A CO-INTEGRATION ANALYSIS ON THE SAVING RATE DETERMINANTS IN MALAYSIA

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Kertas kerja ini mengkaji penilaian mengenai penentu kadar tabungan di Malaysia menggunakan Hipotesis Kitaran Hidup (LCH) lanjutan dengan menggunakan data siri masa bagi tempoh 1964–2001. Teknik statistik ekonometrik moden seperti ujian kepegunan, kointegrasi dan model vektor ralat pembetulan digunakan. Kajian ini mendapati peningkatan pendapatan, persaraan jaminan sosial, kadar inflasi dan kadar penyertaan tenaga buruh warga tua adalah penentu kadar tabungan di Malaysia. Namun demikian, koefisien vektor ralat pembetulan yang tidak signifikan menunjukkan bahawa vektor kointegrasi yang unik tidak dapat ditentukan.

This paper assesses the determinants of saving rate in Malaysia using the extended Life Cycle Hypothesis (LCH) on time series data for the 1964–2001 periods. Modern statistical econometric techniques such as unit root testing, co-integration and vector error correction modelling were used. I desire at least one co-integrating vector between saving rate and its postulated elements. The study finds that income growth, social security retirement wealth, inflation and labour force participation rate of the elderly are important determinants of saving rate in Malaysia. However, the statistical insignificance of the error correction model coefficient indicates that the co-integrating vector is not identified.

I. INTRODUCTION

This paper seeks to add to the literature on the understanding of the microeconomic behaviour of saving in Malaysia. Such analysis, using extended Life Cycle Hypothesis (LCH) fundamentals to time series data for 1964–2001, with the appropriate definition of income and saving, and a comprehensive coverage of the social security retirement benefits,

is new in Malaysia. The saving-income ratio, however, has been investigated predominantly on a cross-country basis, comparing developed and developing countries (Feldstein, 1977; Modigliani & Sterling, 1983; Koskela & Viren, 1983; Graham, 1987). There have been even fewer studies of the saving-income ratio in the context of a particular country (Faruqee & Husain, 1998; Kwack & Lee, 2005; Modigliani & Cao, 2004).

Previous empirical studies on saving behaviour in Malaysia have used gross domestic product (GDP) as a proxy for income, and saving was estimated from the private saving figures published by the central bank (Shome & Saito, 1978; Faruqee & Husain, 1998). Following the LCH, my definition of saving is the residual of income minus consumption, whereby social security contribution is treated as life-cycle saving and is included in the measurement of income, which excludes the pension benefits received. This definition has provided us with an accurate measurement of the personal saving.

This paper also estimated the appropriate actuarial value of social security retirement benefits as compared to the previous work of Shome and Saito (1978), Husin (1987), and Faruqee and Husain (1998). Shome and Saito (1978) provided a general definition of social security retirement benefits calculated as annual payments of the Employee Provident Fund (EPF) less the benefits paid out. The estimation by Husin (1987) was incomplete for three main reasons. First, it only covered the period up to 1984; second, the assumptions used were no longer valid for current situations; and third, the calculation did not cover the pension scheme for public servants. Faruqee and Husin (1998), on the other hand, used a crude measurement for social security retirement wealth (only covering private workers) figures taken from the annual accumulated saving published by the EPF.

The remainder of the paper is organized as follow. Section II provides the data, section III presents the saving function, section IV details the results of the empirical analysis and section V concludes the paper.

II. DATA

The variables used in the analysis are as follows, the definitions, sources of each and their time-graphs are provided in the appendix.

SAVRAT	Saving rate
INCGRW	Income growth
DEP	Dependency ratio
AGED	Elderly ratio
SSRW	Social security replacement ratio
PR	Labour force participation rate of the elderly
INF	Inflation rate

III. SAVING FUNCTION

At the microeconomic level, the LCH implies that saving behaviour is a function of age. The assumptions of the model are:

1. Individual receives utility only from present and prospective consumption.

2. No assets are inherited at the beginning of the life or at any other point of life where $a_t = 0$, $t = 1$ and $\bar{a}_{L+1} = 0$ with accumulation of asset through own saving only.

3. The proportion of an individual's total resources that s(he) plans to devote to consumption in any given year τ of his (her) remaining life is determined only by her (his) tastes and not by the size of her (his) resources.

4. Constant price level.

5. Interest rates equal zero[1].

6. Certainty.

7. The utility function is homogeneous in $c_t, c_{t+1}, ..., c_L$.

8. Income is consumed at the same rate throughout the balance of the life.

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[1] While this assumption is not essential, it is introduced for convenience of exposition.

The saving profile by age, presented in Figure 1, shows that saving² rate rises moderately up to middle age and then drops rapidly, becoming negative after retirement. Following the LCH each period is labelled as *d, w,* and *r* for dependency, work and retirement years. The income stream for each period is y_d, y_w and y_r with y_d and y_r smaller than y_w. Individuals select a consumption stream of c_d, c_w and c_r to maximize the discounted present utility of future consumption. The quantity *s*, which equals $y-c$, is s_d, s_w and s_r with s_d and s_r smaller than s_w. Because y_d and y_r are low relative to y_w, there will be a good chance that s_d and s_r are negative as long as the individual can smooth consumption expenditures by borrowing and lending. As a result, s_w is the highest in one's life-cycle. The weakness of the traditional model is that it has always treated retirement as fixed. Since this is misleading in reality, the LCH has been extended to include retirement as an endogenous variable where individuals cannot only choose consumption and saving level but also labour supply. Feldstein (1974, 1977) developed the extended LCH, with retirement as endogenous explicitly.
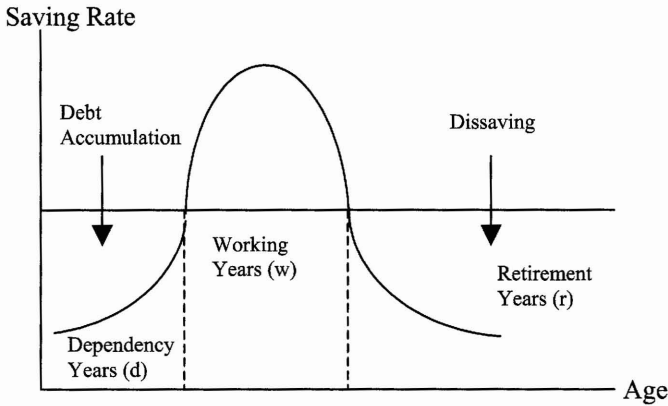

Figure 1: The LCH Hump Shaped of Saving-Age Profile

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2   Saving, in this context is referred as the positive or negative change in one's net worth during the *t*-th year of one's life, where *t* is measured from the beginning of the earning span.

Modigliani and Brumberg (1954), and Ando and Modigliani (1963) investigated the relationship between consumption (saving), income and wealth. LCH explains that the aggregate saving (S_t) in any year t is a linear and homogenous function of current income (Y_t), currently expected income (Y_t^e) and the weighted sum of net worth (A_t).

$$S_t = Y_t - C_t = (1-\alpha)Y_t - \beta Y_t^e - A_t \qquad (1)$$

However, reliable data on wealth for a developing country such as Malaysia are unavailable for the whole period of analysis. Nevertheless, even without the inclusion of the wealth variable, the saving function could be estimated using the principle of Friedman's method. He uses a Koyck adaptive model in which saving, depends not only on income but also on past incomes and its own lagged values. The saving function can then be rewritten as

$$S_t = -\alpha(1-\lambda) - (1-\beta)Y_t - \lambda Y_{t-1} + \lambda S_{t-1} \qquad (2)$$

Change in wealth is approximated by equation 2, ΔWealth $= S = Y - C$. Modigliani (1966) explained that wealth, which can be changed, but slowly through saving or dissaving, behaves pretty much the same as lagged income. This concept is used directly to estimate the saving function. This dynamic model of the consumption (saving) function is then used together with some other related variables to evaluate the determinants of saving.

Modigliani and Sterling (1983) emphasized that the saving ratio is a constructive way to examine the relationship among saving, social security and retirement age. From equation (1), it can be deduced that (r: the rate of interest; N: the earning span and M: the retirement span)

$$S\left[\sum_{t=1}^{N}\frac{1}{(1+r)^{t-1}}\right] = (Y-S)\left[\sum_{t=N+1}^{L}\frac{1}{(1+r)^{t-1}}\right] \qquad (3)$$

and so

$$\frac{S}{Y} = \frac{\left[\sum_{t=N+1}^{L} \frac{1}{(1+r)^{t-1}}\right]}{\left[\sum_{t=1}^{N} \frac{1}{(1+r)^{t-1}}\right] + \left[\sum_{t=N+1}^{L} \frac{1}{(1+r)^{t-1}}\right]} \tag{4}$$

From assumption 5, interest rate is zero that $r_1 = r_2 = ... = r_L = 0$. Therefore,

$$\frac{S}{Y} = \frac{(L-N)}{[N+(L-N)]} = \frac{M}{(N+M)} \tag{5}$$

and equation (5) can be simplified to the following

$$\frac{S}{Y} = \frac{M}{L} \tag{6}$$

Equation (6) indicates that saving rate is highly determined by demographic factors such as life expectancy (L) and the retirement duration $M = (L-N)$. The equation envisages that the longer the retirement duration as compared to the earning period, N, the larger is the saving rate. In this paper, retirement duration is proxied by the labour force participation rate of the elderly in the labour market.

Recalling the relationship between saving rate and the population age structure, the hypothesis indicates that the non-working population dissaves while saving comes from the working population. The hypothesis implies that saving rate increases with a higher proportion of working population and decreases with an ageing or younger dependent population. In regard to social security retirement or pension, only empirical testing could explain the existing relationship and its effect on saving. In analyzing the relationship of saving rate to social security retirement benefits, the latter are commonly entered as a ratio of social

security retirement benefits to earnings (Feldstein, 1977, 1980; Edwards 1995; Fougère & Mérette, 2003). The definition and measurement of social security replacement ratio by Modigliani and Sterling (1983) are followed in the investigation of the determinants of the saving rate for Malaysia[3].

LCH also emphasize on the importance of income growth in generating saving. Income growth would lead to a positive saving ratio and that in a steady state, the ratio would be constant, whether the growth resulted from population or productivity growth (Modigliani, 1966; Tobin, 1967; Mason, 1981).

The empirical analysis estimates the parameters of the following long-run relationship

$$SAVRAT_t = f(LR_t) \tag{7}$$

with LR_t as a vector of variables that determine the long-run value of saving rate. The initial investigation of the empirical determinants of the saving rate considers the following general model[4]

$$LR_t = (INCGRW_t, AGED_t, DEP_t, SSRW_t, PR_t, INF_t) \tag{8}$$

IV.   EMPIRICAL ANALYSIS

Unit Root Tests

I first examined the stationarity of the data using the Augmented Dickey Fuller (ADF) and Phillips and Perron (P-P) tests. The results of the tests (Table 1) indicate that SAVRAT, SSRW, PR and AGED are non-stationary in levels and stationary in their first differences. DEP is found to be stationary in levels at both 1 percent and 5 percent critical values. INCGRW and INF, are stationary in levels, at the 5 percent critical value. However, considering a small sample size and that the variables

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[3]   The formula for social security replacement ratio is shown in the appendix.
[4]   Inflation rate is included as one of the structural factors following the work of Modigliani and Cao (2004).

are stationary in their first differences, it is safe to conclude that INCGRW and INF are I(1).

Table 1: ADF and P-P Statistics for Testing a Unit Root[5]

Variables		Level Data			Difference Data			
		Lag	t-test	Z-test		Lag	t-test	Z-test
SAVRAT	k, t	2	-1.355883	-2.248266	k, t	1	-7.59927**	-7.157706**
SSRW	k, t	0	-1.241331	-1.022435	k, t	2	-5.123852**	-7.934266**
AGED	-	0	-0.29317	-0.214779	-	0	-4.829246**	-4.926112**
DEP	-	1	-3.04371**	-8.925979**	-	-	-	-
INF	k	0	-3.44945*	-3.381630*	-	2	-6.249512**	-6.568204**
INCGRW	k	0	-3.59746*	-3.657921*	-	1	-6.06386**	-9.963175**
PR	k, t	0	-2.592254	-2.634489	k	1	-6.466910**	-7.016431**

k = constant; t = trend
** significant at 1% critical values; * significant at 5% critical values

Co-integration Tests

This paper tests for co-integration in a multivariate system, following Johansen (1995). As this empirical work deals with variables of different orders of integration[6], the I(0) variable will be treated as exogenous. PcFiml 9.0 is used to obtain the adjusted trace statistics allowing for small sample size and Monte Carlo simulation using the DisCo programme of Santoso (2001) is performed to come up with the appropriate critical values to take into account the existence of an exogenous variable.

All the structural factors shown in equation (8) are examined for the possibility of co-integrating vectors using the *general-to-specific* testing procedure that could best explain a long-run relationship of the saving function according to the LCH. This involves eliminating structural factors in a step-wise manner, on the basis of the least significant long-run parameter and/or on the basis of passing all the diagnostic tests, the mathematical and statistical stability of the Vector Autoregressive (VAR) and also the consistency of the Error Correction Model (ECM) adjustment coefficient under the weak exogeneity test to identify the saving function. The test for the presence of co-integration will be

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[5] The critical values for the tests are provided in the appendix.
[6] DEP is found to be I(0) while the other variables are I(1).

investigated via the VAR model of the following *general* specification of a six-dimensional VAR

$$X_t = [SAVRAT_t, INCGRW_t, AGED_t, SSRW_t, PR_t, INF_t | DEP_t] \quad (9)$$

AGED was found to be statistically insignificant in entering the co-integrating relationship, therefore, following the *general-to-specific* procedure, AGED is deleted from the estimated equation and a *specific* equation to be estimated is

$$X_t = [SAVRAT_t, INCGRW_t, SSRW_t, PR_t, INF_t | DEP_t] \quad (10)$$

The decision on the deterministic model and co-integrating rank of equation (10) will be investigated using the *joint-hypothesis* method, comparing Model 2, $H_1^*(r)$ and Model 3, $H_1(r)$ of Johansen[7]. Table 2 indicates that when the trace statistics corrected for small samples are compared to the Monte Carlo critical values, Models 2 and 3 of Johansen provide one co-integrating vector. Model 2 and one co-integrating vector is accepted because $H_1^*(r)$ is accepted while both $H_1(0),...,H_1(r-1)$ and $H_1^*(0),...,H_1^*(r-1)$ are rejected. Model 3 is not chosen for VAR(1) because while $H_1(0),...,H_1(r-1)$ and $H_1^*(0),...,H_1^*(r-1)$ are rejected and $H_1(r)$ is accepted, $H_1^*(r)$ is accepted instead of rejected.

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[7] We recall that *Model 2* refers to a model with no linear trends in the levels of data, such that the first differenced series have a zero mean while *Model 3* refers to a model where there are linear trends in the levels of the data but not in the co-integrating relations.

Table 2:   Tests of Co-integrating Rank for VAR(1) of

$$X_t = \left[SAVRAT_t, INCGRW_t, SSRW_t, PR_t, INF_t \,|\, DEP_t\right]$$

Ho: rank=r	Model 2				Model 3			
	-T\Sum log(.)	T-nm	95% Monte Carlo critical values	95% Standard critical values	-T\Sum log(.)	T-nm	95% Monte Carlo critical values	95% Standard critical values
r = 0	99.84	85.98	85.578863	76.97277	95.09	81.88	79.42767	69.81889
r <= 1	48.64	41.89	50.805654	54.07904	45.37	39.07	45.57339	47.85613
r <= 2	24.2	20.84	28.937601	35.19275	20.97	18.06	24.61235	29.79707
r <= 3	10.25	8.824	14.560304	20.26184	7.032	6.056	11.36395	15.49471
r <= 4	4.384	3.775	5.5152803	9.164546	1.629	1.403	3.797244	3.841466

Co-integration Analysis

Table 3:   Co-integration relation for VAR(1) of

$$X_t = \left[SAVRAT_t, INCGRW_t, SSRW_t, PR_t, INF_t \,|\, DEP_t\right]$$

(with t-Statistics in square bracket and standard errors in parentheses)

SAVRAT	C	SSRW	INF	INCGRW	PR
1.00000	-0.616252 (0.31632) [-1.94819]*	-0.000417 (0.00011) [-3.84722]**	-0.027054 (0.00416) [-6.50887]**	2.072745 (0.19470) [10.6459]**	0.259766 (0.09653) [2.69092]**

** significant at 1% critical values; * significant at 10% critical values

From Table 3 above, all co-integrating coefficients are statistically significant and have the correct sign as prescribed by the LCH. However, demographic factors fail to act as one of the saving rate determinants as prescribed by the LCH. The elderly ratio is found to be statistically insignificant and deleted from the co-integrating vector, whereas the dependency ratio is treated as an exogenous variable and does not enter the co-integrating relation. Income growth and labour force participation rate of the elderly are positively related to saving rate whereas social security replacement ratio and inflation rate are negatively related to it; a finding confirming the LCH.

While the LCH puts emphasis on the importance of demographic factors in explaining the saving rate, demographic factors appear to be statistically insignificant for the case of Malaysia. The situation could best be explained by the cultural aspect of the society in its treatment of

the elderly and their dependants. Taking care of the elderly, for example, is more of a compulsory obligation rather than an option. Hence, regardless of the economic situation or how much income or saving one has, taking care of the elderly is unquestionable[8].

The significance of income growth in driving the saving rate and the economy is undoubtedly questioned. A 1 percent increase of income growth leads to an approximately 2 percent increase on the saving rate. The role of social security retirement benefits in Malaysia is as what LCH predicted. While public workers benefit from the guaranteed pension from the government and the private workers benefit from the accumulated saving in the EPF, a higher pension and a higher return to accumulated saving in EPF, would decrease the saving rate. A higher social security retirement benefits adds up to more promising retirement expenditure and the need for less saving for it. However, the reduction in saving rate of 0.0004 percent for every 1 percent increase in SSRW is negligible. The labour force participation rate also has a positive relationship with the saving rate. The longer the elderly stay in the labour market, the higher is the saving rate. Equivalently, for every additional year spent in the labour market, the saving rate increases by approximately 0.26 percent. A higher inflation decreases the saving rate with approximately 0.027 percent for every 1 percent of the increase.

Figure 2 shows the graphs of the co-integrating relation, $\hat{\beta}'_1 X_t$ and the co-integrating relation corrected for the short-run dynamics, $\hat{\beta}'_1 R_{1t}$. As emphasized by Johansen and Juselius (1992) the more satisfactory result of $\hat{\beta}'_1 R_{1t}$ illustrates an important property of the saving rate model; its ability to describe an inherent tendency to move towards the equilibrium states, without necessarily ever reaching it because of frequent and often large shocks pushing it away from the equilibrium path. The obvious difference between the graphs indicates that the long-run and the short-run dynamics are totally different from each other.

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[8] This cultural behaviour is called *balas jasa* or repaying the parents, where children should take care of their parents when the parents are old.

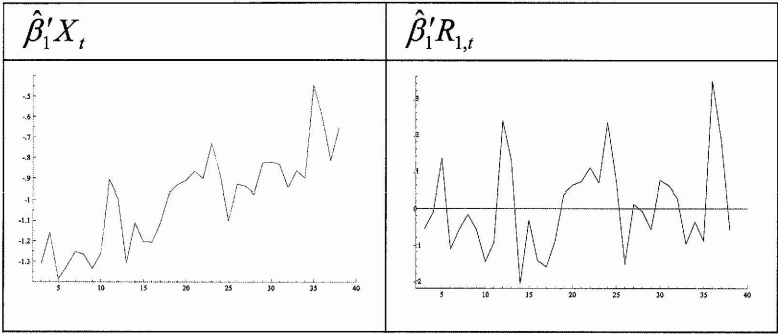| $\hat{\beta}_1' X_t$	$\hat{\beta}_1' R_{1,t}$

Figure 2: Co-integrating Relations

Vector Error Correction Model (VECM)

While the graph of the adjustment path corrected for the short-run dynamics of the saving rate model looks satisfactorily stationary, the alpha coefficients, as shown in Table 4, do not indicate that we can condition on all values on the right-hand-side of the co-integrating relations coefficients shown in Table 3. Only the labour force participation rate of the elderly can be considered to be weakly exogenous, as it is statistically insignificant and the null hypothesis of the zero restriction; $H_0 : \alpha_{41} = 0$, cannot be rejected, with a test statistic of $\chi^2(1) = 0.561379$ and a *p*-value of [0.453705]. The other coefficients are statistically significant and are endogenous. Hence, a unique co-integrating relation cannot be identified.

From Table 4 it is observed that the ECM coefficient for saving rate is positive and statistically insignificant. Hence, analysis of impulse response functions and variance decompositions are not performed. The variables also fail to explain the short-run movements of the saving rate, as all coefficients are statistically insignificant. Even the dependency ratio appears to be statistically insignificant in the ECM of the saving rate function. The statistically insignificant dependency ratio in the VECM is puzzling, especially given the quite recent estimates of Faruqee and Husain (1998) on Malaysia as well as other studies on the developing countries (Muradoglu & Taskin, 1996; Masson, Bayoumi & Samiei, 1998; Baharumshah, Thanoon & Rashid, 2003; Modigliani & Cao, 2004) who found the dependency ratio to be an important determinant of the saving rate.

58

The ECM, however, satisfies all the diagnostic tests, except for normality (Table 5) and maintains its stationarity (Table 6). From the result of the ECM, it can be concluded that not only saving rate is an important determinant in explaining the economic development, but other variables such as income growth, labour force participation rate of the elderly, social security retirement wealth and inflation are also important forces that drive the economy. A similar conclusion is attained with that of the saving function, in which the saving rate itself pushes the system from equilibrium for a given shock in the system.

Table 4: Estimation Results of the ECM for VAR(1)

$$of X_t = \left[SAVRAT, INCGRW_t, SSRW_t, PR_t, INF_t | DEP_t \right]$$

(with t-Statistics in square bracket and standard errors in parentheses)

Explanatory variable	Dependent Variable				
	Δ(SAVRAT)	Δ(SSRW)	Δ(INCGRW)	Δ(PR)	Δ(INF)
ECM_{t-1}	0.014365	303.8660	0.229433	0.108293	-16.58195
	(0.03645)	(114.695)	(0.08965)	(0.14163)	(3.59336)
	[0.39410]	[2.64933]**	[2.55929]**	[0.76463]	[-4.61461]**

** significant at 1% critical values

Table 5: Diagnostic Tests of the ECM

Tests	Results
Autocorrelation	LM(1) = 20.48338 p = [0.7210]
	LM(4) = 17.31564 p = [0.8700]
Heteroscedasticity	$\chi^2(60) = 70.28476$ p=[0.1710]
Normality	Jarque Bera (10) = 30.62318
	p = [0.0007]
	Skewness $\chi^2(5) = 19.70531$
	p = [0.0014]
	Kurtosis $\chi^2(5) = 10.91786$
	p = [0.0530]

Table 6: Eigen Values of Companion Matrix

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.188800	0.188800

V. CONCLUSION

This paper has dealt with empirical testing for the saving rate function for Malaysia. While the LCH and most empirical testing prove that the determinants of the saving rate in the long-run are income growth, demographic factors (elderly and dependency ratio) social security replacement ratio, and the labour force participation rate of the elderly, this cannot be corroborated empirically for Malaysia.

Co-integration analysis under the *joint-hypothesis* method produces one co-integrating vector. Although the co-integrating vector is not identified, because of the statistical insignificance of the alpha coefficients, except for labour force participation rate of the elderly, the co-integrating vector shows that income growth, social security retirement wealth, inflation and labour force participation rate of the elderly are important determinants of saving rate in Malaysia.

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