Southeast Asian Studies, Vol. 17, No. 2, September 1979

The ERC Forecasting Model of the Hong Kong Economy

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I Introduction

This paper presents a brief discussion of the ERC model of the Hong Kong economy and a summary of preliminary forecasts and simulations obtained from it. The ERC model is a yearly econometric forecasting model consisting of 45 simultaneous equations with 45 endogenous variables and about 60 predetermined variables. Each equation is linear in parameter, but the model itself is a non-linear system. Since the model is a simultaneous system, we cannot obtain consistent estimators of the parameters by the Ordinary-Least-Squares (OLS) method. Instead, we have employed the Two-Stage-Least-Squares (2SLS) technique. The first-stage results have been estimated by using the first four principal components of the predetermined variables, which account for 97% of the total variation.

Due to the non-linear nature of the model, the iterative procedure has to be employed to solve the system. Both the Newton-Raphson and the Gauss-Seidel iteration methods have been experimented. Finally, we have chosen the latter in regard of its economy in machine time and computer memory requirements. To speed up the convergence of the solutions, we have arranged the equations in an approximately recursive form. In some instances, the solutions did not converge. We then either had to look into the initial values assigned to the system, or to proceed with the 'normalization' process by re-arranging terms in some particular equations.

We have used both the usual dummy variables and the linear splines[1] to take care of structural changes. For example, if there is a structural change in the jth year, we then define the following transformed variables: $t_1=t$; $t_j=\max(t-\bar{t}_{j-1}, 0)$ where t is the vector of time trend $(1, 2, 3, \ldots, n)$, and $\bar{t}_{j-1}$ is the $(j-1)$th element in this vector. These variables, or the splines, are then regarded as independent variables in the regression. This technique improves our results in quite a number of equations, especially

* The Chinese University of Hong Kong, Shatin, N. T., Hong Kong. The author is particularly indebted to Mr. Franics Lui, for compiling the data and carrying out the actual calculation work. His thanks also go to Professors Mo-huan Hsing, Lawrence J. Lau and Dr. Win-lin Chou for their valuable comments and suggestions.

1) See [35] for a detailed discussion of the splines.

when the number of splines in a single equation is not very large and consequently the degree of freedom problem does not cause great difficulties.

The data of the model are obtained primarily from the Hong Kong Government publications, such as the *Estimates of GDP* [46], the *Monthly Digest of Statistics* [49] and the *Economic Background of the Budget Speech* [45]. Some data, however, have to be obtained directly from the Census and Statistics Department of the Hong Kong Government. Finally, the data on quite a number of the predetermined variables were compiled by the ERC staff.

II Discussion of Equations

Some of the equations in the model represent accounting identities, for which no statistical estimation was required. Since the purpose of our model is macroeconomic forecasting, the model contains several basic macroeconomic variables — *GDP*, consumption, investment, price level, and money supply, etc. The specification of our model involves a considerable degree of interrelationship among these variables. In this section, we discuss briefly the estimation of the basic equations.[2)]

Private Consumption Expenditure

There are two equations specified in the ERC model concerning consumption expenditures, namely, consumption expenditures on non-durable and on durable goods. Personal disposable income (Y) was not used directly to explain private consumption expenditure on non-durable goods (*CPND*) because its estimated t-value was too low. Instead, the changes in disposable income (ΔY) and its lagged value (ΔY_{-1}) are included as explanatory variables. A two-year summation of lagged *CPND* is also one of the explanatory variables. In addition, money supply $M1$ (demand deposit and currency) is included and found to have positive effect on *CPND*. Splines are used to account for a change in propensity to consume for non-durable goods in 1977. The significant coefficients of splines indicate a shift in propensity to consume.

Private consumption expenditure of durable goods (*CPD*) depends significantly on lagged personal disposable income. The sign of stock of durable goods is negative, which is consistent with theoretical expectation. During recession years, *CPD* drops a good deal. However, after the recession, it rises rapidly because consumers are trying to compensate for the previous decrease in purchase. This phenomenon is observed only for the durable goods but not for the non-durables. The dummies in the equation take care of these structural changes. Imported goods under SITC 5 to 9 lagged by one year ($M59_{-1}$) are also found to be related significantly to *CPD*, indicating that the supply of durable

2) See Section III for the estimated equations.

goods can help to determine their consumption.

Private Investment

Private investment in building and construction sector (*IPBC*), as expected, depends negatively on the stock of buildings. Moreover, the *t*-tests are all very significant. We have added a dummy to explain the high rate of capital accumulation in this sector in some years, since *IPBC* in Hong Kong is very much influenced by non-economic, political factors.

Similarly, private investment in land and in producer durables (*IPPL*+*IPPD*) depends also on income and stock. $M\,59_{-1}$, which represents the supply factor, again helps determine the amount of investment. The best lending interest rate has a correct negative sign in the equation, but the estimated *t*-value is not very significant.

The Foreign Sector

Export of goods (*EC*) is rather sensitive to the volume of world trade (*VWT*). In recession years, it drops sharply. The sign of the effective exchange rate index is negative in equation (7), showing that when the Hong Kong dollar is strong, the demand for exported goods decreases. The positive relation between *M59* and *EC* may be explained by the fact that in order to import machines, the manufacturers must have a large amount of remaining orders and be confident of future sales of their products to foreign countries.

The effective exchange rate index (*EX*) equation (see equation 45) caused many problems in the estimation, partly because Hong Kong does not have complete data on the balance of payments account. Consequently, we used only the interest rate differential between Hong Kong and the United States to explain the capital movement. The signs of export and import obtained are nearly always opposite to the acceptable ones. Finally, 3 splines have been used to reverse the signs of import and export. The estimated equation now has all the estimated coefficients with signs which agree with prior expectations.

Total import (*M*) consists of imported goods (*MC*) and services (*MS*). *MC* is further disaggregated into *M 01*, *M 24*, *M 3*, and *M 59*, which in turn are estimated separately. The explanatory variables included are import prices, the lagged imports, gross domestic product and lagged output of the manufacturing sector. The signs are all correct. In estimating *M 01*, we also add the population (*N*) in the equation because consumption of goods depends very much on the number of people in Hong Kong. In *MS* equation, lagged imported services and income are used as explanatory variables.

The Money Sector

Currency in Hong Kong has been increasing rapidly for a long period. However, in the recession year of 1974, it dropped significantly. In equation (39), we used only the lagged currency

and the spline for 1974 as explanatory variables.

The time, savings and demand deposits are all positively related to their lagged values, respectively. Interest rate of 12-month time deposit (i_t) is used to explain different types of deposits. However, in the case of savings deposits, the sign of the interest rate was found to be negative which did not agree with our prior expectation, thus this explanatory variable was dropped from savings deposits equation. For demand deposits, the sign of time deposit interest rate is negative. This seems to indicate that when the latter is high, people are willing to decrease their demand deposits and increase their time deposits in order to earn more interest.

The Manufacturing Sector

Value added in the manufacturing sector (XM) is estimated by using the number of people employed, the capital stock available, and the real wage of the workers as explanatory variables. Their effects on XM are all significantly positive.

Value added in the manufacturing sector (XM), exports of goods (EC) and wage rate in the manufacturing sector (WMF) are found to be the three major factors determining the employment in manufacturing sector (NIM) (see equation 22). The economy of Hong Kong depends very much on its exports. Therefore, when EC is high, NIM is bound to increase. The sign for WMF is negative, so that a negatively sloping demand curve is observed in the Hong Kong labour market.

III The Estimated Model

Equations and Identities of the Forecasting Model

			R^2	Se	DW
1)	$CPND$	$= \underset{(3.5268)}{3.4377} + \underset{(1.6396)}{0.1677}\,(CUR+DD)$	0.9969	0.2783	3.0813
		$+ \underset{(0.3804)}{0.0557}\sum_{i=1}^{2} CPND_{-i} + \underset{(1.2058)}{0.3315}\Delta Y$			
		$+ \underset{(0.4467)}{0.0887}\Delta Y_{-1} + \underset{(2.1883)}{1.3423}\,t_{16} + \underset{(3.0521)}{0.5034}\,t_1$			
2)	CPD	$= \underset{(-1.8276)}{-0.2543} + \underset{(3.7935)}{0.3694}\,d_4 - \underset{(-4.3624)}{0.2756}\,d_1$	0.9909	0.0779	1.4791
		$+ \underset{(3.3923)}{0.1554}\,Y_{-1} - \underset{(-2.6957)}{0.2875}\,KPD$			
		$+ \underset{(3.9410)}{0.1114}\,M59_{-1}$			
3)	CP	$= CPND + CPD$			

			R^2	Se	DW
4)	$IPBC$	$= 0.4677 + 0.0894\ Y - 0.2074\ KPBC_{-1}$ $(6.3299)\ (4.8883)\ (-3.7154)$ $+ 0.1192\ d_2$ (1.9573)	0.8378	0.0955	1.0262
5)	$IPPL+IPPD$	$= 0.2433 - 0.0916\ KPPD$ $(0.7790)(-1.1689)$ $+ 0.0598\ Y + 0.1816\ M59_{-1}$ $(1.0950)\ (4.9765)$ $- 0.0321\ i_p$ (-1.0837)	0.9805	0.1233	2.4229
6)	CF	$=(IPPL+IPPD+IPBC)+I_g$			
7)	EC	$= 1.2217 + 0.0453\ VWT$ $(0.2279)\ (1.8650)$ $- 1.3787\ d_6 - 2.9417\ EX + 0.4419\ M59$ $(-1.5114)\ (-0.5526)\ (1.2046)$	0.9934	0.4873	1.2455
8)	ES	$= 1.8874 + 0.1686\ SW$ $(9.3832)\ (7.8855)$ $- 0.8601\ PWE/P + 0.2454\ d_5$ $(-3.5244)\ (3.4920)$	0.9024	0.0888	1.3455
9)	E	$=1.05(EC+ES)$			
10)	$M\ 01$	$= - 2.6563 - 0.6071\ PM\ 01$ $(-7.4382)(-10.5732)$ $+ 0.2102\ WMF + 1.4417\ N$ $(4.2906)\ (12.9313)$	0.9951	0.0381	9.2547
11)	$M\ 24$	$= 1.6207 + 0.0226\ XM_{-1}$ $(3.7475)\ (0.4337)$ $- 0.1419\ PM\ 24/P - 1.0061\ M\ 24_{-1}$ $(-0.2889)\ (-4.3368)$ $+ 0.1442\ t_1 - 0.0393\ t_{10} + 0.4386\ t_{15}$ $(5.2110)\ (-1.2768)\ (5.3827)$	0.9867	0.0637	4.6802
12)	$M\ 3$	$= 0.0746 + 0.0695\ XM_{-1} + 0.2425\ M3_{-1}$ $(4.6698)\ (6.3603)\ (1.9383)$	0.9900	0.0202	1.5848
13)	$M\ 59$	$= 3.8062 + 0.3350\ GDPMP$ $(0.5281)\ (0.6348)$ $- 4.5261\ PM\ 59/P + 0.3810\ M\ 59_{-1}$ $(-0.5142)\ (1.4721)$ $+0.2627\ t_1 - 1.8706\ t_{13} + 2.5583\ t_{14}$ $(0.5903)\ (-1.6767)\ (1.4633)$	0.9862	0.0964	2.1377
14)	MC	$=M\ 01+M\ 24+M\ 3+M\ 59$			
15)	MS	$= - 0.2183 + 0.0291\ Y + 1.0218\ MS_{-1}$ $(-3.3376)\ (2.2496)\ (10.1287)$	0.9906	0.0694	1.3923
16)	M	$=MC+MS$			
17)	$GDPMP$	$=CP+CG+CF+(E-M)$			
18)	$GDPFC$	$=GDPMP-TI$			
19)	$NDPFC$	$=GDPFC-DC$			

			R^2	*Se*	*DW*
20)	*Y*	$=NDPFC-TD+GS$			
21)	*GDPP*	$=0.11\sum_{i=1}^{5}0.89^{i}GDPMP_{-i}$			
22)	*NIM*	$=\underset{(19.3342)}{0.5502}+\underset{(3.9669)}{0.0431}\,XM+\underset{(2.3264)}{0.0143}\,EC$ $-\underset{(-4.7214)}{0.1770}\,WMF+\underset{(1.6302)}{0.0088}\,t_1$ $+\underset{(3.8343)}{0.0341}\,t_{11}$	0.9818	0.0124	2.3514
23)	*XM*	$=\underset{(-5.3975)}{-8.5618}+\underset{(4.3091)}{11.0234}\,NIM$ $+\underset{(3.0129)}{3.6414}\,\frac{WMF}{PC}+\underset{(2.7919)}{0.5505}\,KPPD$ $-\underset{(-1.7743)}{0.2976}\,t$	0.9865	0.2860	1.1714
24)	*KP*	$=XM/XMC$			
25)	*WMF*	$=\underset{(1.2878)}{0.3596}+\underset{(2.5764)}{0.6966}\,WMF_{-1}$ $+\underset{(0.7020)}{0.0249}\,t_1+\underset{(1.1583)}{0.0636}\,t_6+\underset{(1.0555)}{0.0654}\,t_{13}$	0.9920	0.1180	1.4343
26)	$\ln XMC$	$=\underset{(0.5083)}{1.1848}+\underset{(0.3188)}{0.2419}\,\ln KPPD$ $+\underset{(0.3597)}{1.2847}\,\ln NIMC+\underset{(1.6540)}{0.2539}\,\ln t$	0.9454	0.1161	0.0275
27)	*NIMC*	$=0.18\,N$			
28)	*XBCCY*	$=\underset{(-0.3390)}{-0.0270}-\underset{(-2.2872)}{0.0675}\,KPBC$ $+\underset{(1.3082)}{0.0180}\,GDPFC+\underset{(3.2341)}{0.1927}\,IPBC_{-3}$ $+\underset{(2.1205)}{0.1397}\,IPBC_{-2}+\underset{(0.0721)}{0.0011}\,t_1$ $-\underset{(-3.7939)}{0.0653}\,t_{14}$	0.8795	0.2333	2.7819
29)	*WBC*	$=\underset{(-1.7456)}{-0.6948}+\underset{(1.7361)}{1.1510}\,IPBC$ $+\underset{(3.4816)}{0.6145}\,WBC_{-1}+\underset{(2.5914)}{0.1208}\,t$	0.9766	0.2807	1.1228
30)	*P*	$=\underset{(-0.1060)}{-0.0062}+\underset{(1.8273)}{0.2074}\,PIM-\underset{(-2.8861)}{0.0862}\,d_7$ $+\underset{(5.6262)}{0.8038}\,P_{-1}+\underset{(2.1256)}{0.0123}\,t$	0.9945	0.0375	1.4060
31)	*PC*	$=\underset{(6.5234)}{0.2847}+\underset{(6.9011)}{0.5003}\,PIM+\underset{(8.0830)}{0.1965}\,WMF$	0.9947	0.0320	2.1593
32)	*PM*	$=\underset{(9.1706)}{0.4082}+\underset{(1.2999)}{0.1663}\,P+\underset{(3.0025)}{0.5049}\,PM\,59$	0.9776	0.0386	0.5539

			R^2	Se	DW
33)	PRA	$= -0.0229 + 0.5469\ P + 0.4927\ PRA_{-1}$ $(-0.3375)\ \ (2.4196)\ \ \ (1.8837)$	0.9796	0.0647	0.6161
34)	PE	$= -1.5342 + 1.9660\ PM - 0.0963\ t$ $(-8.7855)\ \ (10.3432)\ \ \ (-4.3998)$ $+ 0.0058\ VWT - 0.0561\ d_3$ $(3.7931)\ \ \ \ (-0.9010)$	0.9901	0.0514	2.4821
35)	$DT/GDPP$	$= -0.1325 + 0.1053\ i_t$ $(-0.6145)\ \ (3.4876)$ $+ 0.3597\ \left(\frac{DT}{GDPP}\right)_{-1} + 0.2500\ CUR$ $(1.9576)\ (3.4109)$	0.9619	0.1306	1.2151
36)	$DS/GDPP$	$= 0.2826 - 0.2829\ CUR$ $(1.7064)\ \ (-0.9222)$ $+ 0.7254\left(\frac{DS}{GDPP}\right)_{-1} + 0.3277\ t_{14}$ $(1.5519)\ (3.2542)$ $+ 0.1006\ t_1$ (2.2139)	0.9722	0.1413	1.6707
37)	$DD/GDPP$	$= 0.6791 + 0.6221\ (DD/GDPP)_{-1}$ $(4.5847)\ \ (2.9871)$ $- 0.0977\ i_t + 0.0298\ t_1 + 0.0140\ t_{11}$ $(-4.5489)\ \ \ (3.3067)\ \ \ (0.4690)$	0.9599	0.0812	2.1496
38)	D	$= DD + DT + DS$			
39)	CUR	$= 0.3311 + 0.0698\ t_1 + 0.7067\ CUR_{-1}$ $(1.2878)\ \ (1.0317)\ \ \ (2.1445)$ $+ 0.2587\ t_{13}$ (2.3586)	0.9864	0.1949	1.8600
40)	TI	$= 0.2174 + 0.0124\ GDPMP$ $(3.9280)\ \ (1.2684)$ $+ 0.0934\ KPBC - 0.1952\ d_6$ $(2.3232)\ \ \ \ \ (-3.8538)$	0.8967	0.0629	1.9686
41)	TD	$= -0.2254 + 0.0693\ GDPFC_{-1}$ $(-5.1139)\ \ (20.0527)$	0.9664	0.0604	0.4576
42)	$KPPD$	$= \sum_{i=1}^{15} 0.8578^i IPPD_{-i}$			
43)	KPD	$= \sum_{i=1}^{10} 0.7943^i CPD_{-i}$			
44)	$KPBC$	$= \sum_{i=1}^{20} 0.8912^i IPBC_{-i}$			
45)	EX	$= 1.1827 + 1.1255\ \frac{E-M}{E+M}$ $(27.2344)\ \ (2.9380)$ $- 0.0106\ USID - 0.0163\ t_1$ $(-1.2332)\ \ \ \ \ (-4.4173)$ $+0.0416\ t_{10} - 0.0505\ t_{16}$ $(6.1833)\ \ \ (-1.7965)$	0.8504	0.0161	1.8824

Note: Values in parentheses are estimated t-values, R^2=Coefficient of determination, Se=Standard error of estimate, DW=Durbin-Watson statistic

Variables Used in the Forecasting Model

Endogenous Variables

(1) — *CPND*: Private consumption expenditure on consumer non-durables in 1961 dollar

(2) — *CPD*: Private consumption expenditure on consumer durables in 1961 dollar

(3) — *CP*: Private total consumption expenditure in 1961 dollar

(4) — *IPBC*: Annual capital formation in private building and construction sector in 1961 dollar

(5) — *IPPD*+*IPPL*: Annual capital formation in private machinery and equipment sector plus that in land in 1961 dollar

(6) — *CF*: Total capital formation (private and government) in 1961 dollar

(7) — *EC*: Export of goods in 1961 dollar

(8) — *ES*: Export of services in 1961 dollar

(9) — *E*: Total export of goods and services in 1961 dollar

(10) — *M 01*: Import of goods under SITC 0 and 1 in 1961 dollar

(11) — *M 24*: Import of goods under SITC 2 and 4 in 1961 dollar

(12) — *M 3*: Import of goods under SITC 3 in 1961 dollar

(13) — *M 59*: Import of goods under SITC 5 to 9 in 1961 dollar

(14) — *MC*: Import of goods in 1961 dollar

(15) — *MS*: Import of services in 1961 dollar

(16) — *M*: Total import of goods and services in 1961 dollar

(17) — *GDPMP*: Gross domestic product at market price in 1961 dollar

(18) — *GDPFC*: Gross domestic product at factor cost in 1961 dollar

(19) — *NDPFC*: Net domestic product at factor cost in 1961 dollar

(20) — *Y*: Personal disposable income in 1961 dollar

(21) — *GDPP*: Permanent gross domestic product in 1961 dollar

(22) — *NIM*: Labor employed in manufacturing sector

(23) — *XM*: Value added in manufacturing sector in 1961 dollar

(24) — *KP*: Index of capacity utilization, 1961=100

(25) — *WMF*: Wage rate index (including fringe benefits) for manufacturing workers in 1961 dollar

(26) — *XMC*: Maximum gross output originating in manufacturing sector, in 1961 dollar

(27) — *NIMC*: Labor force available in manufacturing sector

(28) — *XBCCY*: Gross output originating in building and construction sector in 1961 dollar

(29) — *WBC*: Wage index in building & construction sector, 1961=100

(30) — *P*: Implicit *GDP* deflator, base year=1961

(31) — *PC*: General consumer price index, 1961=100

(32) — *PM*: Domestic price index for manufacturing goods, 1961=100

(33) — *PRA*: Rent index, 1961=100

(34) — PE: General export price index, 1961=100

(35) — DT: Time deposit in current dollar

(36) — DS: Savings deposit in current dollar

(37) — DD: Demand deposit in current dollar

(38) — D: Total deposits (time, savings and demand) in current dollar

(39) — CUR: Currency (government and Bank issues) in current dollar

(40) — TI: Indirect tax in 1961 dollar

(41) — TD: Direct tax in 1961 dollar

(42) — $KPPD$: Stock of private investment in machinery and equipment in 1961 dollar

(43) — KPD: Stock of consumer durables in 1961 dollar

(44) — $KPBC$: Stock of private investment in building and construction sector in 1961 dollar

(45) — EX: Effective exchange rate of HK dollar, 1971=100

Predetermined Variables

(46) — CG: Government consumption expenditure in 1961 dollar

(47) — CP_{-1}: Lagged private total consumption expenditure in 1961 dollar

(48) — CUR_{-1}: Lagged amount of currency in current dollar

(49) — DC: Depreciation cost of private investment in 1961 dollar

(50) — DD_{-1}: Lagged demand deposit in current dollar

(51) — DS_{-1}: Lagged savings deposit in current dollar

(52) — DT_{-1}: Lagged time deposit in current dollar

(53) — d_1: Dummy variable of political disturbance and recession

(54) — d_2: Dummy variable of high investment in building and construction sector

(55) — d_3: Dummy variable of years when exchange rate is rapidly falling

(56) — d_4: Dummy variable of some years following a recession

(57) — d_5: Dummy variable of good years of tourism

(58) — d_6: Dummy variable of recession

(59) — d_7: Dummy variable of years when P is pulled downward by very low PE

(60) — $GDPFC_{-1}$: Lagged gross domestic product at factor cost

(61) — $GDPP_{-1}$: Lagged permanent GDP in 1961 dollar

(62) — GS: Government subvention in 1961 dollar

(63) — I_g: Government investment expenditure in 1961 dollar

(64) — i_p: HK prime interest rate

(65) — $IPBC_{-1}$: Lagged annual capital formation in private building and construction sector in 1961 dollar

(66) — $IPBC_{-2}$: Annual capital formation in private building and construction sector in 1961 dollar lagged two years

(67) — $IPBC_{-3}$: Annual capital formation in private building and construction sector in 1961 dollar lagged three years

(68) — $IPPD_{-1}$: Lagged annual capital formation in private machinery and

equipment sector in 1961 dollar

(69) — IS: Short-term interest rate

(70) — IT: Long-term interest rate

(71) — $KPBC_{-1}$: Lagged stock of investment in building and construction in the private sector in 1961 dollar

(72) — $M\,3_{-1}$: Lagged import of goods under SITC 3 in 1961 dollar

(73) — $M\,59_{-1}$: Lagged import of goods under SITC 5 to 9 in 1961 dollar

(74) — MS_{-1}: Lagged import of services in 1961 dollar

(75) — N: Population

(76) — P_{-1}: Lagged implicit *GDP* deflator, 1961=100

(77) — $PM\,01$: Unit value index for imported goods under SITC 0 & 1, 1961=100

(78) — $PM\,24$: Unit value index for imported goods under SITC 2 and 4, 1961=100

(79) — $PM\,59$: Unit value index for imported goods under SITC 5 to 9, 1961=100

(80) — PIM: General import price index, 1961=100

(81) — PC_{-1}: Lagged general consumer price index

(82) — PRA_{-1}: Lagged rent index, 1961=100

(83) — PWE: Index of world export unit value, 1961=100

(84) — $RL\,2$: Rate of increase of $M\,2$ (money supply definition 2)

(85) — SW: Index of world tourist expenditure, 1961=100

(86) — t: Time trend

(87) — $USID$: US discount rate minus HK long term interest rate

(88) — VWT: Index of world trade volume

(89) — WBC_{-1}: Lagged wage rate index for building and construction workers

(90) — WMF_{-1}: Lagged wage rate index for manufacturing workers, 1961=100

(91) — XM_{-1}: Lagged gross output originating in manufacturing sector in 1961 dollar

(92) — Y_{-1}: Lagged personal disposable income in 1961 dollar

(93) — $Z\,2$: $(CPND_{-1})+(CPND_{-2})$

(94) to (109) — t_1 to t_{16}: Splines

IV Forecasts and Simulations

Apart from estimation and hypotheses testing, the ERC model is also used for forecasting, by which is meant the prediction of values of certain variables outside the observed sample period. A robustness test was given to see whether the model can reproduce statistics which occurred in the past. If the test results were satisfactory, the model will have the potential to produce the economic situation well in the future. Thus it can be used as an analytical tool for planning purposes. In this section, we discuss the methods we use to get the long-term forecasts[3] and simulations.

The method used to obtain forecasts is

3) Customarily, the long-term forecasts refer to time horizons in excess of five years.

to assign appropriate values to the predetermined variables and then solve the system of equations. There are two kinds of predetermined variables in the model, the lagged endogenous variables and the exogenous variables. We treat forecast values of the jth year as the lagged values of the $(j+1)$th year in making long-term projections. For the exogenous variables, we usually use time trend projections or assign them the values which were deemed most reasonable.

Although the values of lagged endogenous variables are determined by the solutions of the previous year, there are some freedom in assigning values to the exogenous variables. Since there are a large number of exogenous variables, we can make many different assumptions. To simplify the picture, for seven exogenous variables, namely, the government consumption expenditure (CG), government investment expenditure (I_g), volume of world trade (VWT), dummy variable of recession years (d_1), dummy variable of some years following recession (d_4), dummy variable of good years for the building and construction section (d_2), and the population of Hong Kong (N), we had the upper, medium and the lower estimates of each variable. To all the other exogenous variables only one set of values (which are assumed to be the most reasonable) is assigned. Different combinations of these assumptions form the bases of different forecasts and simulations. The forecast period is 1978–1985.

Assumptions on Some Exogenous Variables

The following assumptions are made to obtain the different estimates for the seven chosen exogenous variables.

1. CG: a) Upper estimate: It is assumed that CG increases at a rate of 10.7% every year which is equivalent to the average annual rate of increase between 1975 and 1977.
   b) Medium estimate: The annual percentage increase is 9.5% which is equivalent to the average annual increase from 1971 to 1977.
   c) Lower estimate: This is the time trend projection from 1971 onwards.
2. I_g: a) Upper estimate: It is assumed that the annual rate of increase is 20%.
   b) Lower estimate: This is the time trend projection using data from 1972 onwards.
3. VWT: a) Upper estimate: From 1978 to 1980, the increase is assumed to be 5% per year. From 1981 onwards, the increase is 6%.
   b) Medium estimate: The annual increase is assumed to be 5% throughout the entire period.
   c) Lower estimate: The annual increase is 5% throughout, except 1980 in which the growth rate is assumed to be zero.
4. d_1: a) Upper estimate: Assume there is no recession between

1978 and 1985.

b) Lower estimate: There is a recession in 1980.

5. d_4: a) Upper estimate: The value of 1 was assigned to 1981 and 1982, respectively.

b) Lower estimate: The variable takes on the value zero throughout the forecast period.

6. d_2: a) Upper estimate: The value of 1 was assigned to all the years following 1978.

b) Lower estimate: The value of 1 was only assigned to 1978, 1979 and 1980.

7. N: a) Upper estimate: We assume that the average rate of population increase is 2.2% per year.

b) Lower estimate: We use time trend projection which utilized data from 1962 onwards.

Table 1 outlines the 6 combinations of assumptions upon which our forecasts for the period of 1978 to 1985 are based. The results of each set of forecasts are also given in the subsequent tables.

Table 1 Combined Assumptions on Seven Chosen Exogenous Variables

Scenario	CG	I_g	VWT	d_1	d_4	d_2	N	Remark
I	M	L	M	U	L	L	U	Median estimate
II	M	L	U	U	L	L	U	Upper Median estimate. Only VWT is increased as compared to Scenario I.
III	M	U	U	U	L	L	L	Optimistic estimate. VWT, I_g are increased as compared to Scenario I. Population grows not so fast.
IV	U	U	U	U	L	U	L	Most optimistic estimate.
V	L	L	L	U	L	L	U	Minor recession. CG, I_g, VWT are decreased as compared to Scenario I.
VI	L	L	L	L	U	L	U	Pessimistic estimate.

L=Lower estimate. M=Median estimate. U=Upper estimate.

Discussion of Forecast Results

A. *Private Consumption Expenditure* (CP)

Table 2 Percentage Changes of CP in Different Scenarios

	$S1$	$S2$	$S3$	$S4$	$S5$	$S6$
1978	10.31	10.31	10.44	10.46	10.26	10.26
1979	8.72	8.72	9.04	9.08	8.60	8.60
1980	9.75	9.75	10.03	10.06	9.22	7.97
1981	10.00	10.08	10.41	10.50	9.11	11.90
1982	10.24	10.47	11.83	10.96	10.10	10.15
1983	10.00	10.23	10.67	10.67	9.94	9.58
1984	10.17	10.38	10.88	10.88	10.02	8.59
1985	10.98	10.09	10.68	10.71	9.63	9.55

$S1$: Under normal conditions, consumption of non-durables $CPND$ is very stable. It grows consistently at around 10% per year. In the case of durable goods, its consumption expenditure CPD is much more volatile. Historically, there had been a large decrease in CPD followed by a rapid rise. In this forecast, the relatively low 8.72% increase in total private consumption in 1979 is mainly due to the drop in CPD in that year. Since

the share of *CPND* in *CP* is very large, the latter is almost completely determined by the former. As a result, with the exception of 1979, *CP* is in general quite stable.

S 2: The effect of greater world trade volume (*VWT*) on *CP* becomes perceptible from 1981 onwards.

S 3 and *S* 4: These two optimistic scenarios are effective on *CP* because government consumption and investment are more directly related to the *CP* equation. *CP* grows at higher rates as compared with that in scenario *S* 1. Again the drop in *CPD* in 1979 causes *CP* to grow more slowly in that year. These two scenarios have similar effects, and the difference is trivial because *CG* represents only a very small part of the total economic activities.

S 5: Decreases in I_g, *VWT* and *CG*, as expected, have negative effects on the growth of *CP*. Compared with *S*1, the effect in 1981 is the strongest because *VWT* is assumed to have zero growth rate in 1980.

S 6: The negative effect is mostly felt in 1980, when the growth rate is merely 7.97%. Both non-durable and durable consumptions experience a slowdown in 1980. But a strong recovery is foreseen in 1981 mainly because people are compensating for their previous drop in durable goods consumption. In the subsequent years, the recovery is expected to continue.

B. *Capital Formation* (*CF*)

Table 3 Percentage Changes of *CF* in Different Scenarios

	*S*1	*S*2	*S*3	*S*4	*S*5	*S*6
1978	10.75	10.75	14.71	14.75	10.57	10.57
1979	6.77	6.77	9.54	9.63	6.41	6.41
1980	4.64	4.64	7.92	8.02	2.92	2.44
1981	3.85	4.14	8.14	9.98	1.18	1.57
1982	6.49	7.24	11.52	11.65	6.00	7.76
1983	6.55	7.31	12.08	11.67	6.54	6.36
1984	7.27	7.94	13.06	12.66	7.22	6.22
1985	6.94	7.53	13.14	12.90	6.65	5.61

S 1: The rate of Capital Formation (*CF*) declines from 1978 to 1981 mainly due to the decline of investment in building and construction. After 1982, the slower growth rate in the capital stocks of building and construction again pulls up investment in this sector. This, together with investment in other sectors, will increase total *CF* to the level of 6 to 7% annually.

S 2: The increase in the world trade will improve *CF*. But there is a lag of two years.

S 3: Increase in government investment (I_g) causes a big difference in *CF*. Generally speaking, the annual growth rate is about 4 to 5 points more compared with that in scenario *S* 2. Government investment may be an effective and direct way to increase total capital formation in Hong Kong.

S 4: As compared with the results of *S* 3, the growth rate is higher in the first five years up to 1982. After 1983, the large stock of investment

will gradually slow down the growth of *CF*.

S 5: A minor decline in *CG*, I_g and *VWT* triggers a substantial decrease in *CF* from 10.5% in 1978 all the way down to 1.18% in 1981. After 1982, it again climbs up to 6 to 7% growth level. Therefore, *CF* is sensitive to changes in this scenario, and is subject to the principle of acceleration.

S 6: The results are similar to those in *S* 5.

C. *Export E* ($E=EC+ES$)

Table 4 Percentage Changes of *E* in Different Scenarios

	*S*1	*S*2	*S*3	*S*4	*S*5	*S*6
1978	7.48	7.48	7.85	7.88	7.33	7.33
1979	6.03	6.03	6.34	6.38	5.91	5.91
1980	6.27	6.27	6.65	6.69	1.86	1.43
1981	7.05	7.91	8.32	8.53	6.75	7.76
1982	5.82	6.68	7.15	7.21	5.70	5.75
1983	6.59	7.45	7.98	7.97	6.59	6.45
1984	5.99	6.81	7.42	7.42	5.86	5.27
1985	6.66	7.45	8.12	8.15	6.54	6.50

S 1: Export remains at the 6 to 7% growth level with no significant fluctuations. Generally speaking, the visible export grows at a higher rate than that of the invisible export.

S 2: In terms of annual growth rate, it is generally about 10% higher than that of *S* 1 after 1981. In 1979, there is a slowdown in export performance. This implies the need for industrial diversification.

S 3: Increase in government investment (I_g) together with a population check will lead to higher growth rates in the total export. This phenomenon is demonstrated by the results in the Table 4.

S 4: The results are virtually identical to those of *S* 3. This indicates that the increase in *CG* does not have any great effect on export.

S 5: A minor recession caused by a decrease in the world trade volume and government total expenditure will lead to a rather drastic decrease in export, especially the commodity export. This declining growth stops in 1980 when the growth rate is merely 1.86%. After that year export performance, especially the visible part, is back to normal. This shows the high speed that Hong Kong industries can adjust to the world trade conditions.

S 6: The situation is similar to that of *S*5.

D. *Import M* ($M=MC+MS$)

Table 5 Percentage Changes of *M* in Different Scenarios

	*S*1	*S*2	*S*3	*S*4	*S*5	*S*6
1978	9.89	9.89	10.53	10.59	9.62	9.62
1979	6.31	6.31	6.84	6.92	6.08	6.08
1980	8.70	8.70	9.24	9.32	6.16	5.38
1981	7.97	8.42	9.09	9.47	7.14	8.87
1982	8.71	9.25	10.02	10.13	8.48	8.61
1983	8.10	8.63	9.53	9.52	7.90	7.68
1984	8.80	9.30	10.30	10.29	8.56	7.58
1985	8.20	8.68	9.85	9.89	7.83	7.73

S 1: There is a sign that total import may slow down in 1979, although its absolute magnitude is still increasing. For the remaining years, *M* is expected to grow steadily at

an average annual rate of 8%. *M* is the sum of visible and invisible imports. The former grows at around 8%, the latter at a much higher rate of around 13 to 15%. This implies that Hong Kong's residents will travel abroad increasingly and purchase services provided by foreign countries. *MC* consists of *M 01*, *M 24*, *M 3* and *M 59*. Among these four components, *M 24* is the most volatile one. Its growth rates range from −3.76% for 1979 to 23.50% in 1980.

S 2: Except for the magnitudes, the features of *S* 2 are essentially the same as those of *S* 1. After 1981 the growth rate is systematically higher. This is due to the assumed higher growth of world trade. The increase in *VWT* is 1% (from 5 to 6%). This leads to an additional increase in import of around 1/2% annually.

S 3: Both visible and invisible imports will go up as a result of government investment increase. The effect is about half to one percent for the growth of imports. However, the assumed absence of population pressure will slow down the import of food (*M 01*).

S 4: The situation is similar to that of *S* 3, except that the favorable effect is stronger in the first few years. The effects are almost indiscernible after 1983.

S 5: Reduction in the growth of *CG*, I_g and *VWT* can clearly lead to a drop in the growth of imports. Compared with *S* 1, which may be taken as the 'norm,' the effect is equivalent to a 1/2% drop in imports.

S 6: The results are similar to those of *S* 5.

E. *Gross Domestic Product at Market Price* (*GDPMP*)

Table 6 Percentage Changes of *GDPMP* in Different Scenarios

	*S*1	*S*2	*S*3	*S*4	*S*5	*S*6
1978	10.30	10.30	10.96	11.02	10.03	10.03
1979	8.45	8.45	9.07	10.15	8.21	8.21
1980	6.43	6.03	7.18	7.26	3.98	3.24
1981	8.11	8.55	9.33	9.70	7.16	8.76
1982	6.96	7.52	8.41	8.56	6.69	7.03
1983	8.26	8.80	9.77	9.76	8.21	7.97
1984	7.26	7.75	8.87	8.85	7.05	6.03
1985	8.30	8.73	9.93	9.95	8.06	7.85

GDPMP is composed of private consumption, investment, net of exports and imports and government expenditure. The last item is treated as exogenous, while the remaining ones are classified as endogenous variables. Their projected percentage changes have already been displayed in Tables 2–5.

We have worked out six scenarios with different forecast results for the components. Therefore, we also have six sets of results for the growth rates of *GDPMP*. They have been shown in Table 6.

S 1 and *S* 2: These two scenarios have more or less the same growth results. Both indicate that 1980 is a relatively poor year for Hong Kong. The remaining years can

be expected to enjoy an annual growth rate of 7 to 8 percent. For 1978 and 1979, the growth rates are identical because a more favorable world trade condition is assumed to operate after 1979.

S 3 and *S* 4: These two scenarios have considerably higher growth rates due to an expansionary government expenditure policy, favorable world trade climate and lower population increase. Again, 1980 is a relatively discouraging year.

S 5 and *S* 6: These two scenarios show the growth of *GDPMP* under the assumption that there is a world-wide economic slackening. The hard-hit year is again 1980, which, under the assumptions, will see a growth rate of three to four percent, very low by Hong Kong standard. In the remaining years, the growth rate is forecast to be six to nine percent.

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