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Sovereign Risk and Simple Debt Dynamics in Asia

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Abstract:
In this paper we develop a simple neoclassical growth model with perfect international capital mobility to analyze the international debt dynamics of developing countries in general and Korea, Malaysia and Thailand in particular. We show that three different regimes can be distinguished: a stable steady state debtor regime, a stable steady state creditor regime and an unstable regime. A switch from a stable debtor or a stable creditor position to an unstable creditor regime may be a sign of forthcoming trouble. We investigate this issue empirically for the three Asian countries in the run-up to the 1997 Asia crisis, using data over the period 1975-2000. Over the full sample, the evidence suggests that debt dynamics evolved according to the stable debtor case in each country. Using a rolling regression technique, we find that indeed occasional switches to the unstable regime occurred. More in particular, we demonstrate that all three countries investigated here were facing deteriorating domestic fundamentals – reflected in potentially unstable debt dynamics – prior to the breakout of the Asia crisis. As such, our approach appears to offer an interesting early warning indicator for financial (debt) crises.

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1. Introduction

After the hectic Latin-American debt crisis in the early 1980s, sovereign risk appeared to have disappeared from the scene. However, a series of international crises in the late 1990s have brought the issue of sovereign risk back on the agenda. First, the Asia crisis in 1997 hit international financial markets, followed by the Russia crisis in 1998 and the Argentina meltdown in 2001-2002. Moreover, interest rates on Brazilian debt were rising throughout the first half of 2002 for fears of the populist politician Lula being elected. Apparently, international investors expect more domestically oriented, protectionist policies and a possible default on Brazil's international debt.

Unsurprisingly, a large theoretical and empirical literature has emerged on the analysis of sovereign risk. On the theoretical side, a distinction has been made between ability-to-pay models and more modern willingness-to-pay models. The first category focuses on the development of solvency and liquidity ratios to determine the creditworthiness of individual countries. The more modern approach uses concepts from financial contracting theory and asymmetric information problems to investigate in which circumstances a country may choose not to honor its international debts, even if it could afford to do so in principle. Obstfeld and Rogoff (1996) provide an excellent overview of this type of literature. In general, both strands of literature yield a number of potential indicators of forthcoming debt crises. However, empirical studies generally show that forecasting sovereign defaults is far from easy. The performance record of both commercial rating agencies and academic research in this respect is poor; see for example Oetzel, Bettis and Zenner (2001). A prime example of the difficulties in forecasting financial crises and country defaults is the 1997 Asian debt crisis. This crisis took many investors completely by surprise. Ex post, well-known economists claimed that there was merely an irrational financial panic, while the economic fundamentals of the countries in question were solid. In this paper we develop and apply a method to test such claims. In particular, we show in this paper that the above claim may have been a misperception, which could have been avoided using our procedure.

To this purpose, we return to an older literature that focuses on simple debt dynamics. The model by Amano (1965) is the simplest variant of a model type, which explains the occurrence of debt crises in a neoclassical framework solely due to shocks.

In addition, the model generates conditions under which the traditional idea of a debt cycle can be shown to hold or not to hold respectively.[1] Amano (1965) does not go into details of the debt cycle but rather emphasizes that a country's GNP may grow at a rate larger than the natural one if it saves much and foreign investment (credit) income is a large share of GNP. We will use the model to show analytically (i) that the model can show debt crises only in the form of a shock, and (ii) that a dynamic debt process can be derived graphically with several possible outcomes.

These outcomes can be dichotomized as follows. First, a debtor country can be on a stable path towards a steady state. In the final steady state, the country will remain a debtor if its saving ratio is low. However, it can also become a creditor in the steady state if its saving ratio is high enough. Second, the country can be on an unstable path without ending up in a steady state. In that case, the country can become a permanent creditor – again if its saving ratio is high enough. In a sense, we might call this the stable arm of the unstable path. Amano (1965) emphasizes the latter case, in which the country's GNP is dominated by foreign income and grows at a rate higher than the natural rate. Alternatively, the country can be situated on the unstable arm of the unstable path and experience an exploding debt, inevitably leading to a crisis. We derive each of these cases from a linear differential equation in debt per unit of GNP.

Subsequently, we estimate these equations for Korea, Thailand and Malaysia respectively both for the whole period 1975-2000 and for shorter periods. Our purpose is to show that a country's debt dynamics can switch between the stable and unstable paths over time in response to unexpected shocks. Evidence that the country is situated on the unstable path at some point in time potentially contributes to the analysis of its creditworthiness and to the prediction of the possibility of a forthcoming debt crisis. We demonstrate that all three countries investigated here were facing deteriorating domestic fundamentals – reflected in potentially unstable debt dynamics – prior to the breakout of the Asia crisis.

The paper is structured as follows. In section 2 we present the model, which we use to derive the various debt dynamic processes in section 3. In section 4 we present data

[1] For alternative and more complex models of debt cycles we refer to Fischer and Frenkel (1972), Frenkel and Fischer (1974a,b), Onitsuka (1974) and Hori and Stein (1977).

and estimation procedure for the three Asian countries under investigation. We present and discuss the results in section 5. The summary and conclusions follow in section 6.

2. A simple neoclassical growth model with perfect capital mobility

We start from a simple neoclassical growth model with a fixed rate of interest. Due to the assumption of perfect international capital mobility, the domestic interest rate is given and fixed at the level of the world interest rate. In addition, we assume that output (Y) is produced by the production factors capital (K) and labor (L) with labor-augmenting technology (A). The production function is linearly homogeneous with positive first and negative second partial derivatives:

$$Y = F(K,AL) \qquad (1)$$

Profit maximization of the representative firm yields the marginal productivity condition

$$r = f'(k) \quad \text{with} \quad k \equiv K/AL \quad \text{and} \quad \hat{K} = \hat{A} + \hat{L} \equiv g \qquad (2)$$

Since r is given, the marginal productivity condition determines the capital/efficient-labor ratio. The capital stock K consists of domestic capital W and foreign capital or debt D. Conditional on the level of the domestic stock of capital W, the country can choose its desired level of foreign indebtedness D to make equation (2) hold at any moment. The labor force L grows at rate n. In the steady state the capital stock K and output Y grow at the same constant rate g, keeping k constant.

We assume goods market equilibrium to hold. In a small open economy under perfect capital mobility, the country then can finance any domestic investment in excess of national savings through the international capital market. Excess investment results in an equal increase in the country's international indebtedness, as reflected in equation (3):

$$\dot{D} = \dot{K} - S\,, \qquad (3)$$

Dots indicate the change in a variable per unit of time. Domestic savings is assumed to depend on the country's income net of foreign interest payments, with marginal propensity to save equal to s:

$$S=s(Y-rD), \tag{4}$$

Combining equations (2)-(4) yields a differential equation for the change in the country's external debt per period.

$$\dot{D} = gK(0)e^{gt} - s[Y(0)e^{gt} - rD] \tag{3'}$$

For a formal treatment of this differential equation we refer to appendix A. Note that these debt dynamics are derived from the goods market equilibrium condition and therefore reflect only the 'fundamentals': investment and savings. In the next section we provide a more intuitive explanation.

3. Debt cycle versus permanent debtor position

First, we slightly rewrite equation (3'). From the marginal productivity condition (2), we see that r = βY/K where β is the initial capital share.[2] Substitution leads to:

$$\dot{D} = K(0)[g - sr/\beta]e^{gt} + srD \tag{3''}$$

Subsequently we express D in terms of GDP (Y). To this purpose, we first divide both sides of equation (3'') by D, subtract g – the steady-state growth rate of Y – and then multiply by D/Y.[3] The result is

$$\dot{d} = \underline{k}[g - sr/\beta] - [g - sr]d \tag{5}$$

where d denotes the ratio of debt over GDP (D/Y). In equation (5), $\underline{k}$ is the capital-output ratio corresponding to equation (2). The sign and size of the slope and the intercept depend on the (unobserved) parameters g, s, β, and r and can be positive or negative. The three possible cases – corresponding to the different stable and unstable paths of the

[2] This expression is only used to eliminate Y(0) in the differential equation.

[3] Alternatively, we may express D as a percentage of the stock of efficient labor (AL). Equation (5) is unaltered by this transformation, apart from the definition of d, which now is D/AL. Unreported results show that our empirical results are qualitatively the same for both definitions of d. We prefer to use GDP as the denominator as both GDP and D are generally available in US$, whereas AL is only available in real terms. Hyperinflationary periods make conversion much more problematic when AL is used to normalize.

differential equations – are shown in figure 1. In this figure *d* is on the horizontal axis, while $\dot{d}$ is on the vertical one.

If sr/β> g > sr, both the slope and the intercept are negative. The corresponding line in figure 1 is indicated by SC. The stable stationary point (I) is at negative values of d, implying that the country becomes a creditor in the long run. In point I, the ratio of foreign wealth (D) to GDP remains constant if there are no more shocks. Both D and Y grow at the same rate *g*. Since D is negative, it implies the country holds positive net foreign assets in the steady state. Suppose the country starts out as a debtor at positive values of *d*. Subsequently, *d* will decrease to converge to the steady state along line SC. It can be easily shown that initially the level of external debt D will still grow – though at a slower pace than GDP – corresponding to a current account deficit. Over time, the current account deficit is reduced and turns into a surplus with reduction in D. This case is the traditional view on the debt cycle in which every country eventually becomes a creditor (non-debtor).

If g>sr/β, and g>sr, the slope remains negative, but the intercept becomes positive. This case is captured by line SD in figure 1. Now, the country converges to a steady state (II) where *d* is positive. The economy remains a debtor because of its low savings ratio and/or the low world interest rate. The low savings rate forces the country to externally finance its domestic investment, while the low world interest rate helps to reduce the cost of doing so. In the steady state, D again grows at the rate g, which implies that the country remains a capital importer. The current account is not balanced in the long run unless the horizontal intercept of the differential equation is at the origin.[4]

If g-sr<0, the slope is positive and the vertical intercept is negative. This is the unstable case, labeled U in figure 1. By implication, g –sr >0 is a stability condition, but obviously, there is no reason to a priori impose such stability assumption. The stationary but unstable point (III) is at a positive value of *d*. If d(0) is less than in the stationary point, the economy starts moving to the region of negative and continuously declining *d*.

[4] In the literature it is often assumed that the current account must be balanced in the long run, based on the assumption that creditors will try to increase their welfare by not allowing other countries to borrow permanently (see Cohen 1991). Whether this is the case, however, is an empirical as well as a theoretical question. In our model we do not explicitly impose the restriction of a balanced CA.

In that case, the country will be a creditor in the long run, where GNP grows faster than GDP. This was the point Amano (1965) tried to make.

A starting point to the right of the stationary point implies that D(0) sufficiently exceeds K(0), as shown in appendix A. The country then starts out with more debt than capital and will have negative current wealth for all periods. Clearly this is unsustainable in the longer run. A country on such explosive path will be forced to adjust, one way or the other.[5] As D(0) > K(0) seems to be an unrealistic case from an empirical point of view, we will interpret explosive debt dynamics as a case of sovereign risk when it appears in our estimates.

In this type of model, a switch from one dynamic process – say the SD line – to another – say the SC line – can only arise due to changes in the underlying parameters of the system, g, s, β, and r.[6] As an example, we will discuss a non-anticipated and permanent upward jump in the world interest rate. If this happens, the marginal product of capital will increase and the optimal amount of capital K to be used will fall. For a given national wealth W, a fall in the desired level of capital K implies that less external debt D is required. As a result less debt is obtained from the international capital market. Alternatively stated, it implies that more domestic wealth is invested abroad at the higher world interest rate level. Such a decrease in capital inflows or increase in capital outflow – even capital flight – thus can be rooted in the economy's fundamentals and need not be a purely monetary phenomenon of irrational speculators. Domestically, the resulting lower marginal product of labor leads to a fall in real wages. This is the social side of the crisis.

We can also describe these dynamics in terms of differential equation (5) and Figure 1. Starting from a situation where the country is a long-run debtor (the SD line), a jump in the interest rate leads to both a counter-clock wise rotation (flatter slope) and a downward shift of the SD line. The economy can move from the situation $g > sr/\beta > sr$

[5] Neher (1970) assumes that debt d grows at the same rate as the capital stock. As we have shown, this is only the case in the steady states of the stable cases. Amano (1965) has treated only the left arm of the unstable case. Our model integrates all these cases and can be seen as a simplified version of the model by Onitsuka (1974).

[6] Of course, there can also be exogenous shocks to d without changing the prevailing differential equation. This moves the economy along the relevant line in figure 1 rather than changing the position of the line itself.

(SD in figure 1) to a situation sr/β > g > sr (SC) or even to a situation sr/β > sr > g (U), depending on the size of the interest rate shock.

A similar analysis can be given for other exogenous events changing the slope and intercept of the differential equation, like for instance a jump in the savings rate *s* or in the rate of population growth *n* or technical change which in turn changes *g.*

In the empirical part of our paper, we will present evidence on the extent to which Korea, Malaysia, and Thailand respectively have switched between the different regimes of debt dynamics over the period 1975-1999. The empirical equivalent of equation (5) that we use in our estimation is:

$$\dot{d} = \alpha_0 + \alpha_1 d(-1) \qquad (6)$$

with $\alpha_0 = \underline{k}(g - sr/\beta)$, $\alpha_1 = sr\text{-}g$. Clearly, the regression coefficients are complex functions of behavioral parameters like the savings rate and exogenous but time-varying variables like the world interest rate. Without additional information on these parameters and variables, we can just report the regression estimates and account for potential time-variation. If more information were available, an extended regression equation could be estimated. For instance, if adequate information on interest rate *r* could be used, one could (nonlinearly) regress $\dot{d}$ on *d*(-1), *r*, and *r***d*(-1). We leave such exercises for future research. Note also that the explanatory variable in equation (6) is lagged one year. This is due to the switch from the continuous-time derivation of our theoretical model to the discrete-time formulation of the empirical model.

4. Data

For our analysis, we need the stock of external debt and the level of GDP for each country. While GDP is readily available both in current and constant prices, this is not the case for developing country's net stock of external debt. What is available is the time series of gross investments and savings for each country. These are flow variables and the difference between the two can be used as a proxy for the change in a country's debt position (D). In order to arrive at an adequate measure of the level of D, we focus on the year 1980 as the benchmark year. The procedure is as follows for each country.

First, we use the IMF Balance of Payments Statistics[7] to find investment income paid to the rest of the world and investment income from abroad in 1980 for each country. The difference corresponds to rD in our model. For an estimate of D, an appropriate value for the interest rate r is needed. To obtain an estimate of r, we compute the ratio of investment income paid abroad in 1980 to the gross stock of external debt in 1980 according to the Global Development Finance database. Dividing net interest payments (rD) by the computed interest rate yields a net foreign debt position D as an initial value for 1980. Subsequently, we cumulatively add (subtract) the gross investment-savings balance for later (previous) years. The resulting debt series is divided by nominal GDP (in mln US $) to arrive at our series d (and its first difference $\dot{d}$). Appendix B contains the data, where the 1980 debt position is printed bold to indicate its benchmark role.

The time paths of debt/GDP ratios for each country can be found in figure 2. Korea experiences a relatively steep decline in its debt ratio between 1985 and 1988. Subsequently, a gradual rise takes place to a peak in 1997. After the crisis, the debt ratio declines quickly. The debt ratios of Malaysia and Thailand are quite similar after 1980. First, they show a rise till the mid 1980s, followed by decline. The latter is steeper for Malaysia than Thailand. After 1989 a similar gradual rise in debt ratios occurs in both countries, comparable to the one in Korea. The Asia crisis leads to a turn around in Malaysia and Thailand as it did in Korea. From 1998 onwards, all debt ratios fall. In the 1990s, the level of the debt ratio is considerably lower in Korea than in the other two countries. Note that a rising debt ratio is not necessarily a sign of a forthcoming crisis according to our theoretical model. A country on the left arm of the stable debtor (SD) line in figure 1 would be characterized by a combination of a rising debt ratio and a declining (but positive) change in the debt ratio. It is when the level of the debt ratio and the change in the debt ratio increase together that our model predicts an unstable time path.

[7] When sources are not explicitly mentioned the data are from Global Development Finance, 2002.

5. Empirical Results

We first estimate equation (6) for Korea, Malaysia and Thailand over the whole sample period, 1975-2000. The first column for each country in Table 1 contains the results. The point estimates of slope and intercept are consistent with the stable dynamics of our theoretical model. For Thailand, the strongest results are obtained. The intercept is positive and significant according to standard critical values, while the slope coefficient is significantly negative. It suggests that Thailand had debt dynamics consistent with the stable debtor case. For Korea and Malaysia, the significance of the results is weaker and coefficients are insignificant. Both slopes are negative. Since the intercepts are not significantly different from zero, the evidence suggests a steady state debt ratio of about zero, implying these countries would neither be a debtor nor a creditor.

A caveat is in order, however. The dynamic specification of equation (6) can be interpreted as a simple Dickey-Fuller unit root test – or equivalently a stability test – of the debt ratio. It is well known that standard critical values are invalid in case the dependent variable in fact is non-stationary. Moreover, the Durbin Watson statistics suggest a considerable amount of serial correlation in the residuals for each country that needs to be accounted for. Therefore, we run an extended regression including additional lags of the dependent variable to mop up serial correlation. The results are in the second column for each country in table 1. Using the correct 10 percent MacKinnon critical t-values, we reject a unit root for Malaysia, but fail to do so for Korea and Thailand. Equivalently, we cannot formally reject the debt ratio in Korea and Thailand to be a random walk and behaving as an unstable process. Nevertheless, the results in terms of sign and size of the intercepts and slopes are qualitatively similar to the original simple regression. For Malaysia the intercept turns significantly positive. Both Thailand and Malaysia appear to have been stable debtor (SD) countries on average, while for Korea a steady state debt ratio of zero is implied.

In our view, the lack of statistical evidence to be able to strongly reject a unit root is not particularly worrisome. Part of the lack of strong statistical results may come from the short period we are investigating. It is well known that unit-root tests have low power in small samples. Unfortunately, there is little we can do to solve this problem since extending the sample backward is infeasible due to data limitations. Only time can solve the issue. Another explanation for the lack of statistical significance is that the debt dynamics of the countries under consideration have switched back and forth between the three different regimes (SD, SC, and U). In that case, the average estimate will be biased towards zero and insignificance.

In fact, we are interested exactly in the issue if and when countries switch between regimes and to what extent it contributes to predicting that we are moving into the direction of a crisis (from stable debtor to stable creditor to an unstable situation). Therefore, we would like to identify the sub periods over which different regimes were operative. But small sample problems then become even more overwhelming than in the full sample case. Before presenting at least some evidence of time-variation in the debt dynamics in Korea, Malaysia and Thailand, we shortly discuss the routes we explored but not used in the end.

First we re-estimated equation (6) with dummy variables (for both intercept and slope for economically plausible sub periods for the sub periods. As could be expected, results failed to gain significance due to the lack of degrees of freedom. Moreover, we could not be sure we had picked the right timing of regime switches. More sophisticated methods to endogenously determine the timing of structural breaks were inapplicable due to the short time series.[8] Second, we tried Markov regime-switching and state space estimation with random walk coefficients. Neither approach yielded convergence or interpretable results, again due to the short length of our time series.

Therefore, we turned to a rolling regression approach, where equation (6) is estimated for consecutive windows of six, seven, and eight years respectively. In figure 3 we present the time paths for estimated intercept and slope of the Korean debt dynamics. Figures 4 and 5 contain corresponding information for Malaysia and Thailand respectively. Note that the point estimates of slope and intercept are dated on the last year included in the specific window. That is, the first observation in the 6-year rolling window regressions is put at 1980 and represents the regression result for the period 1975-1980. Due to the small samples, regressions coefficients typically fail to gain

[8] See Bai and Perron (1998) and Perron and Vogelsang (1992) for such methods.

significance. For this reason, standard deviations are not reported. In the discussion, we focus exclusively on the point estimates of intercept and slope.

5.1 The 1997 Asia Crisis

The Asia crisis started in Thailand. In May 1997 the central bank of Thailand imposed new restrictions on international capital flows. July 2nd, the bath devalued. Malaysia and Korea followed later that year. We start with a discussion of the results for Thailand in Figure 5, as that country was the first one in crisis.

The results in figure 5 shows that the slope of the regression equation starts gradually rising already around 1990.[9] At that time, the estimated slope is around –0.6, which implies a stable regime for the debt dynamics. But already in 1993 it is about zero in the 6-year window. According to the theoretical model, a positive slope indicates trouble and forthcoming instability. Clearly, the 6-year window offers a faster indication of new developments at the expense of greater uncertainty. For the 7-year and 8-year windows respectively, the slope coefficient arrives at zero in 1993 and 1994 only, thus lagging behind the 6-year window. On the other hand, the 6-year window shows a small turnaround of the estimated slope coefficient in the mid-1990s, which might be interpreted as a signal that potential trouble is receding. The 7-year and especially the 8-year results are more stable and show less of a turnaround. In 1996, the 6-year window shows an upward surge in the slope estimate, which is reinforced when the crisis year 1997 is included. The data underlying Appendix B show that the discrepancy between domestic savings and investments was growing steadily between 1992 and 1996, especially due to increased investment. Both, the debt ratio and its change were increasing since 1993 (see appendix B) indicating that the economy was on the unsustainable arm of the unstable debt dynamics. Only after the decline in stock and real estate prices in 1997 do investments return to the overall savings level. In summary, we conclude that the debt situation in Thailand was deteriorating since the early nineties. At the minimum, it provided an early warning of a potentially unsustainable development.

[9] Note that the slope coefficient starts around zero in 1980, indicating potential instability then as well. Unfortunately, our data go back insufficiently long to analyze the time path of the coefficients in the 1970s. Interestingly, Glick and Hutchison (2001) identify the early 1980s as a period in which both banking and currency crises occurred in Thailand using a completely different method.

Korea was hit a few months later. It has been suggested that contagion effects due to herd behavior of foreign investors was the main source of the Korean crisis. However, the regressions coefficients in figure 3 do show an upward trend in the slope estimate in the mid 1990s. Especially the 6-year window again gives an early warning. Starting in 1994 the slope estimate rises. It is around zero in 1996 and positive in 1997. For the 7-year and 8-year windows, the increase of the slope starts later, but is more pronounced. In 1996, the slope estimate in the 8-year window exceeds zero. Similar to Thailand, the Korean debt ratio increased substantially prior to 1997. The gap between investment and domestic savings increased six fold. While the development of the Korean debt dynamics points at a potentially unstable debt path, we do note that the level of the debt ratio was quite low compared to Thailand and Malaysia. In that respect, we cannot exclude the possibility that the events in Thailand played a role in triggering the crisis in Korea. The deteriorating fundamentals in Korea nevertheless provided a fertile soil. As a side remark, we note slope coefficients as large as +0.8 for the 6-year (in 1986) and 7-year window (in 1987). To interpret this as an indicator of a forthcoming crisis would be a mistake.[10] Appendix B may clear why. In the early 1980s, Korea actually is on the left arm the unstable line (U). That is, the level of the debt ratio falls (due to growing current account surpluses) while the corresponding change in the debt ratio is negative. As a result, Korea actually becomes a net creditor in 1989 for a few years. If this trend would continue, it would lead to unlimited positive net foreign assets for Korea.

For Malaysia, the picture is somewhat less clear, though the estimated slope coefficients are similar to the Korean ones in the mid 1990s. The first signs of deteriorating fundamentals – as reflected in rising slope coefficients – only become visible after 1994, because the debt ratio and its change are increasing from 1992 through 1997 with the exception of 1996. The slope gets positive in 1997 for the 6-year and 8-year windows and in 1998 for the 7-year window. The results also point at potential instabilities around 1985 when all windows show a peak in the slope coefficients. For the 7-year and 8-year windows, the coefficient is about zero in 1985. Glick and Hutchison

[10] Glick and Hutchison (2001) indeed fail to report a banking and/or currency crisis in Korea in the 1980s. The only crisis they report is in 1997.

(2001) report a banking crisis in Malaysia in 1985-1988 and a currency crisis in 1986. Our approach apparently is able to pick up the risk of such crises slightly before.

In general, the data and our empirical results suggest that switches to undesirable and unstable debt dynamics tend to be sudden and short-lived, making them hard to predict. These characteristics make it also difficult to find statistically convincing proof of our model. Cross-country comparison of the estimated intercept and slope coefficients in a given year is hampered by the relatively large standard deviations of the coefficients. We do show, however, that the different qualitative regimes of the theoretical model can be observed in reality. More in particular, we demonstrate that all three countries investigated here were facing deteriorating domestic fundamentals prior to the breakout of the Asia crisis. It suggests internal problems probably played a significant role with respect to the timing of the crisis. That does not exclude the possibility that non-fundamental behavior of international investors had an independent effect. For each of the three countries, our simple approach did manage to give some advance warning of potentially dangerous developments. Moreover, our approach did not give false warnings for any country over the period 1980-2000. Other periods for which we find deteriorating debt fundamentals coincide with crisis periods as reported in Glick and Hutchison (2001). Additional research covering more countries and longer periods is needed to determine the robustness and reliability of our approach. Nevertheless, the first results are promising in our view.

6. Conclusion

In this paper we develop a simple neoclassical growth model with perfect international capital mobility to analyze the international debt dynamics of developing countries in general and the events in Korea, Malaysia and Thailand in the run-up to the 1997 Asia crisis in particular.

We show that three different regimes can be distinguished: a stable regime where the country in the end always converges to a steady state debtor position, a stable regime where the country ends up in a steady state creditor position and an unstable regime which leads the country either to become a creditor without ever reaching a steady state or to get on an unsustainable path with an exploding debt ratio. Switches between these regimes can be caused only by shocks in the world interest rate or behavioral parameters like the country's savings rate or rates of population growth and technical progress.

A switch from a stable debtor to a stable creditor or even an unstable creditor regime of a growing debt ratio is a sign of forthcoming trouble. If one would be able to identify such shift in advance, it would contribute to our ability to predict debt crises and to our understanding of such crises.

To investigate this issue empirically, we construct debt ratio series for Korea, Malaysia and Thailand over the period 1975-2000. Subsequently, we use these series to do the simple debt dynamics regression derived from the theoretical model. Over the full sample, the evidence suggests that debt dynamics evolved according to the stable debtor case in all three countries, although the results in some cases lack formal significance. Especially for Thailand, the results are convincing. They are weaker for Malaysia and particularly Korea.

Both the small sample and the possibility of short-lived intermediate switches between regimes over time prevent us from obtaining stronger statistical evidence. Using a rolling regression technique, we find that indeed occasional switches to the unstable regime occurred. We demonstrate that all three countries investigated here were facing deteriorating domestic fundamentals prior to the breakout of the Asia crisis. It suggests internal problems probably played a significant role with respect to the timing of the crisis. That does not exclude the possibility that non-fundamental behavior of international investors had an independent effect. For each of the three countries, our simple approach did manage to give some advance warning of potentially dangerous developments. Moreover, our approach did not give false warnings for any country over the period 1980-2000. Other periods for which we find deteriorating debt fundamentals coincide with crisis periods as reported in Glick and Hutchison (2001).

In general, our model appears a useful tool of the analysis of a country's debt dynamics. Additional research covering more countries and longer periods is needed to determine the robustness and reliability of our approach. Extending the theoretical model to include for instance interest rate spreads and economic features that are typical of developing countries such as imported capital goods, which would link the goods market equation to the balance of payments equation provide another route for additional research. Nevertheless, the first results are promising in our view.

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Appendix A: Solution of the differential equation

The differential equation has the solution

$$D(t) = D(0)e^{srt} + K(0)B(e^{gt} - e^{srt}) \qquad \text{(A1)}$$

with B≡(g-sr/β)/(g-sr). In the long run the larger of the two growth rates will dominate the process:

$$\begin{aligned} &\lim D(t)_{t\to\infty} = \\ &e^{gt}K(0)B = K(t)B \quad \textit{if} \quad g - sr > 0, \quad \textit{or} \qquad \text{(A2)} \\ &e^{srt}[D(0) - K(0)B] \quad \textit{if} \quad g - sr < 0 \end{aligned}$$

As sr/β>sr, we can distinguish four cases, which are interpreted as alternative levels of the savings ratio in Onitsuka (1974):

1.	g > sr/β > sr	implies 1 > B > 0	and	K(t) > D(t) > 0
2.	sr/β> g > sr	implies B < -1	and	K(t) > 0 > D(t)
3.	sr/β > sr > g	implies B > 1	and	K(0) > D(0) > 0 > D(t)
4.	sr/β > sr > g	implies B > 1	and	D(0) > > K(0) > 0

In the first case, the country remains a debtor, but the capital stock is larger than the debt. In the second case the country becomes a creditor and foreign wealth D is larger than capital K. In the third case, assuming D(0)-K(0) < 0, D becomes negative and the country is again a creditor in the long run. In the fourth case, if D(0)-K(0) = - W(0) > 0 and sufficiently large, D remains negative, grows at the rate *sr* while capital K grows at rate g. This case if fairly unrealistic because it implies that the country has negative current wealth from the beginning and through eternal times while we see from the data that all countries have positive savings at almost all times.

Appendix B: Data

	Korea					Malaysia					Thailand				
year	- CA (mln$)	Debt (D) (mln$)	GDP (Y) (mln$)	d=D/Y (%)	d-d(-1) (%)	- CA (mln$)	Debt (D) (mln$)	GDP (Y) (mln$)	d=D/Y (%)	d-d(-1) (%)	- CA (mln$)	Debt (D) (mln$)	GDP (Y) (mln$)	d=D/Y (%)	d-d(-1) (%)
1975	n.a.	10238	21132	48,4	3,5	270	5492	9890	55,5	3,8	606	-4629	14883	-31,1	7,1
1976	581	10819	28921	37,4	-11,0	-710	4782	11754	40,7	-14,8	419	-4210	16985	-24,8	6,3
1977	522	11341	37077	30,6	-6,8	-470	4312	13975	30,9	-9,8	1093	-3117	19779	-15,8	9,0
1978	1995	13336	50068	26,6	-4,0	-145	4166	16658	25,0	-5,8	1150	-1967	24007	-8,2	7,6
1979	5151	18487	64124	28,8	2,2	-936	3230	21603	15,0	-10,1	2086	119	27372	0,4	8,6
1980	4852	**23340**	62210	37,5	8,7	279	**3509**	24937	14,1	-0,9	2077	**2197**	32354	6,8	6,4
1981	4044	27384	69575	39,4	1,8	2452	5961	25463	23,4	9,3	2570	4767	34847	13,7	6,9
1982	1887	29271	74453	39,3	0,0	3614	9575	27287	35,1	11,7	1005	5772	36590	15,8	2,1
1983	965	30236	82317	36,7	-2,6	3651	13227	30683	43,1	8,0	2881	8654	40043	21,6	5,8
1984	779	31015	90578	34,2	-2,5	1699	14926	34566	43,2	0,1	2093	10746	41798	25,7	4,1
1985	534	31549	93460	33,8	-0,5	638	15564	31772	49,0	5,8	1544	12290	38901	31,6	5,9
1986	-4824	26725	107620	24,8	-8,9	124	15688	28243	55,5	6,6	-248	12043	43097	27,9	-3,7
1987	-10276	16448	135184	12,2	-12,7	-2564	13124	32182	40,8	-14,8	364	12407	50535	24,6	-3,4
1988	-14475	1974	180612	1,1	-11,1	-1867	11257	35272	31,9	-8,9	1600	14007	61668	22,7	-1,8
1989	-5412	-3439	220710	-1,6	-2,7	-315	10942	38849	28,2	-3,7	2527	16534	72251	22,9	0,2
1990	1877	-1561	252622	-0,6	0,9	837	11779	44024	26,8	-1,4	7276	23809	85345	27,9	5,0
1991	8246	6684	295234	2,3	2,9	4182	15962	49134	32,5	5,7	7612	31421	98234	32,0	4,1
1992	3991	10675	314737	3,4	1,1	2168	18130	59151	30,7	-1,8	6302	37723	111453	33,8	1,9
1993	-978	9697	345716	2,8	-0,6	2990	21120	66894	31,6	0,9	6364	44087	125213	35,2	1,4
1994	3789	13486	402523	3,4	0,5	4551	25671	74481	34,5	2,9	8080	52167	144513	36,1	0,9
1995	8296	21782	489258	4,5	1,1	8656	34328	88832	38,6	4,2	13550	65717	168280	39,1	3,0
1996	23228	45011	520205	8,7	4,2	4476	38804	100852	38,5	-0,2	14685	80402	182413	44,1	5,0
1997	6641	51651	476486	10,8	2,2	5960	44764	100169	44,7	6,2	1319	81721	151137	54,1	10,0
1998	-40399	11253	317079	3,5	-7,3	-9708	35056	72175	48,6	3,9	-14317	67403	111909	60,2	6,2
1999	-24599	-13346	406070	-3,3	-6,8	-14179	20878	79037	26,4	-22,2	-12426	54977	122055	45,0	-15,2
2000	-11209	-24555	457219	-5,4	-2,1	-18947	1931	89659	2,2	-24,3	-8816	46161	122166	37,8	-7,3

Table 1 Simple debt dynamics regressions, 1975-2000

	Korea		Malaysia		Thailand	
Intercept	-0.01		0.08	0.14	0.06	0.05
	(0.40)		(1.24)	(2.62)	(4.28)	(2.60)
debt (-1)	-0.08	-0.05	-0.28	-0.44	-0.14	-0.13
	(1.29)	(-1.50)	(1.64)	(2.89)	(3.20)	(2.61)
d(debt(-1))		0.93		0.76		0.35
		(4.97)		(4.20)		(1.87)
d(debt(-2))		-0.47				
		(2.65)				
Adj R^2	0.026	0.512	0.066	0.441	0.278	0.362
SE of regression	0.052	0.035	0.093	0.071	0.048	0.046
Durbin-Watson	0.688	2.028	0.757	1.773	1.252	1.82

Note: t-statistics are in parentheses.

Figure 1 Three different regimes for debt dynamics

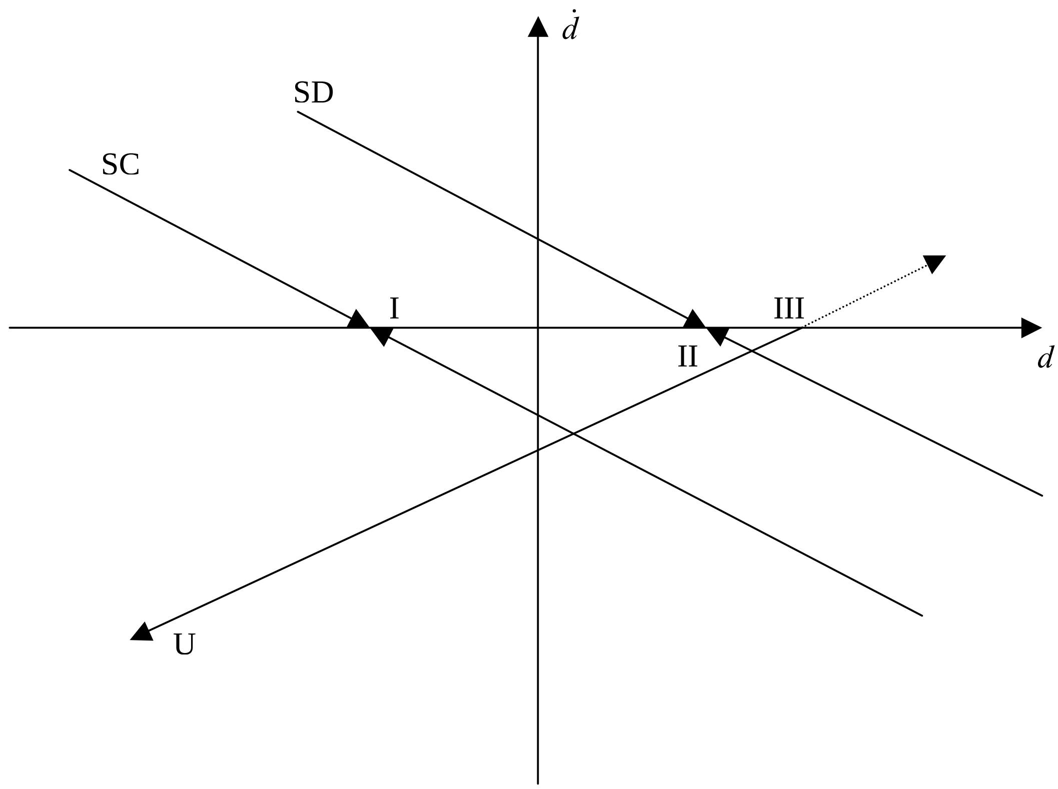

Figure 2 Asian Debt Ratios 1975-2000

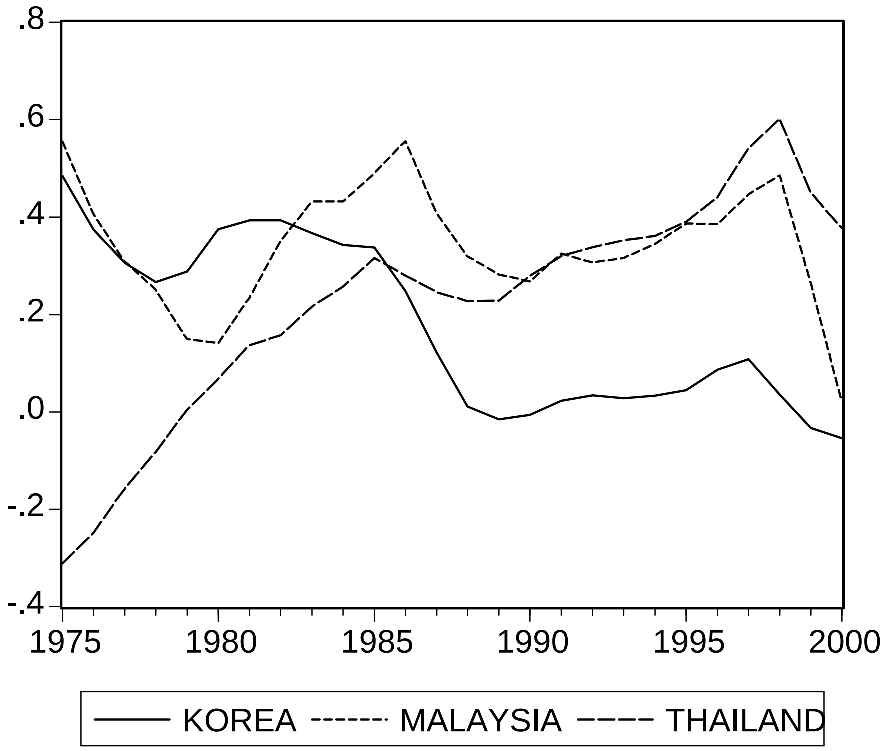

Figure 3 Rolling window results for Korea

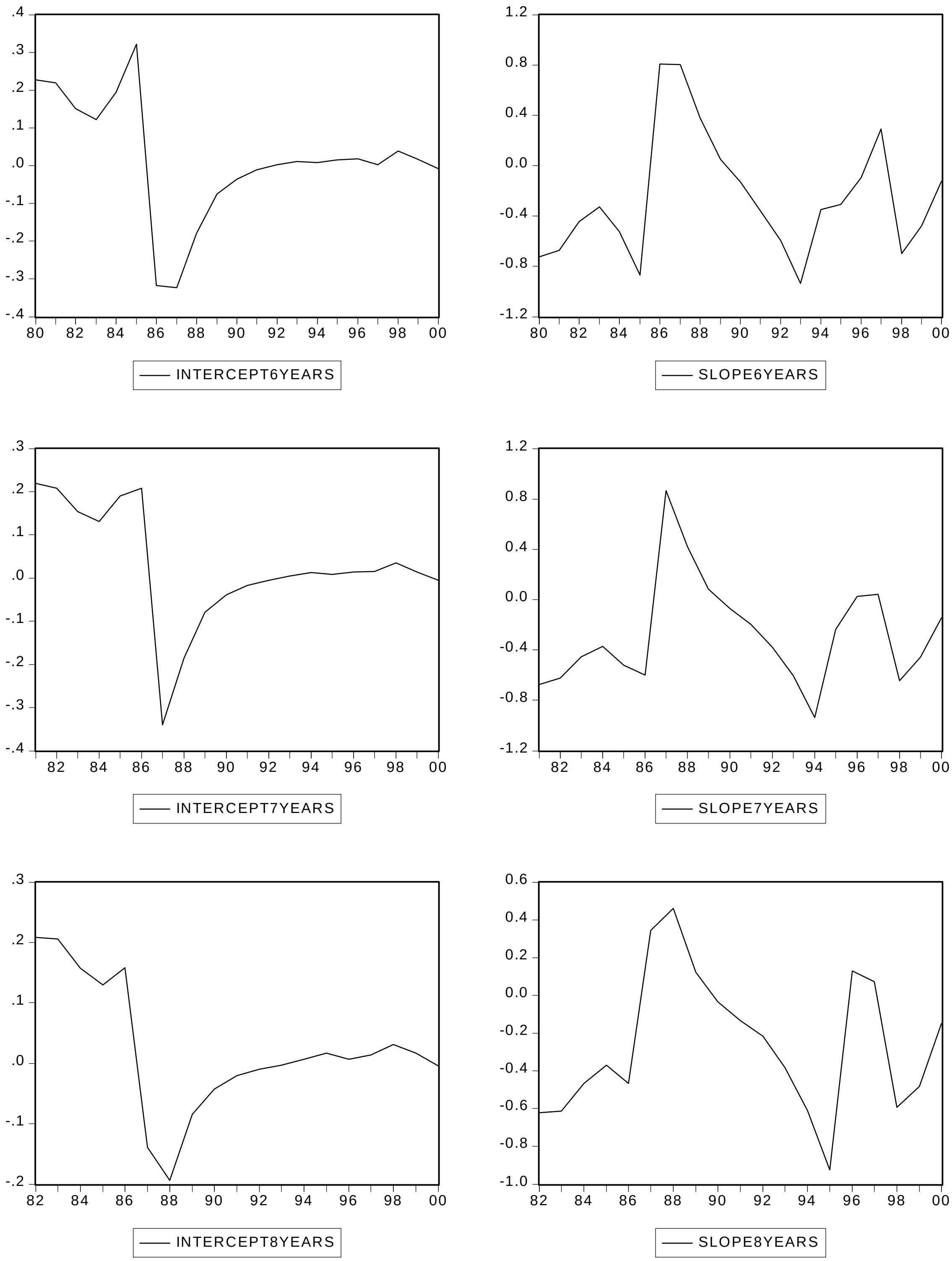

Figure 4 Rolling window results for Malaysia

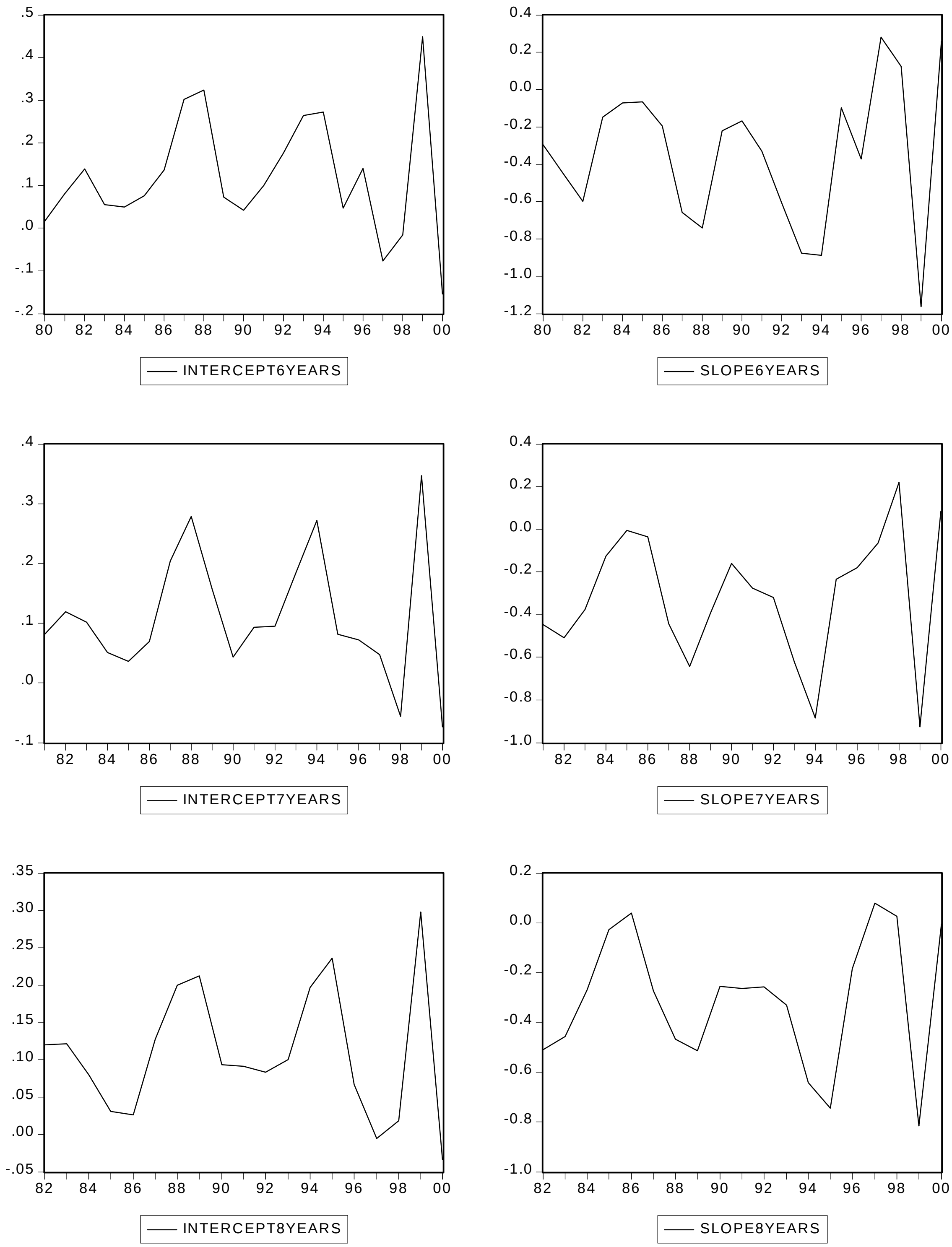

Figure 5 Rolling window results for Thailand