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AN EMPIRICAL ANALYSIS OF LONG RUN RELATIONSHIP BETWEEN SAVINGS AND INVESTMENT

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Long run relationship between national saving and domestic investment is re-examined with Johansen MLE cointegration approach. Regression coefficient β's of Feldstein-Horioka (1980) are estimated in VAR system. The results show quite high degree of capital mobility for OECD countries and Singapore but a low capital mobility for other developing countries.

I. INTRODUCTION

How mobile is the world's capital internationally? There are several methods to measure the degree of capital mobility in the literature. Two of them will be referred to in this paper. First, uncovered interest parity condition (UIRP) shows that if capital is perfectly mobile internationally, the yield to the investors should be equalized among the countries. We can analyze the UIRP condition to check the extent of capital mobility. Secondly, according to Feldstein and Horioka (1980) (hereafter FH), the relationship between national saving and domestic investment would be used as a measure of international capital mobility. We are focusing on this latter method to investigate capital mobility.

According to FH, if capital is perfectly mobile, the investors don't care which country they are investing in and the crucial factor is the rate of return. This means that, with perfect world capital mobility, domestic saving is not necessarily related to domestic investment. Savings in each country respond to the worldwide opportunities for investment while investment in that country is financed by the worldwide pool of capital. Conversely, if incremental savings tend to be invested in the country of origin, differences among countries in investment rates should correspond closely to differences in saving rates. FH assesses the relationship between savings rate and investment rates by estimating the regression equation of

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savings rates on the investment rates with the OECD counties data. Their results show that the regression coefficient is close to 1, which indicates that most of incremental savings tend to remain in the country where the savings have occurred. This evidence strongly contradicts the hypothesis of perfect world capital mobility.

After the FH suggestion, there has been quite a big body of literature which indicates the high correlation between savings and investment. We are going to focus on the capital mobility in the sense of FH. This paper re-examines the relationship between the two variables by checking their time series aspect. If the data series are non-stationary, the conventional approach of FH could be invalidated because of the spurious regression problem.

Our proposal differs from the existing articles in the following sense. First, in using the cointegration approach, we are checking non-stationarity of data using several well known unit root tests. Secondly, with the spurious regression problem in mind, this paper uses the cointegration approach to analyze the saving-investment relationship. Thirdly, we compare the degree of capital mobility in OECD countries with that of some developing countries, including Korea.

We obtain the following results. First, the domestic savings and investment have unit roots in rates as well as in levels. Secondly, generally speaking, we can find a high degree of capital mobility from the data of OECD countries and Singapore. On the other hand, the developing countries' data show a low degree of capital mobility. Thirdly, from Korean data, we can definitely state that the capital mobility has been increased after 1980's.

In section 2, a brief literature survey is given, and we confirm the results of existing literature using OLS in section 3. Section 4 shows the results of unit root test for the data and cointegration analysis using Johansen Maximum Likelihood Estimation methods. We suggest another way for the further research in the concluding section.

II. RESULTS AND INTERPRETATION FROM EXISTING LITERATURE

A large body of literature shows that there has been consistent results in the savings-investment relationship. This indicates very close correlation of two variables. (See FH(1980), Feldstein(1983), Frankel (1987), Dooley et al(1987), Feldstein and Bacchetta (1989)). Do these results mean that the capital is immobile in the world capital market? One way to solve the question is to focus on the econometrics approach. Various econometrics problems have been re-examined to solve the the puzzle(if we may call). But the results were pretty robust to various econometrics specifications and to various econometrics techniques, such as measurement error, endogeneity, auto correlation of errors etc.

Another way to solve the puzzle is to accept the results and attempt to find

theoretical models which incorporate various factors, such as productivity shocks, population growth, government policy, country size etc. (See Murphy(1984), Obstfeld(1986), Baxter and Crucini (1990)). As an example, country size affects the size of the correlation coefficient in the sense that savings increase in a large country leads to interest rate falling, which may cause investors to increase their investment. If this is the case, the savings and investments move in the same direction and have close relationship each other. We might call this "large country effect".

In this paper we consider non-stationarity of data. If data have unit roots, it is very well known that we might have spurious regression, from which we would obtain wrong results with high R^2 and low Durbin-Watson statistics. Cointegration analysis may be a way to avoid the spurious regression problem. Bodman(1995) tested whether savings and investments were cointegrated by using the Engle-Granger residual based cointegration test for OECD countries data. The results showed no-cointegration of saving-investment. He interpret that there has been very high capital mobility in OECD countries because they obtain no-cointegration between two variables. These results are quite different from those of previous papers. It is also very well known however that ADF test used by Bodman(1995) has only very low power, which means it is possible that we may obtain wrong results of no-cointegration even though there is a cointegration relationship.

Ⅲ. RESULTS FROM CONVENTIONAL APPROACH

In this section we use same methods as FH, which uses investment rate (the ratio of investment to GDP) and saving rate (the ratio of saving to GDP). We estimate β from following equation.

$$(I/Y)_i = \alpha + \beta(S/Y)_i + u_i \tag{1}$$

Here I, S, Y 's are domestic gross investment, national saving, GDP respectively. These are shown in the following equations.

Domestic investment = Fixed capital formation + inventory investment
National saving = GDP − Private consumption Expenditure
− Government Consumption Expenditure

In the equation (1), β is called 'saving retention coefficient'. When the saving in a certain country increases, most of the increment of that saving will be invested into that country if β is close to 1. In other words, the large β might mean that the capital is likely to be immobile among countries. If the international capital market is closely incorporated and the capital is perfectly mobile between countries, β would be zero. Therefore the size of β can be used as a measure of

[Table 1] OLS of (1) with CORC* (annual data : 1960-1993**)

country		$\hat{\beta}$	t-value	adjusted R^2	D-W
Asian countries	Korea	0.49	4.67	0.86	0.68
	Singapore	0.25	1.32	0.90	2.20
	Malaysia	−0.18	−1.27	0.86	1.55
	Thailand	0.50	2.58	0.84	1.94
	Indonesia	0.50	1.00	0.93	2.78
OECD	USA	0.57	2.86	0.54	1.66
	Japan	1.09	8.05	0.88	1.62
	UK	0.56	2.82	0.53	1.69
	Germany	0.88	5.90	0.81	1.34
	France	0.88	9.27	0.87	1.89

* Cochrane-Orcutt method
** For Indonesia, 1969-1993

the degree of international capital mobility. All data are from IFS CD-Rom version data set.

In table 1, we report the results from the OLS estimation. For OECD countries, β's are close to 1 rather than close to zero, which means low capital mobility. These results are consistent with the results in FH and other succeeding papers. How about for the developing countries? In this case, β's are not so big as for OECD countries. Does this mean that the capital has been more mobile in the developing countries than in the OECD countries? Considering the international capital market development, it is not likely to be a good conclusion. We may think of three aspects to interpret these results.

First, The size of economy of developing countries under consideration is smaller than that of OECD countries. Having the large country effects in mind, it is possible that β is quite large in OECD countries. Surely, other usual interpretation in the previous literatures would also be appropriate for OECD countries (See section 2).

Secondly, we suggest our own interpretation from the point of foreign capital inflow in the process of economic development of these countries. It was not unusual that the governments in these countries should have made great efforts to encourage foreign capital inflow for economic development. If we admit this as a fact, it is not strange that the amount of domestic investment have nothing to do with savings. This may make β of developing countries even smaller than that of the OECD countries.

Third, the results may be due to spurious regression problem. If we refer to the table 1, it is shown that R^2 is high and D-W statistic is low.

Ⅳ. RESULTS FROM COINTEGRATION ANALYSIS

1. Saving-Investment relationship and cointegration

According to the famous Nelson-Plosser (1982), most macro-economic time series data are non-stationary and have unit roots. For these time series data, if we use conventional OLS estimation method, it may give rise to so called spurious regression problem. We won't explain this problem in detail here because it is quite standardized knowledge for the macro-economists. One way to avoid this problem is to difference the time series data before the regression analysis. But we know as well that we may lose long run properties of the data in the case of time differencing. Another and natural choice is to use cointegration approach. After checking whether there is cointegration relationship by using cointegration test, if there is cointegration between variables, we may make statistical inference by using appropriate estimation methods with corresponding distribution theory and tables of critical values.

Engle-Granger(1987) suggests a residual based cointegration test which uses unit root tests for the residuals from the usual regression. Note that this method uses Augmented Dickey Fuller (ADF) test or Phillips Perron test for checking unit roots for residuals, which is told to have some shortcomings. First of all, they have a low power and secondly, we cannot use them if the regressors are cointegrated each other. Hence instead of that, we use another recently popular method, Johansen maximum likelihood estimation method, which is considered to overcome those shortcomings.

If national saving is cointegrated with domestic investment, we might say there is long run relationship between the two variables. In that case, we interpret that the degree of capital mobility is not high. On the other hand, no-cointegration between saving and investment may indicate a high degree of capital mobility. Furthermore, when we obtain the cointegration relationship, we must check the cointegrating vector. An element of this vector, β, will be large if capital mobility is low. If β is close to zero, even when we have cointegration, capital is very mobile internationally.

2. Non-stationarity of data

The first job we do is to test if the data have unit roots; if the data are stationary, it is OK to use conventional OLS, and if not, we need to have other methods. ADF and Phillips-Perron tests are used for unit root tests and we use AIC and SIC for lag selection. Table 2 shows that we cannot reject the null hypoth-

[Table 2] Unit root tests for saving rates (Annual data : 1960-1993)

countries		ADF		P - P	
		constant	constant & trend	constant	constant & trend
Asian countries	Korea(1)*	−1.50	−3.54	−1.59	−3.15
	Singapore(1)	−0.62	−1.72	−0.85	−1.84
	Malaysia(1)	−1.18	−3.32	−0.07	−1.63
	Thailand(1)	−0.02	−1.57	−0.07	−1.63
	Indonesia(1)	−0.85	−2.90	−0.59	−3.36
OECD countries	USA(1)	−1.97	−2.78	−1.66	−2.37
	Japan(4)	−1.97	−1.86	−2.74	−2.04
	UK(1)	−1.97	−2.78	−1.66	−2.37
	Germany(1)	−1.52	−0.72	−1.59	−0.72
	France(1)	−1.11	−2.23	−0.99	−1.91
Significance level 5%		−3.0	−3.60	−3.0	−3.60
10%		−2.63	−3.24	−2.63	−3.24

* number of lags used

[Table 3] Unit root tests for investment rates (Annual data : 1960-1993)

countries		ADF		P - P	
		constant	constant & trend	constant	constant & trend
Asian countries	Korea(1)	−2.03	−2.21	−1.86	−2.97
	Singapore(1)	−2.93	−1.71	−2.63	−1.56
	Malaysia(1)	−1.6	−2.79	−1.45	−2.37
	Thailand(1)	−0.45	−2.12	−0.26	−2.00
	Indonesia(3)	−1.22	−3.15	−2.03	−5.04
OECD countries	USA(8)	−0.29	−1.29	−2.06	−2.12
	Japan(1)	−1.87	−1.74	−2.14	−2.58
	UK(1)	−0.26	−1.31	−2.06	−2.05
	Germany(1)	−1.94	−1.96	−2.10	−1.88
	France(4)	−0.87	−2.56	−1.10	−2.502
Significance level 5%		−3.0	−3.60	−3.0	−3.60
10%		−2.63	−3.24	−2.63	−3.24

esis of non-stationarity of time series data. Saving rates, investment rates are all shown to have unit roots. Now we are ready to use cointegration approach for saving and investment relation.

3. Johansen's MLE

Using Johansen's MLE method with VAR error correction mechanism, we test if there is cointegration relationship between saving and investment. It will be helpful to give a brief explanation of the Johansen MLE method here. Consider the following VAR error correction mechanism,

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \cdots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \Phi D_t + \mu + e_t \qquad (3)$$

where $X_t = (x_{1t}, x_{2t}, \cdots, x_{nt})'$ and $\Gamma_1, \Gamma_2 \cdots \Pi$'s are coefficients matrix and D_t, u_t are dummy variables and constants respectively. We are checking here the rank of Π. If the rank of Π is n (full rank), all the variables in VAR are stationary and if the rank is 0, there is no cointegration relationship among the variables. If r, the rank, is larger than zero and less than n, the case in which we are most interested, there are r cointegrating vectors. We are testing the null hypothesis that $r \leq k$ against the alternative hypothesis that r is greater than k. Here k is a certain number less than n. In actual test we use a program called 'CATS in RATS' version 1.0, made by Juselius and Johansen. The program includes the procedure for the test for rank of Π and we can get the estimates of β from the CATS when the variables have cointegration relationship.

4. The results from Johansen MLE

In the table 4, 5, we report the statistics and critical values for cointegration analysis. If the values of λ_{max} and Trace are larger than corresponding critical values, we are rejecting the null hypothesis and if not, we cannot reject H_0. From the table, the null hypothesis '$r \leq 0$' is rejected and we cannot reject '$r \leq 1$' for Korea, Thailand, Indonesia and Malaysia. This means there are one cointegrating vector between the variables. According to the statement above, we may say there has been low degree of capital mobility in these developing countries. In contrast to these results, we obtain no cointegration for OECD countries and Singapore. We may therefore say the capital has been highly mobile in OECD countries and Singapore.

Next we check the size of β in 〈table 6〉 for the case of cointegration. For Korea β is 0.474 and β's are close to 1 for Malaysia, Thailand and Indonesia. Now, we test the null hypothesis of '$\beta = 1$': no capital mobility case. Although from Korea data we reject this hypothesis with p-value 0.00 in the table, we can-

not reject '$\beta = 1$' for the other countries. This results mean that the capital is immobile in those countries. For the other countries, we don't investigate β, since we have no-cointegration.

[Table 4] Cointegration test for saving rates and investment rates
Asian countries (annual data :1960-1993)

countries	# of lags	null hypothesis	λ-max	Trace
Korea	1	r=0	12.78	14.69
		r=1	1.91	1.91
Singapore	1	r=0	6.51	9.02
		r=1	2.51	2.51
Malaysia	1	r=0	11.59	11.97
		r=1	0.39	0.38
Thailand	2	r=0	16.84	16.85
		r=1	0.02	0.02
Indonesia	3	r=0	17.77	18.68
		r=1	0.91	0.91

* critical values for the tests at 10% significance level are 10.6, 2.71 (for λ-max) and 13.31, 2.71 (Trace). At 5% level, 14.07, 3.84 (for λ-max) and 15.34, 3.84 (for Trace)

[Table 5] Cointegration test for saving rates and investment rates
OECD countries (annual data :1960-1993)

countries	lags	null hypothesis	λ-max	Trace
USA	1	r=0	6.4	8.16
		r=1	1.76	1.76
Japan	1	r=0	7.07	9.24
		r=1	2.17	2.17
UK	1	r=0	6.37	8.11
		r=1	1.74	1.74
Germany	1	r=0	6.38	8.37
		r=1	1.99	1.99
France	1	r=0	10.03	10.30
		r=1	0.26	0.26

[Table 6] Cointegrating vector (normalized by investment rates)

country	lags	β	p value for $\beta = 1$
Korea	1	−0.474	0.00
Malaysia	1	−1.146	0.56
Thailand	2	−1.289	0.07
Indonesia	2	−1.211	0.11

5. Changes in the capital mobility in Korea, US and Japan

In order to investigate the change of the saving investment relationship as time goes on, we divide the time span into two sub periods ; before 1980 and after 1980. In the table, for Korea we obtain cointegration before 1980 and nocointegration after 1980. This results might mean there has been increase in capital mobility after 1980. This is the same in the case of saving rates - investment rates data.(See the table 8). Similarly, we have the same results and explanation for USA. But it is not easy to explain the Japanese case. (Not reported in Table) For Japan, we have no cointegration for both periods. This is not exactly consistent with our knowledge that there was quite a strict barriers on capital movement in Japan until the late seventies.

[Table 7] Cointegration for subperiods, Korea (quarterly data)

period	null hypothesis	L-max	Trace	critical values at 10%	
				L-max	Trace
60/1-94/2	r=0	16.57	20.26	10.6	13.31
	r=1	3.69	3.69	2.71	2.71
60/1-79/4	r=0	14.71	16.81	10.6	13.31
	r=1	2.10	2.10	2.71	2.71
80/1-94/2	r=0	7.97	12.91	10.6	13.31
	r=1	4.22	4.22	2.71	2.71

V. CRITIQUES AND SUGGESTION

This paper uses FH's β as a measure of the degree of capital mobility and this measure is commonly used in the literature as we surveyed in section 2. Although we have good explanation for this method, there could be still some rooms for criticism.

We are going to compare the meaning of capital mobility and capital movement. For example, capital mobility indicates how easily the capital moves when

the yields to investment differs from one country to other counties. Therefore the concept of capital mobility is closely related with the restrictions on the capital movement, such as, capital control, capital liberalization, etc. On the other hand, we use the term 'capital movement' to indicate the amount of capital which actually moves.

Sometimes it is possible for capital to moves a lot even though there is very strict restriction on capital market. Let us consider the case of the developing countries. It is believed that there was strict restriction on capital market in the developing countries. If there has been large current account imbalance in those countries, large amount of capital will tend to move in order to compensate for that imbalance. The typical example is the foreign debt of the developing countries. In order to accomplish industrialization, the government needs to compensate the current account deficit by foreign capital inflow while they have various restrictions on capital market.

In these cases, we can say the degree of capital mobility is low because of capital market restrictions. If we estimate the β from the data of these cases, however, the size will be very small, close to zero, or we may obtain no-cointegration results. Investment amount depends on the current account deficit and does not depend on the degree of capital market liberalization in our case. Therefore the estimates of β may mislead us to conclude that there is a high degree of capital mobility.

Another example is Frankel (1989). He estimates FH's β with US data including the 1980's and obtains small β. Does this results show the drastic liberalization in capital market of US during 1980's? The answer is probably no. US current account deficit might cause the capital inflow and reduce β.

Our natural choice for further research in this direction is to investigate the relationship between current account and the size of β. We are estimating β by using the time varying coefficient model in cointegration framework (TVC : see Park and Hahn(1995) and we are going to compare this with the current account imbalance to get implication about capital mobility.

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