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Solvency Index in Identifying Asian Crisis: The Case of Malaysia

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ABSTRACT

In this paper, the solvency index for Malaysia is calculated based on the price elasticity of demand and GDP supply. The cointegration analysis is employed in which the dynamic OLS is used to estimate the price elasticity. The solvency index for Malaysia was 0.74% and the amount that was actually paid was greater than a fraction needed to be considered "solvent" (9.0%). From the empirical findings, it is suggested that the crisis was a matter of short-term liquidity difficulties and panic rather than insolvency. From Asian countries' experience, they began to gain back momentum toward recovery after experiencing negative growth rates in 1998. This once again supports the view that the cause of Asian crisis was an illiquidity problem rather than insolvency. As can be seen today Malaysia's economy is envisaged to register stronger growth; with global economic growth intact and supported by a strong domestic sector, Malaysia's economy is expected to further strengthen. As targeted in Budget 2002, the real GDP is projected to grow at 4%-5% within an environment of low inflation and stronger economic fundamentals.

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I. Introduction

The Asian currency crisis has once again brought up the debate of the causes of currency crisis. Many have argued the core of the crisis was the result of deteriorating market fundamentals. Others have argued that the cause is a self-fulfilling crisis or investor's herd behavior. The purpose of this paper is to use the solvency index to identify the cause(s) of the Asian crisis. The actions of speculators who panicked, and the herding behaviour of investors who feared financial losses, were factors that could help explain the cause of the crisis. However, the question arises: is it the problem of illiquidity or insolvency?

The solvency index was calculated following Cohen's method, which is based on the price elasticity of demand and GDP supply. The cointegration analysis was used whereby the dynamic OLS method was employed to obtain the price elasticity of demand and GDP.

This study can be justified as follows: i) it uses the dynamic OLS method instead of static OLS since the estimated parameters are subject to bias in small samples, ii) the invariant measure of wealth (IMW) has advantages over the static measure of external debt i.e., debt/GDP and debt/exports. The use of IMW as the proxy of a country's resources also avoids the possibility of a moral hazard problem, iii) the solvency index takes into account the dynamic aspects which it includes future expectations of output growth and real interest rate, iv) the findings of this study gives support for the view that the Asian crisis can be explained by the short-term illiquidity problem/ creditors panic rather than insolvency.

II. Literature Review

Many studies have been carried out to identify the main causes of the crisis. Studies by Currie and Levine (1991), Ghatak and Levine (1994), Wickens and Uctum (1993) suggest that a nation is solvent if it can meet its intertemporal budget constraint, or in other words, the country net debt does not exceed the present value of current and future price (non-interest) surpluses.

In 1985 Cohen developed a solvency index to measure the fixed fraction of a debtor country's earning that should be allocated to the repayment of the external debt to satisfy the solvency condition. If a country's trade surplus is greater or equal to the fixed fraction, a debtor country is considered as solvent. As long as the growth rate is greater than interest rate ($n_t > r_t$), in the long run the debtor country's wealth is infinite (in discounted present value term) and there is no solvency problem. The country's income can repay any level of initial debt in finite time. However, if $n_t < r_t$, the country's wealth is finite and the external debt level must be compared with the present value of future revenue.

The solvency index actually calculates the minimum level of external debt repayment when $r_t > n_t$. The index weights the external debt/exports ratio by an average measure of the difference between expected real growth and real interest rates in the future. Here the hierarchy of these two rates in time is taken into consideration. Thus the index is superior to the traditional static measures of solvency, i.e., external debt/GDP ratio or external debt/exports ratio, etc. In this case, although a country has a small foreign debt, it may be less solvent if the growth rate is slower compared to a country with a larger foreign debt but grows faster.

The invariant measure of wealth (IMW), which is the linear combination (weighted average) of the country's GDP and export, is used; if the creditors prefer basing their lending on the GDP measure, this will encourage the debtor country to change its relative price structure in such a way as to artificially increase the value of its GDP (i.e., by overvaluing its currency). Conversely, if creditors base their estimations on export measures, the country will devalue its currency ineffectively.

As the concern is on the solvency of an indebted nation, the domestic budgetary problem is eliminated, and the government's wealth is the same as the nation's wealth. This is expressed as Equation 1 below:

$$W_t = \sum_{t=0}^{\infty} \frac{Y_t}{\prod_{s=0}^{t}(1+r_s)} \qquad (1)$$

Based on Equation (1), we have two possibilities which are;

i) The rate of interest (r) is above the rate of growth (n) of the economy ($r_t > n_t$). Under this circumstance, the country's wealth is said to be finite and a fixed fraction of its resources should be transferred to creditors to be considered as solvent.

ii) The rate of interest (r) is below or equal the rate of growth (n) of the economy ($r_t < n_t$). In this case the country's wealth is infinite, and therefore, there is no solvency problem.

In the second case where $r_t < n_t$, time can help solve the external debt problem, whereby rescheduling the external debt can always reduce the debt/GDP or debt/exports ratio of a nation. As argued in the literature, in the long run the real interest rates exceed the growth rate ($r_t > n_t$) of the economy. This restriction is imposed because in the case of $r_t < n_t$, there is no solvency problem.

Based on the situation when real interest rate is greater than the growth rate of the economy, the nation is said to have finite wealth, and it cannot play a successful "ponzi-game". As in a household or a government, a nation faces a budget constraint, which is its balance of payment constraint.

III. Analytical Method

Many developing countries have problems of external debt in which they have to borrow to finance their development projects, government expenditure, etc. However, a debt will not be a problem as long as the country is solvent. Traditionally the static measures of

external debt i.e. debt/GDP, debt/exports or debt service ratio are usually used to evaluate the ability-to-pay of an indebted country. If the debt problem reflects insolvency, rescheduling or new loans will not improve the situation, in fact these will add a burden to the country's existing debt. But if it is an illiquidity problem, it will be solved by new financing arrangements.

What happened in the 1997 crisis was that most creditors were in fear of financial losses and therefore, they were not willing to roll over their lending. The series of events that were subsequently triggered in Thailand caused creditors to pull back their lending to most of South-east Asian countries. As mentioned earlier creditors should not panic, as they should look at the debtor countries' credibility to pay back their debts. As long as a nation is solvent, i.e., it can meet its intertemporal budget constraints or its net debt does not exceed the present value and future price surpluses, the debt should not be a problem.

Inter-temporal Budget Constraint

Generally, the basic accounting identity for an open economy during period t can be written as follows:

$$Y_t = (1 + n_t)\, Y_{t-1} \qquad (2)$$

$$D_t = (1 + r_t)\, D_{t-1} - TB_t = (1 + r_t)D_{t-1} + (IM_t - EX_t) \qquad (3)$$

where

- Y = gross domestic product
- D = net external debt (gross debt-gross assets)
- n = growth rate
- r = the world real interest rate
- TB = trade balance
- EX = exports
- IM = imports

Basically at any time t, the nation produces Y and its aggregate spending is given as:

$A_t = C_t + I_t + G_t$

Therefore,

$$Y_t = A_t + (EX_t - IM_t) \quad (4)$$

The left-hand side of Equation (4) represents the nation's aggregate income at the end of period t, and the right-hand side of the equation denotes total expenditure.

The trade balance of the nation can be expressed as:

$$TB_t = (EX_t - IM_t) = Y_t - A_t \quad (5)$$

where $TB_t - rD_{t-1}$ is the current account of the nation.

Based on this framework, solving forward in time the intertemporal budget constraint that a nation must obey can be expressed as:

$$D_0 = \sum_{t=0}^{\infty} \frac{TB_t}{\prod_{s=0}^{t}(1+r_s)} \quad (6)$$

or

$$D_0 = \sum_{t=0}^{\infty} \frac{Y_t - A_t}{\prod_{s=0}^{t}(1+r_s)}$$

Equation (6) simply means that the external debt at the end time t must be equal to the present value of the future net surplus if the country is solvent, provided that,

$$\lim_{t\to\infty} \frac{D_t}{\prod_{s=0}^{t}(1+r_s)} = 0 \qquad (7)$$

This condition is the so-called 'no-ponzi' game condition in the economic literature (or transversality), a condition whereby a country cannot roll over its external debt forever. If the left hand-side of equation (7) is greater than zero, and the debt stock is greater than the future expected payments, it means that the country has a debt overhang problem. In other words, the present discounted value of a nation's external debt must tend toward zero in the long run. The only constraint that the transversality condition imposes on the debt is that $r_t > n_t$, in the long-run this means that the numerator in equation (7) must grow less rapidly than the denominator.

An Invariant Measure of Wealth (IMW)

To avoid the 'moral hazard' problem, the best way is to use an appropriate measure of weighted average of these two measurements; exports and GDP (Cohen, 1985). Accordingly,

$$IMW = \alpha(EX) + (1-\alpha)(GDP)$$

where EX is real exports, and GDP is real home output. Following the method proposed by Cohen (1985, 1988, 1994) the IMW is calculated as a linear combination, and it does not depend on the real exchange rate.

Derivation of the Calculation for the Solvency Index

Following Cohen (1985), the solvency indices for Malaysia is calculated. However, before proceeding, it is necessary to clarify the proxy that will be used to calculate the nation's resources. The use of GDP or exports alone will create distortions, therefore, the linear combination of GDP and exports is used, whereby:

$$IMW = \alpha\ EX + (1-\alpha)\ GDP$$

Where EX = exports

GDP = real output

α = the weight of exports

(1-α) = the weight of the home output

By using IMW, a small change in the real exchange rate would not affect the IMW.

$$\frac{dIMW}{de} = \frac{\alpha dEX}{de} + \frac{(1-\alpha)dGDP}{de} = 0$$

where e = real exchange rate which is defined as e = PW/PX where PW is the world price facing the country, and PX is the domestic prices (express in US dollar), *d* is the total derivative operator. The above expression then can be written as:

$$\alpha = \frac{\frac{dGDP}{de}}{\frac{dGDP}{de} - \frac{dEX}{de}}$$

$$\alpha = \frac{(e/GDP)(dGDP/de)}{(e/GDP)(dGDP/de) - [(e/GDP)(dEX/de)]}$$

$$\alpha = \frac{\eta GDP}{\eta GDP - [(EX/GDP)(\eta EX)]} \qquad (8)$$

Where ηEX = the elasticities of Export

ηGDP = the elasticities of GDP with respect to real exchange rates

EX/GDP = the export share in home output

As the estimation of export demand and output supply equations use real exchange rate as *e= PX/PW*, the expected signs of the long run elasticities in equation (8) have opposite signs. Thus the appropriate weights for export and output can be written as:

$$\alpha = \frac{-\eta GDP}{-(\eta GDP) + [(EX/GDP)(\eta EX)]} \tag{9}$$

As mentioned earlier, the solvency index measures the fixed fraction (let us say π) of a country's resource (IMW) that it should allocate to repay its external debt.

$$D_t = \sum_{s=1}^{\infty} \frac{\pi IMW_{t+s}}{\prod_{j=t+1}^{t+s}(1+r_j)}$$

π is a fixed fraction of a country's resource that should be allocated to repay the external debt in order to satisfy the inter-temporal external solvency condition. The solvency index is proportional to the debt/resource ratio and to the difference between growth rate and interest rate. In order for a country to be considered solvent, it requires that the external debt grow slower than the real interest rate, meaning that the debtor's resources must grow faster than the debt.

In evaluating whether an indebted country which transfers a fixed fraction of its resources to the creditors is solvent or not, the country's resource base (*IMW*) needs to be calculated. As shown in Equation (9), in order to calculate the countries *IMW*, the export demand elasticities and GDP supply elasticities are required.

Calculation of the IMW

Referring to Equation (9), two long run elasticities; which are export demand elasticity and GDP supply elasticity together with the export share in GDP are needed to calculate the weight of exports and GDP.

The long run exports demand and GDP supply equations are as follows:

$$\log Q_{xt}{}^{d} = a_0 + a_1 \log (Px/Pw)_t + a_2 \log Yw_t + a_3 \log Gci_t + ux_t \quad (10)$$

$$a_1 < 0, a_2 > 0, a_3 > 0$$

$$\log GDP_t = b_0 + b_1 \log (Px/Pw)_t + b_2 \log K_t + v_t \quad (11)$$

$$b_1 > 0, b_1 > 0$$

Where,

Q_x	=	Exports of goods
Px	=	Price of exports
Pw	=	Price of world exports
Yw	=	a scale variable
Gci	=	Export composition index
u, v,	=	error terms
GDP	=	the real GDP of the country
K	=	capital stock – Following Muscatelli, it is constructed by using the gross fixed capital formation, where the capital output ratio is multiplied by GDP. The capital-output ratio is derived on the basis of a three-year moving average of incremental GDP and gross fixed capital formation for 1966. (Data is gathered from the International Financial Statistics, various issues).

Equation (10) is the export demand, which depends upon the relative price of exports to the world price (*Px/Pw*), the world income and the exports composition index. Coefficients a_0, a_1, a_2 are expected to be negative, positive and positive respectively. Equation (11) is the GDP supply, which depends upon the relative price of exports to the world price (*Px/Pw*), and the stock of capital (*K*). Coefficients b_1 and b_2 are expected to be positive.

In estimating the price elasticities of export demand and GDP supply, the dynamic OLS method is used as the static long run OLS is subject to bias in a small sample, and since the lagged terms are ignored. The inclusion of lagged and leading values of the first differences of the I(1) variables can solve the potential of simultaneity bias and small sample bias among regressors. Based on this model, the long run export demand and import demand equations are as follows:

Long-run exports demand

Z=(a0, a1, a2, a3), X=[1, (px/pw), (Yw), (Gci)]

$$Qx_t^{\,d} = z'x_t + \sum_{j=-m}^{j=m} \alpha_j \Delta(px/pw)_{t-j} + \sum_{j=-n}^{j=n} \beta_j \Delta Yw_{t-j} + \sum_{j=-p}^{j=p} \lambda_j \Delta Gci_{t-j} + ux_t$$

Long-run GDP Supply.

Z=(b0, b1, b2,), X=[1, (px/pw), (K)]

$$QGDP_t^{\,s} = z'x_t + \sum_{j=-j}^{j=j} \delta_j \Delta(px/pw)_{t-j} + \sum_{j=-k}^{j=k} \eta_j \Delta K_{t-j} + vm_t$$

The unit root test is employed to see whether all variables are stationary. By using the DF/ADF test, all variables are I(1), thus we can proceed to test for cointegration by using the dynamic OLS where lags and leads are included. The ADF residual based test for cointegration for both exports demand and GDP supply are carried out, and these are shown in Table 1 below.

Table 1: ADF Residual-based Test for Cointegration

The Long-run Export Demand and GDP Equations

	Test Statistics		**Critical Values**	
	DF	**ADF(1)**	**10%**	
			U	**L**
Export*	-4.24	-4.32	-3.16	-3.33
GDP**	-3.21	-4.13	-2.80	-2.96

Notes :*The critical values are obtained from Charemza and Deadman (1992) with 30 numbers of observation and m=3.** The critical values are obtained from Charemza and Deadman (1992) with 30 observations and m=2.
One also can refer to other sources of critical value tables i.e MacKinnon (1991), Engle-Granger (1987 - Table II and III), Engle and Yoo (1987).

The estimated long run export demand and GDP are shown in Table 2.

Table 2: The DOLS Export Demand and GDP Supply Equations (long run)

	(px/pw)	K	Yw	GCI	ser	R^2
Export Demand	-0.35	-	0.21	1.69	0.05	0.99
	(0.0646)		(0.0621)	(0.171)		
GDP	0.33	0.60	-	-	0.05	0.99
	(0.0955)	(0.0579)				

Notes: value in parenthesis is standard error.

The relationship between export demand and all the variables are as expected. All variables have correct signs, and these have proved to be of a sensible magnitude, and all are significantly different from zero at the 5 percent level. Similarly this is also true for the GDP supply.

The *IMW* can be estimated Based on the estimated elasticities of export demand and GDP supply, the *IMW* is then estimated. From Equation (9),

$$\alpha = \frac{-(\eta GDP)}{-[\eta GDP + [(EX/GDP)(\eta EX)]}$$

By replacing the relevant long run elasticities into the above equation, the weight of export and GDP is obtained as follows:

$$\text{IMW} = 0.66(\text{Ex}) + 0.34(\text{GDP}) \qquad (12)$$

IV. Solvency Index for Malaysia

Using the formula below, the solvency index is calculated

$$D_t = \sum_{s=1}^{\infty} \frac{\pi IMW_{t+s}}{\prod_{j=t+1}^{t+s}(1+r_j)}$$

As mentioned earlier, π is the fraction that is needed to service the debt. Assuming that the growth rate (of the IMW) and the interest rate are constant (i.e $r_t = r$ and $n_t = n$), the following is obtained:

$$D_t = \sum_{s=1}^{\infty} \frac{\pi IMW_{t+s}}{(1+r)^s}$$

$$D_t = \sum_{s=1}^{\infty} \frac{\pi[(1+n)]^s \, IMW_t}{(1+r)}$$

$$D_t = \pi IMW_t \frac{[(1+n)/(1+r)]}{1-[(1+n)/(1+r)]}$$

$$D_t = \frac{\pi IMW_{t+1}}{(r-n)}$$

Hence,

$$\pi = (r-n)\frac{D_t}{IMW_{t+1}}$$

π is the debt/IMW ratio, which takes into account the difference between the growth and interest rates. The solvency indices for Malaysia in the 1990s (prior to the crisis) are calculated based on the above formula. Here, one needs to know the external debt at the end of 1996 and also the resource base of each country at the end of 1997. In addition, the future growth of the IMW and the real interest rate need to be forecasted. Two different hypotheses about the future growth and interest rate are made: pessimistic and optimistic. Accordingly, two different scenarios under which the difference between future growth and interest rate are assumed constant. First, the pessimistic view in which the difference between interest rate and growth rate is 5.5 percent. Second the optimistic view in which the difference between those two rates is 1 percent. As stated by Corsetti et al. (1999a), the optimistic view is the realistic one.

All variables used to calculate the solvency indices are as shown in Table 3. Based on the value of α, the resource base (IMW) is calculated. The ratio of net debt/exports, net debt/GDP and net debt/IMW are also shown in Table 3.

Table 3: External Debt Ratio (million of US $)

Year	Exports	GDP	IMW	Net Debt*	Net Debt/Ex	Net Debt/GDP	Net Debt/IMW
1990	34514.0	42274.6	37322.6	5574.0	0.16	0.13	0.15
1991	37630.0	45844.6	40422.9	5899.0	0.16	0.13	0.15
1992	42558.0	53223.5	46184.3	2559.0	0.06	0.05	0.05
1993	48368.1	53084.5	49971.7	-973.5	-0.02	-0.02	-0.02
1994	57593.6	60928.3	58/721.6	4128.0	0.07	0.07	0.07
1995	68793.6	69869.3	69159.3	8455.2	0.12	0.12	0.12
1996	71806.3	75787.9	73160.0	9667.2	0.13	0.13	0.13
1997	70657.0	72945.3	71434.9	19585.2	0.28	0.27	0.27

*Net debt = Total debt – (SDR + reserve position + foreign exchange)
Sources: World Bank, World Debt Tables, various issues and International Financial Statistics

Based on total debt and IMW under two different scenarios, results obtained are as shown in Table 4.

Table 4: Solvency Index and Actual % Paid

	Scenario 1	Scenario 2	
	Debt/IMW*5.5%	**Debt/IMW*1.0%**	**TDS/IMW**
1990	0.76%	0.14%	10.7%
1991	0.71%	0.13%	6.0%
1992	0.28%	0.05%	7.7%
1993	-	-	7.2%
1994	0.33%	0.06%	7.4%
1995	0.64%	0.12%	6.6%
1996	0.74%	0.14%	9.0%

Notes: TDS is total debt service. IMW is the invariant measure of wealth obtained from Equation 12.

As can be seen in Table 4, percentage in first and second columns are the fixed fraction of Malaysia's IMW that have to be allocated to the foreign debt service to be declared solvent under pessimistic and optimistic scenarios. As the actual total debt service

Malaysia had paid in the 1996-1997 period was greater than the index, Malaysia was considered as solvent (see the third column in Table 4). Further details on the calculation of the solvency index and percentages that were actually paid by Malaysia are shown in Table 5 and 6.

Table 5: The Computation of Solvency Indices

Year	Scenario 1	Scenario 2
	Debt/IMW * 5.5%	**Debt/IMW * 1.0%**
1990	5574.0/40422.9*5.5% = 0.76%	5574.0/40422.9*1.0% = 0.14%
1991	5899.0/46184.3*5.5% = 0.71%	5899.0/46184.3*1.0% = 0.13%
1992	2559.0/49971.7*5.5% = 0.28%	2559.0/49971.7*1.0% = 0.05%
1993	-	-
1994	4128.0/69159.3*5.5% = 0.33%	4128.0/69159.3*1.0% = 0.06%
1995	8455.2/73160.0*5.5% = 0.64%	8455.2/73160.0*1.0% = 0.12%
1996	9667.2/71434.9*5.5% = 0.74%	9667.2/71434.9*1.0% = 0.14%

Table 6: Actual Percentage Paid

Year	TDS/IMW
1990	4333.0/40422.9 = 10.7%
1991	2780.0/46184.3 = 6.0%
1992	3861.5/49971.7 = 7.7%
1993	4230.1/58721.6 = 7.2%
1994	5143.7/69159.3 = 7.4%
1995	4816.8/73160.0 = 6.6%
1996	6432.8/71434.9 = 9.0%

V. Conclusion

From empirical results obtained, the solvency condition for Malaysia is satisfied. Malaysia is said to be satisfying its intertemporal external solvency condition as long as it allocates a fixed fraction (π) of its IMW to service the external debt, where π is the fraction required to satisfy the national budget constraint. It is clear that Malaysia passed the solvency test in the late 1997.

Malaysia was solvent prior to the crisis whereby the percentage of actual debt service paid (in 1997) was greater than the percentage that needs to be paid to be solvent. The solvency index for Malaysia was 0.74% and the amount that was actually paid was greater than a fraction needed to be considered "solvent" (9.0%). A further external credit could have solved the problem, as it was a matter of short-term liquidity difficulties and panic, rather than insolvency. The financial system should then encourage the external private creditors to maintain their credit level rather than permitting them to "take off" (i.e. not to roll over their short term credit) and also to restructure their short-term credit over a longer term.

There are several other hypotheses which could explain the Asian crisis i.e., the financial bubbles and declining returns to investment, moral hazard which led to banks and other financial institutions in Asia to a situation of over indebtedness, imprudent domestic financial liberalisation and capital account opening, etc. Empirical results of this study provide support for the view that the Asian crisis can be explained by the short-term illiquidity problem and creditors panic rather than insolvency. From Asian countries' experience, they began to gain back momentum toward recovery after experiencing negative growth rates in 1998. This once again supports the view that the cause of Asian crisis was an illiquidity problem rather than insolvency. As can be seen today Malaysia's economy is envisaged to register stronger growth; with global economic growth intact and supported by a strong domestic sector, Malaysia's economy is expected to further strengthen, particularly during the second half of 2002. As targeted in Budget 2002, the real GDP is projected to grow at 4%-5% within an environment of low inflation and stronger economic fundamentals.

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