0.3
Current account *(% of GDP)*	-0.3	0.4	-0.2	0.4
Fiscal balance *(% of GDP)*	-0.1	0.0	0.0	-0.1

Note: Figures are deviations in percentage points from the baseline.

Scenario 4: Oil price hike

Assumption: Oil price rises permanently by US$20 per barrel

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-0.9	-1.4	-0.6	-0.9
Consumption *(%, yoy)*	-0.6	-0.8	-0.5	-1.1
Investment *(%, yoy)*	-0.8	-3.0	-0.3	-0.3
Exports *(%, yoy)*	-1.7	-0.1	-0.9	-1.1
Imports *(%, yoy)*	-1.4	-1.9	-0.9	-1.1
Inflation *(%, yoy)*	0.3	0.4	0.1	-0.1
Unemployment Rate *(%, per annum)*	0.1	0.2	0.1	0.3
Current account *(% of GDP)*	-1.3	-0.6	-2.0	-2.1
Fiscal balance *(% of GDP)*	-0.1	-0.1	0.0	-0.3

Note: Figures are deviations in percentage points from the baseline.

Table 4. Domestic Shocks

Scenario 5: Investment retrenchment

Assumption: Investment growth declines by 15ppt for 1 year

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-5.6	-2.3	-1.9	-1.4
Consumption *(%, yoy)*	-1.4	-1.7	-1.4	-1.1
Investment *(%, yoy)*	-15.0	-5.8	-1.7	-1.1
Exports *(%, yoy)*	-0.9	0.9	-3.5	-2.4
Imports *(%, yoy)*	-11.3	-5.1	-3.4	-2.3
Inflation *(%, yoy)*	-0.6	-1.7	-0.3	-0.8
Unemployment Rate *(%, per annum)*	0.7	0.6	0.5	1.1
Current account *(% of GDP)*	3.7	6.3	-0.8	-1.2
Fiscal balance *(% of GDP)*	-0.4	-0.1	0.0	-0.3

Note: Figures are deviations in percentage points from the baseline.

Scenario 6: Credit crunch

Assumption: Credit growth declines by 20ppt for 1 year

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-1.8	-0.3	-0.9	-0.5
Consumption *(%, yoy)*	-0.5	-0.4	-1.1	-0.7
Investment *(%, yoy)*	-3.8	-0.9	-1.4	-0.7
Exports *(%, yoy)*	-0.1	0.3	-0.5	-0.4
Imports *(%, yoy)*	-1.5	-0.9	-0.5	-0.4
Inflation *(%, yoy)*	-0.1	-0.4	-0.1	-0.2
Unemployment Rate *(%, per annum)*	0.2	0.1	0.2	0.5
Current account *(% of GDP)*	0.5	0.9	0.3	0.5
Fiscal balance *(% of GDP)*	-0.1	0.0	0.0	-0.1

Note: Figures are deviations in percentage points from the baseline.

Scenario 7: Banking and currency instability

Assumption: Interest rate rises by 10ppt, exchange rate depreciates by 50% and credit growth declines by 20 ppt for 1 year

	Mainland		Hong Kong	
	Year 1	Year 2	Year 1	Year 2
GDP *(%, yoy)*	-4.7	-6.3	-4.1	-0.3
Consumption *(%, yoy)*	-2.1	-1.9	-5.0	-0.3
Investment *(%, yoy)*	-12.8	-14.8	-5.8	0.1
Exports *(%, yoy)*	-0.1	3.5	-2.9	-0.9
Imports *(%, yoy)*	-9.8	-1.9	-3.2	-0.8
Inflation *(%, yoy)*	2.2	-1.4	-0.7	-1.2
Unemployment Rate *(%, per annum)*	0.6	0.6	1.1	1.7
Current account *(% of GDP)*	5.0	5.1	0.8	0.7
Fiscal balance *(% of GDP)*	1.0	-0.8	0.0	-0.5

Note: Figures are deviations in percentage points from the baseline.

6.3 Caveats

A note of caution is in order when interpreting the simulation results. Given the complexity of economic transmission mechanisms, model simulation typically only provides an incomplete account of what would happen in the shock scenarios. Many other factors might affect the outcomes, but are difficult to be fully captured by a model.

The analysis so far, for example, has not assumed any policy response on the part of the Mainland authorities. Authorities often take measures to support the economy when deemed necessary. For example, when the full depth of the Asian crisis became apparent, monetary policy was loosened on the Mainland and a steady stream of fiscal packages, geared to infrastructure projects, were undertaken. During 2001-2002, fiscal stimulus was injected to counter the large negative shock brought about by the global economic slowdown in the wake of the 9/11 event. If monetary and fiscal stimuli are considered in those risk scenarios, the economic downturns will be shallower than envisaged earlier. In Hong Kong, the government's large net asset position allows the use of fiscal policy to help cushion the impact on domestic demand if and when necessary.

As also indicated in earlier discussions, the outcomes in some of the shock scenarios can be critically affected by expectation effects. The way Hong Kong's

risk premium is modelled captures in many important ways expectation effects through financial linkages, but still may not reflect their full impacts. For example, if further appreciation of the renminbi is expected, there can be large capital inflows into Hong Kong, partly because of its close proximity and economic links to the Mainland economy, and partly because the Hong Kong dollar is used as a proxy in the absence of full convertibility of the renminbi. The resulting large liquidity can help hold down interest rates. Some funds may enter equity and stock markets, pushing up asset prices. Given the strong wealth effect in Hong Kong, higher asset prices, especially property prices, can significantly boost consumption and residential investment. Developments in the domestic economy can cushion the negative impact of a renminbi appreciation, leading to a milder slowdown or even higher overall growth. On the downside, though, large speculative capital flows may be withdrawn from Hong Kong if renminbi appreciation expectations cease, thus pushing the economy into a deeper downturn.

7. HISTORICAL PERSPECTIVES

To gauge the plausibility of the analysis of this study, the shock scenarios and simulation results can be usefully compared to actual historical episodes of economic downturns (Table 5). In general, the simulation results appear to be plausible, although the economic losses in Hong Kong during the Tian'anmen incident and, most notably, the Asian crisis were greater than the predictions in any of our simulated scenarios.

This can be explained by the fact that historical episodes reflect the combined impact of multiple shocks, whereas our simulation exercises focus mostly on a single shock. For example, the Tian'anmen incident represented not only a large shock to domestic demand on the Mainland but also a political shock to Hong Kong. The collapse of domestic demand in Hong Kong during the Asian crisis reflected a sharp rise in interest rates as a result of the crisis in the region, as well as the bursting of the property market bubble in the local economy. Replicating the historical episodes by the model would require a careful calibration of all the shocks—some of which cannot be easily quantified—hitting the economy during that period of time.

Table 5. Historical episodes

	Tiananmen incident (1989)		Macroeconomic Adjustment (1994-96)		Asian Crisis (1997-98)	
	Mainland	Hong Kong	Mainland	Hong Kong	Mainland	Hong Kong
GDP *(%, yoy)*	-7.2	-5.3	-3.9	-2.1	-1.8	-9.7
Consumption *(%, yoy)*	-7.9	-4.9	1.0	-1.8	-3.6	-12.2
Investment *(%, yoy)*	-26.6	-3.1	-19.2	7.1	2.9	-18.4
Exports *(%, yoy)*	10.0	-14.4	-2.3	-7.4	2.6	-9.4
Imports *(%, yoy)*	-17.5	-16.6	-25.1	-7.8	-3.2	-10.7
Inflation *(%, yoy)*	-0.3	2.6	+9.6 (1994) -15.9 (1995-96)	-2.5	-9.1	-3.4
Unemployment Rate *(%, per annum)*	0.6	-0.3	0.4	0.8	0.1	1.6
Current account *(% of GDP)*	0.0	2.6	2.9	-8.2	2.5	2.1
Fiscal balance *(% of GDP)*	-0.1	-1.2	0.0	-0.2	-0.5	-1.2

Note: Figures are changes in percentage points during a historical episode.

8. CONCLUDING REMARKS

The simulation analysis of this study suggests that Hong Kong is able to withstand macroeconomic shocks that are deliberately calibrated to be of small probability events but of considerable magnitudes. In most of the scenarios we consider, Hong Kong's economic growth falls relatively moderately, by less than 1.5 percentage points cumulatively in the two years following the shock. But the financial instability and trade war shocks would have larger impacts. In the former case, growth can decline by around 4.4 percentage points. The most drastic scenario is the trade war shock, which can lower growth by a cumulative 6 percentage points in Hong Kong over two years.

Nevertheless, even in the worst cases, the size of the output losses pales in comparison with that experienced by Hong Kong during the Asian crisis. Even in that extreme case, however, the Hong Kong economy endured without major defaults by the corporate sector, the household sector, or the government. Also, the simulations have not assumed any policy response by either the Mainland or the Hong Kong government to cushion the impact of shocks. In fact, with a strong net asset position, the Hong Kong government has sufficient room for policy manoeuvre, and can use fiscal policy to provide support to the domestic economy when deemed necessary.

Overall, this study demonstrates Hong Kong's macroeconomic resilience. Flexible labour markets and strong net asset positions of both the private sector and the public sector render the Hong Kong economy considerable capacity to absorb adverse shocks.

Technical Appendix:
Major Equations in the Mainland and Hong Kong Blocks
of the Oxford Economic Forecasting Model

The *Oxford Economic Forecasting* (OEF) model is a global, general equilibrium model. It contains detailed specifications for eight most important economies including Mainland China with more than 250 equations for each of them. Around 36 countries are also modelled with varying degrees of detail. The country blocks have similar structures, and similar variables in key behavioural equations. There are also blocks of equations to describe the evolution of variables for the world as a whole, as well as for different geographic regions and different types of economies such as the OECD and emerging markets.

The rest of the Technical Appendix describes the major equations in the Mainland and Hong Kong blocks. A number of conventions are used in the equation listing. Lower-case letters indicate natural logarithms. Data are in quarterly frequency. The subscript t denotes the time. Δ indicates a first difference, and Δ_4 a change over four quarters ago. Most major behavioural equations are estimated in an error-correction form, and long-run relationships appear in square brackets. Seasonal dummies are not reported. A full list of variables is provides at the end of the equation listing.

The Mainland block

As one of the eight major economies in the OEF global model, Mainland China is modelled with a great deal of details. The block consists of the real economy, prices, the labour market, the banking and energy sectors.

1. Real output

GDP is modelled by the expenditure approach, breaking down to domestic demand (private consumption, government consumption and investment) and trade.

$$Y_t = DD_t + X_t - M_t$$

2. Domestic demand

(i) Domestic demand

$$DD_t = C_t + I_t + G_t$$

(ii) Private consumption

Private consumption is determined by real income, real financial wealth (mainly in the form of savings) and real interest rates. Real income has a significant role, influencing consumption directly or indirectly through the accumulation of income into financial wealth. Wealth held in the property or stock markets is not taken into account. Interest rates have relatively small effects.

$$\begin{aligned}\Delta_4 c_t = {} & 0.306\Delta_4 y_t^d + 0.276\Delta_4(w_{t-1}^f - p_{t-1}) - 0.002((0.500)(R_{t-1}^l + R_{t-1}^s) - \Delta_4 p_{t-1}) \\ & - 0.172[c_{t-4} - 0.900 y_{t-4}^d - 0.100(w_{t-4}^p - p_{t-4})]\end{aligned}$$

(iii) Investment

Unlike the investment equation for the OECD countries which is based on a Tobin's-Q type formulation, investment in Mainland China is modelled as the sum of funding sources, which include foreign direct investment, government funding, domestic loans and self-financing by businesses from profits and other funding sources.

$$I_t = I_t^{bud} + I_t^{fdi} + I_t^{loan} + I_t^{self}$$

Among the different sources, self-funding is the largest component. It is modelled as relating to the level of economic activity, the operating surplus as a proxy for self-financing potential, competitiveness, capacity utilisation and the lending rate.

$$\begin{aligned}\Delta_4 i_t^{self} = {} & -0.700 + 0.500\Delta_4 i_{t-1}^{self} + 0.050\Delta_4 \log(C_{t-1} + G_{t-1} + X_{t-1}) + 0.001\sum_{i=0}^{3} capu_{t-i} \\ & - 0.005\Delta_4(R_t^l - (100.000)(\pi_{t-1}^{ppi})) \\ & + (0.005)(100.000)(\sum_{i=0}^{3}(FFUNDS_{t-i} + NETPRO_{t-i}) / \sum_{i=0}^{3} Y_{t-i}) \\ & - 0.700[i_{t-4}^{self} - 0.964\log(C_{t-4} + G_{t-4} + X_{t-4}) + 0.114 wcr_{t-4} + 0.021 R_{t-4}^l]\end{aligned}$$

3. External trade

(i) Exports

The export equation is similar to that for other economies in that the key determinants are a demand variable (world demand for the Mainland exports) and competitiveness. The measurement of competitiveness is based on relative unit labour costs, which are affected by changes in wages and exchange rates in Mainland China as well as those in its trading partners. There are two additional variables in the model. Capacity utilisation -- measured by model estimates of the output gap -- has an inverse relation with exports. FDI to the Mainland has been rising very fast in recent years as foreign companies use Mainland China as a low cost production base. An FDI variable is included to capture the impact of fast growth of FDI which tends to be export-oriented.

$$\begin{aligned}\Delta_4 x_t = &-7.100 + 0.122\Delta_4 x_{t-1} + 1.559\Delta_4 wt_t - (0.003)(0.250)\sum_{i=0}^{3} capu_{t-i} \\ &- (0.002)(0.250)\sum_{i=4}^{7} capu_{t-i} \\ &- (0.100)(0.250)(\Delta_4 wcr_t + \Delta_4 wcr_{t-1} + \Delta_4 wcr_{t-3} + \Delta_4 wcr_{t-4}) \\ &- 0.691[(x_{t-4} - wt_{t-4} - fdi_{t-4} + 0.153 wcr_{t-4})]\end{aligned}$$

(ii) Imports

Imports consist of fuel imports, non-fuel retained imports and imports for re-exports. The final imports are directly taken as the half of the export volume. The equation for retained imports is broadly similar to the export equation, but with domestic demand as the demand variable. Capacity utilisation has a positive relationship with imports to reflect the need for more imports when resources of the economy are restrained. Competitiveness is measured as the relative price between imported and domestic products, and is also affected by changes in the exchange rates of the renminbi.

$$M_t = M_t^d + M_t^f + 0.500 X_t$$

$$\begin{aligned}\Delta_4 m_t^d = &-0.080 + 0.398\Delta_4 m_{t-1}^d + 1.162\Delta_4 dd_t - 0.182\Delta_4 (p_{t-1}^{mg} - p_{t-1}^{ppi}) - 0.100\Delta_4 e_t \\ &+ (0.003)(0.250)\sum_{i=0}^{3} capu_{t-i} + (0.002)(0.250)\sum_{i=4}^{7} capu_{t-i} \\ &- 0.411[m_{t-4}^d + 1.890 - dd_{t-4} + 0.300(p_{t-4}^{mg} - p_{t-4}^{ppi}) - 0.003 T_{t-4}]\end{aligned}$$

4. Prices

(i) Consumer prices

Consumer prices are a weighted average of fuel, agricultural and retail prices. Reflecting the changing composition in private consumption, agriculture prices – mainly the food component in the CPI basket -- carries a declining weighting. Retail prices have the largest, and an increasing, weighting.

$$P_t = 0.050P_t^{fu} + (0.150/T_t)P_t^{agr} + (0.950 - (0.150/T_t))P_t^{rpi}$$

(ii) Agriculture prices

Agriculture prices are affected by earnings, employment and production costs:

$$\begin{aligned}\Delta_4 p_t^{agr} &= 0.500\Delta_4 p_{t-1}^{agr} + (0.200/T_t)(\Delta_4 eru_{t-1} + \Delta_4 eru_{t-2}) + (0.200/T_t)\Delta_4 etu_{t-1} \\ &\quad + 0.100 p_t^{ppi} - 0.250[(p_{t-4}^{agr} - p_{t-4}^{ppi})]\end{aligned}$$

(iii) Retail prices

Retail prices are related to a range of prices including fuel, agriculture and industrial prices.

$$\begin{aligned}\Delta_4 p_t^{rpi} &= 1.550 + 0.200\Delta_4 p_{t-1}^{rpi} + 0.050\Delta_4 p_t^{fu} + 0.350\Delta_4 p_t^{agr} + 0.400\Delta_4 p_t^{ppi} \\ &\quad + 0.100\Delta_4(pop_t^u - pop_t) - 0.350[p_{t-4}^{rpi} + 0.100 p_{t-4}^{fu} \\ &\quad - (0.500/T_{t-4})p_{t-4}^{agr} + (0.900 - 0.500/T_{t-4})p_{t-4}^{ppi}]\end{aligned}$$

(iv) Industrial prices

As a key price driver in the model, industrial prices are determined by capacity utilisation, costs for non-labour inputs and unit labour costs:

$$\begin{aligned}\Delta_4 p_t^{ppi} &= -1.300 + 0.100\Delta_4 p_{t-1}^{ppi} + 0.150\Delta_4 p_{t-2}^{ppi} + 0.300\Delta_4 p_{t-3}^{ppi} + 0.250\Delta_4 p_{t-4}^{ppi} \\ &\quad + 0.100(\Delta_4 er_t + \Delta_4 er_{t-1}) + 0.100(\Delta_4(et_{t-4} - y_{t-4}) + \Delta_4(et_{t-8} - y_{t-8})) \\ &\quad + 0.100(\Delta_4 nlc_t - \Delta_4 nlc_{t-4}) + (0.003)(0.250)\sum_{i=0}^{3} capu_{t-i} \\ &\quad - 0.200[p_{t-4}^{ppi} - 0.750(er_{t-4} + et_{t-4} - y_{t-4}) - 0.250 nlc_{t-4}]\end{aligned}$$

5. Interest rates

Interest rates are modelled as a mark-up over the US interest rate:

$$R_t = Max(0.500, (0.100R_t^{FED,US} + (100.000)(0.500)(\pi_{t-1} + \pi_{t-4} - 2.000)))$$

Hong Kong block of equations

The equation block modelling the Hong Kong economy shares many features with the Mainland block, but also has its distinctive features to reflect the economy's characteristics.

1. Real output

GDP is also modelled by the expenditure approach:

$$Y_t = DD_t + X_t - M_t$$

2. Domestic demand

(i) Domestic demand

$$DD_t = C_t + I_t + G_t$$

(ii) Private consumption

Apart from disposable income, financial wealth and real interest rates, the variable of property prices is also included in the private consumption equation to reflect the importance of housing wealth in determining consumer behaviour in Hong Kong. Interest rates have a bigger economic impact in Hong Kong than in the Mainland.

$$\begin{aligned}\Delta c_t = {} & 0.211 + 0.261\Delta(w_t^p - p_t^c) - 0.281\Delta(w_{t-1}^p - p_{t-1}^c) - 0.002\Delta R_t \\ & - 0.092[c_{t-1} - 0.600y_{t-1}^d - 0.250(w_{t-1}^p - p_{t-1}^c) - 0.150(w_{t-1}^f - p_{t-1}^c) + 0.003RR_{t-1}]\end{aligned}$$

(iii) Investment

Investment is split into spending on buildings and construction and business investment on machinery, equipment and computer software.

$$I_t = I_t^g + I_t^{bus} + I_t^{res}$$

(iv) Business investment

The equation for business investment follows a Q-theory where Q is defined as the marginal product of capital relative to the interest rate. Profit maximising firms invest when the marginal return is greater than replacement cost (Q>1).

$$\Delta_4 i_t^{bus} = -1.305 - 0.285(i_{t-4}^{bus} - k_{t-4}) + 0.013QR_{t-4}$$

(v) Investment on buildings and construction

Spending on buildings and construction is determined by interest rates, property prices and population:

$$\Delta_4 i_t^{res} = -5.260 + 0.500\Delta(p_{t-1}^{prop} - p_{t-1}^{c}) - 0.010\Delta RR_{t-1} - 0.020\Delta RR_{t-2} - 0.500[(i_{t-1}^{res} - pop_{t-1} - y_{t-1})]$$

3. External trade

(i) Exports

Reflecting Hong Kong's *entrepôt* status, merchandise exports are decomposed into domestic exports, re-exports and exports of services.

$$X_t = X_t^g + X_t^s$$

$$X_t^g = X_t^{dg} + X_t^{rg}$$

(ii) Domestic exports

Domestic exports are determined by competitiveness and world trade:

$$\Delta x_t^{dg} = 1.000 + 0.450\Delta wt_t + 0.254\Delta wt_{t-1} - 0.100\Delta wcr_t - 0.146[(x_{t-1}^{dg} - wt_{t-1} + 0.350wcr_{t-1})]$$

(iii) Re-exports

In the re-exports equation, the Mainland's total trade volume (exports plus imports) is the key determinant, carrying higher coefficients both in the short and long run than the variable measuring competitiveness.

$$\Delta x_t^{rg} = 0.900 + 0.164\Delta x_{t-1}^{rg} + 0.570\Delta trade_t^{CN} - 0.160[(x_{t-1}^{rg} - trade_{t-1}^{CN} + 0.050 wcr_{t-1})]$$

$$TRADE_t^{CN} = X_t^{CN} + M_t^{CN}$$

(iv) Exports of services

Exports of services consist of trade-related exports, which grow growing along with merchandise trade, and the rest. Non-trade-related exports are affected by world demand and the relative price between export and import services.

$$X_t^s = X_t^{nts} + (X_t^g + X_{t-1}^g)/15.000$$

$$\Delta x_t^{nts} = -0.050 + 1.894\Delta y_{t-1}^w - 1.114\Delta(p_t^{xs} - p_t^{ms}) - 0.127[x_{t-1}^{nts} - y_{t-1}^w + 0.800(p_{t-1}^{xs} - p_{t-1}^{ms}) + 0.020T_t\ ]$$

(v) Imports

Imports are also disaggregated into imports of services, retained imports and imports for re-exports. The final component is determined by re-exports, and hence affected by the Mainland's trade performance.

$$M_t = M_t^g + M_t^s$$

$$M_t^g = M_t^{fu} + M_t^{retain} + M_t^{rg}$$

(vi) Non-fuel retained imports

Retained imports are related to domestic demand and the competitiveness variable:

$$\Delta m_t^{retain} = -1.430 + 1.437\Delta\log(X_t^{dg} + DD_t) - 0.565[(m_{t-1}^{retain} - \log(X_{t-1}^{dg} + DD_{t-1}) - 0.150 wcr_{t-1})]$$

(vii) Imports of services

Imports of services are determined by total demand – proxied by GDP – and the relative price between export and import services:

$$\Delta m_t^s = -1.453 - 0.108\Delta m_{t-1}^s + 0.208\Delta y_t$$
$$- 0.299[m_{t-1}^s - 1.200 y_{t-1} + 0.200(p_{t-1}^{ms} - p_{t-1}^{xs})]$$

4. Prices

(i) Consumer prices

Consumer prices are deposed into three components – rental costs, fuel prices, and other prices.

$$P_t = 0.025P_t^{fu} + 0.050RENT_t + 0.925P_t^{nfu}$$

(ii) Rental costs

Rental costs are determined by total earnings, property prices and population.

$$\Delta rent_t = 0.122 + 0.500\Delta p_t^{prop} + 0.250(\Delta et_t + \Delta er_t)$$
$$- 0.150[rent_{t-1} - \log((0.1)(R_{t-1}^{lt})(P_{t-1}^{prop})) + 0.500(w_{t-1}^p - pop_{t-1}) - 0.005T_t\ ]$$

(iii) Prices excluding fuel and rents

Prices excluding fuel and rents are positively related to economic growth, prices of non-fuel retained imports and the domestic demand deflator:

$$\Delta p_t^{nfu} = 0.010 + 0.211\Delta p_{t-1}^{nfu} + 0.100\Delta p_t^{mrg} + 0.307\Delta p_t^{dd} + 0.100\Delta p_t^{ppi}$$
$$+ \Delta\log(TR_t + 1.000) + 0.050(g_t + g_{t-1})$$
$$- 0.154[p_{t-1}^{nfu} - 0.300 p_{t-1}^{mrg} - 0.500 p_{t-1}^{dd} - 0.200 p_{t-1}^{ppi} - \log(TR_{t-1} + 1.000)]$$

5. Interest rates

Interest rates equal to their US counterparts plus the risk premium. The latter is measured as the sum of the premium paid for foreign debt and the probability of devaluation for the Hong Kong dollar.

$$R_t = Max(0.500, (R_t^{US} + R_t^{risk}))$$

$$R_t^{risk} = R_t^{emc} + (0.500)(100.000)(PROBDEV_t)(EERI_t / 115.000 - 1.000)$$

List of Variables

Name	Description
C	Real private consumption
CA	Current account balance
$CAPU$	Capacity utilization
DD	Real domestic demand
E	Bilateral exchange rate between the renminbi and US dollar
$EERI$	Effective exchange rate
ER	Average earnings of the whole economy
ERU	Average urban earnings per employee
ET	Total employment
ETU	Urban employment
FDI	Cumulative foreign direct investment
$FFUNDS$	Enterprises' self-raised funds for investment
G	Real government expenditure
I	Real total investment
I^{bud}	Real investment funded by government budget (Mainland)
I^{bus}	Real private sector investment on machinery and equipment
I^{fdi}	Real investment funded by foreign capital flows
I^{g}	Real government investment (Hong Kong)
I^{loan}	Real investment funded by loans
I^{res}	Real investment on buildings and construction
I^{self}	Real investment funded by all other sources
K	Real capital stock
M	Real imports (appear in the Mainland block)
M^{CN}	Mainland China's real imports (appear in the Hong Kong block)
M^{fu}	Fuel imports
M^{g}	Imports of goods
M^{retain}	Non-fuel retained imports of goods
M^{rg}	Real imports of goods for re-exports
M^{s}	Real imports of services
$NETPRO$	Profits net of interest payments
NLC	Cost index for non-labour inputs
P	Consumer price index

P^{agr}	Purchasing price index for agricultural products
P^{c}	Deflator for consumption indicator
P^{dd}	Deflator for domestic demand
P^{fu}	Fuel component of the consumer price index
P^{m}	Import price
P^{mrg}	Import price of non-fuel retained goods
P^{ms}	Import price of services
P^{nfu}	Consumer price index exclude fuel and rents
P^{ppi}	Producer price index
P^{prop}	Property price index
P^{rpi}	Retail price index
P^{xs}	Export price of services
π	CPI inflation
π^{ppi}	Producer price inflation
POP	Total population
POP^{u}	Urban population
$PROBDEV$	Probability of devaluation
QR	Relative returns on physical capital (Tobin's Q)
R	Key short-term interest rate
R^{emc}	Risk premium for emerging economies (excluding currency risk)
$R^{FED,US}$	US federal funds rate
R^{l}	Interest rate on loans or bank lending
R^{lt}	Long-term interest rate
R^{risk}	Risk premium associated with exchange rate
R^{s}	Interest rate on 1-year savings deposits
R^{US}	Key short-term interest rate of US
$RENT$	Property rentals
RR	Real interest rate of personal sector
T	Time trend
TR	Effective tax rate
$TRADE^{CN}$	Total trade of Mainland China (appear in the Mainland block)
W^{f}	Net financial wealth of personal sector
W^{p}	Housing wealth
WCR	Relative wage cost index
WT	World trade index

X	Real exports
X^{CN}	Real exports of Mainland China (appear in the Hong Kong block)
X^{dg}	Real domestic exports of goods
X^{g}	Real exports of goods
X^{nts}	Real exports of non-trade-related services
X^{rg}	Real re-exports
X^{s}	Real exports of services
Y	Real GDP
Y^{d}	Real household disposable income
Y^{w}	Real world GDP
YC	Year-on-year rate of change in real GDP