

Three Faces of Crisis 1997 – Lessons to Learn

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Abstract:

Crisis 1997 was particularly stunning for its three characteristics: its abrupt onset, its virulence against the apparently healthy and its wide and unexpected reach. To prevent recurrence, we need thorough understanding. Our focus is on three aspects not yet studied in the literature. We argue that:

A. The international pattern of growth in recent decades leads to unpredictable real exchange fluctuations

B. The political economy causes some states to engage in unsupportable foreign borrowing

C. Uncertainty regarding international lending institutions translates local shocks to global crisis

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1. Introduction

Crisis 1997 – the third and the last crisis of the 1990 – is intriguing for: (a) its *abrupt* onset, (b) its *wide-ranging* reach and (c) its *virulence* against apparently vigorous victims. A firm understanding of this menace is necessary to prevent its recurrence. To fully account for its complexities, we do not look for a single model but address here three aspects in turn.

2. The Political Economy of Foreign Debt

Crisis 1997 is unnerving because it has devastated economies with supposedly sound macro-economic fundamentals and enjoying sustained rapid growth. Korea was a new entrant of OECD, and a showcase for 'getting interventions right' (Rodrik, 1995). Malaysia had won accolades from the IMF right up to the eve of the crisis¹. Thailand was singled out for praise by the World Bank due to its macro-economic management (Christenson et al., 1993). If these economies were not immune, it appears doubtful how any developing economy can be made safe.

Offhand, Crisis 1997 is an anomaly. In East and Southeast Asia, troubles arose from private foreign borrowing, not sovereign debt. As shown in Table 2.1, global crises in the past came from delinquent government in developing economies, or delinquent private firms in developed economies, but not private bad debt in the developing world. It was a bank failure in Austria that triggered the Great Depression and the distress of Latin American governments that made sovereignty debt prominent in international finance. After all, borrowers with dubious credibility can hardly contract loans in such volume to cause transcontinental consequences. Business to business deals are supposedly based upon rational calculations, and risk management is the first principle in finance.

Table 2.1 International Financial Crises and Nature of Borrowing – The Common View

<u>Borrowing Economies</u>	<u>Borrowing Party</u>	
	<u>Government</u>	<u>Private Firm</u>
Developed	Not likely	Likely
Less Developed	Likely	Not likely

Not all victims of Crisis 1997 were Asian² and not all the Asian victims had a debt crisis³. Yet it was Asian debt that gave Crisis 1997 its defining characteristics. These were debts with a difference. To finance rapid growth, the debt of a single Korean business group might outweigh

¹ As Mahathir (pp. 53-4, 1999) has reminded us.

² E.g., Russia and Brazil.

those that covered the Latin American budget deficits. The overt or tacit government guarantee was what made these huge loans credit-worthy to foreign creditors. Regimes of the Asian 'developmental States' are often motivated by the non-economic objective of clinging to power. The evidence is ubiquitous.

Thus, the civil aircraft industry appealed to Indonesia under Suharto, presumably because it was a market (even) the Japanese hesitated to enter. To keep the per capita GDP above the magic figure of 10,000 U. S. dollars, Kim Young Sam's Korea approved short term foreign borrowing rather than a devaluation⁴. To raise national pride, Mahathir built the Petronas towers⁵, bought Britain's Lotus Engineering to launch high-performance cars and constructed the world's largest flag. Behind both Thailand's futile defense of the baht and Hong Kong's successful but costly decision to peg its currency to the U. S. dollar and not to a basket of currencies⁶ politics was involved⁷.

In all times and places, those who hold power are likely to be the ones who love power. If by ballots or bullets, the power to rule can be won easier through economic nationalism, then a governments that gambles for expansion, will also resist market shocks vainly, to the last extremities, making the adjustment costly and abrupt⁸. If rapid growth reflects a society ready to invoke the State against market failure, that society is likely to be prone to government failure, in the particular form of financial crisis. In the end, when bread and circus were enough to trade for allegiance, the Roman public would get the government they deserve. *Caveat emptor!*

In a nutshell, Asian debt arose because of the purposeful actions by a collection of actors:

A populace longing for growth,
A governing party ready to enhance growth by guaranteeing private borrowing,
Entrepreneurs seeking profit under government guarantees, and
Foreign lenders trusting the adequacy of such guarantees.

Left unchecked, these lead to the excessive exposure to unavoidable exchange rate fluctuations⁹.

³ E.g., Hong Kong.

⁴ Chang (p.227, 1998).

⁵ These are the highest buildings in the world.

⁶ from one's trading partners.

⁷ In the latter case, Beijing cannot let the Hong Kong Dollar devalue, so soon after the Handover.

⁸ As Suharto knew correctly, yielding to IMF might save *the economy*, but not *the regime*.

⁹ In one sense, the Korean situation appears to be in sharp contrast with what happened in Taiwan. Yet, for the equally autocratic Nationalists (KMT) then in power, its best option to hold power was its policy stance of 'seeking growth within stability'. That policy was its main appeal to a population traumatized by the hyperinflation decades ago. The long-reign of the KMT (cronyism and all) offered it a credible claim as the defender of stability.

The situation was precarious, but not unprecedented. For example, Korea got into similar situations, not once but twice. What lead matters astray this time? One possible explanation is that the world economy no longer evolves under rational expectations, but under self-fulfilling expectations. This distinction will be dealt with in the next section.

Crisis 1997 is like a wildfire. It ignites with lightning; it spreads by wind, yet it happens only to tinder-dry bushes and forests. In this section, we have seen that the State-backed private foreign debt supplies the spark. In a subsequent section, we shall explain how does the lack of financial transparency facilitate the panic. What remains to be examined next is the world economy that is crisis - prone. It has already happened before. It may wait to haunt us again.

3. Growing into Uncertainty

To a large extent, Crisis 1997 is a debt crisis, arising from international loans. Real life loans are hard to study. The market is incomplete. Moreover, unlike goods that are sold in markets approximating the Walrasian scenario of price-taking agents, loans are project-specific. It is granted not only at a particular interest rate, but also for a definite amount, over a given duration, to a specific borrower, and often for a designated use. Loans granted to produce for export are not to be diverted for real estate purchases¹⁰. In principle, the equilibrium terms of the loan may also depend upon its size, so that in industries enjoying scale economy, a project may be viable only when it exceeds a minimum scale. In such cases, multiple equilibrium may emerge. But for now, this is a complexity we can do without.

By Feldstein and Horioka (1980), international capital movement is usually dominated in volume by domestic saving and investment. For simplicity, we focus here on the equilibrium terms of loans of infinitesimal size, so that our attention is directed to the real exchange rate, where two results have been established in Uchupalanun (1999):

- (A) Multiple equilibrium terms of loans are possible, and
- (B) As the poor catches up with the rich, multiple equilibrium becomes a reality.

For illustration, we present

A Simple Example

For expository ease, we first present the model structure, then demonstrate that multiple solutions exist in the ultimate steady state. Finally we show how multiple equilibrium appears only when the catching-up process is at an advanced stage.

The model structure

There are two countries: the home (West Pacifica) and the foreign (East Pacifica).

¹⁰ Given the same odds, if bankruptcy is a possibility, the borrower prefers a larger stake, which brings a larger gain in success, but not a worse loss in bankruptcy. This is a view the lender never shares.

There is one unit of endowed labor input for each country in each period, $n = 0, 1 \dots$

$$(3.1) \quad L_n = 1 = L_n^*,$$

with the respective labor-augmenting technical efficiency indices,

$$(3.2) \quad 0 < a_n \leq 1 \equiv a_n^*.$$

For the catching up process, the law of motion is simply assumed to be:

$$(3.3) \quad (a_{n+1} - a_n)/a_n = a_n (a_n^* - a_n).$$

With the time unit approaching zero, this process passes to its limit form:

$$(3.3') \quad d \log a / dn = a (1 - a). \quad (\text{The logistic law}).$$

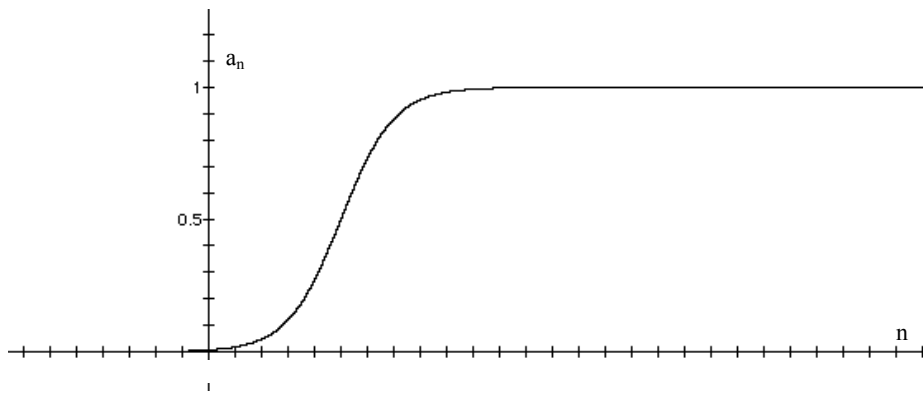


Figure 1 Logistic Dynamics

There are two consumption goods for the representative consumer from each country, local housing, h and h^* , and computers, t and t^* .

The utility indices are assumed to take the simple, fixed coefficient form:

$$(3.4) \quad u = U(h, t) = \min \{h, t\} \quad \text{and} \quad u^* = U^*(h^*, t^*) = \min \{h^*, t^*\}.$$

Computers t and t^* are assembled at home from the tradable products, namely, memory chips and micro-processors and according to a household production function showing constant returns. Again this function is assumed to be the fixed coefficient form. Adopt appropriate notations, we assume both countries enjoy symmetric comparative advantage, namely $m > 1$ (for example, $m = 6$) is a value fixed over time.

	At home			Abroad		
	quantity		unit labor cost	quantity		unit labor cost
	own use	export		own use	export	
Memory chips	x	y	$1/a$	ζ^*		$1/a^*m$
Microprocessors	ζ		$1/am$	x^*	y^*	$1/a^*$

The output of the household production function is.

$$(3.5) \quad t = \min \{x, y^* + \zeta\}, \quad t^* = \{y + \zeta^*, x^*\}.$$

In words, the home (foreign) country enjoys comparative advantage in producing memory chips (micro processors). Doing what one is good for, the home (foreign) country then consumes x (x^*) of that output and export the rest, y (y^*). Alternatively, the home (foreign) country may also produce micro-processors (memory chips) up to ζ (ζ^*). as import-substitute.

The labor allocation for this Ricardian world economy is then represented by,

$$(3.6) \quad h + (x + y) + m\zeta = aL \quad \text{and} \quad h^* + (x^* + y^*) + m\zeta^* = a^*L^*.$$

(3.4-5) can be represented graphically below:

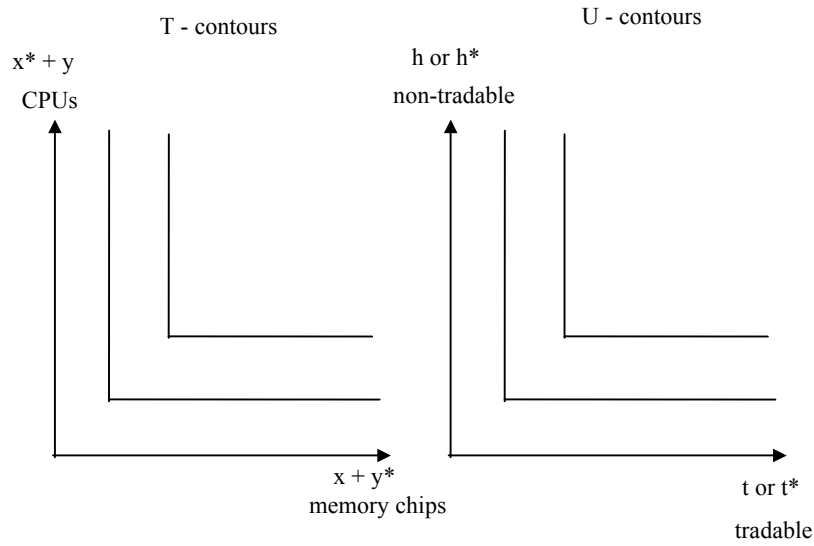


Figure 2 Isoquant and indifference Contours

Chart 1 shows the situation facing the home country in flow diagram,. Labor may be used to produce (a) housing h , or (b) memory chips over which the country enjoys comparative advantage. The latter is both for domestic use, x , and for export, y in exchange for imported microprocessor, y^* . Or, there is also (c) for that matter, the import substitute, ζ .

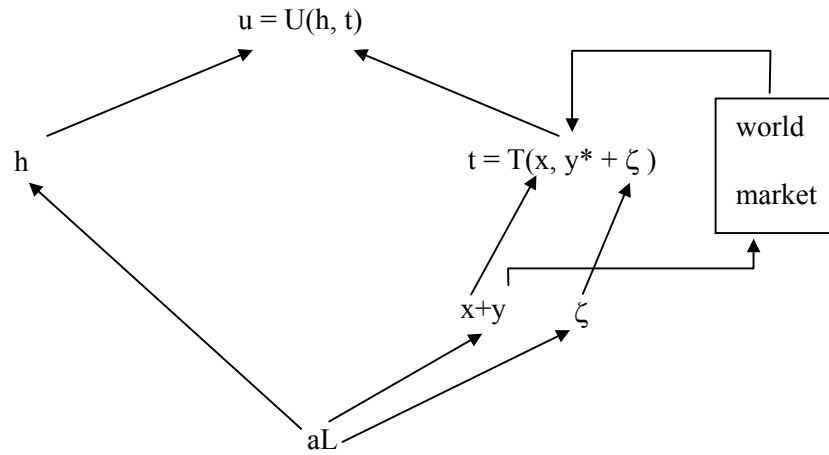


Chart 1 A single open economy

Chart 2 then integrates the trading world as a whole, with the trade flow in dotted arrows..

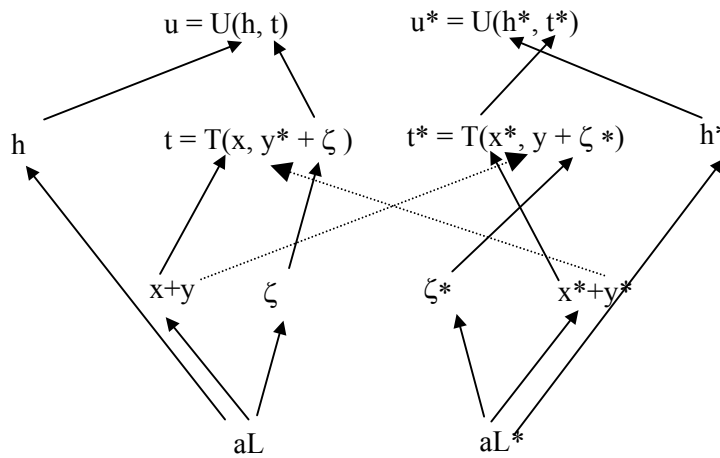


Chart 2 The trading world

Suppose both countries are completely specialized according to their comparative advantage. Then memory chips will only be produced in Pacifica West and microprocessors will only be produced in Pacifica East. In the above chart, the resource flow only follows the solid arrows. Moreover, in terms of input contents, the utility contours of the two countries will be as follows.

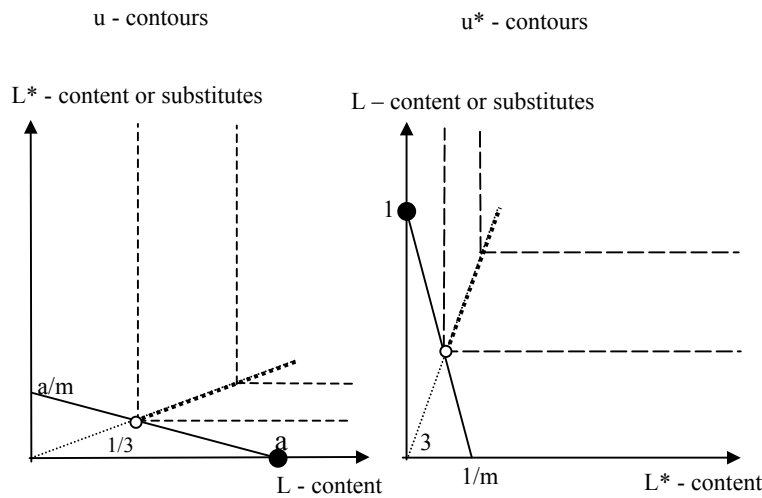


Figure 3 Production and consumption under the fixed coefficient assumptions

The negatively sloped solid line represents a 'production possibility frontier'. It shows the trade off in terms of 'housing and exports' or 'import or import substitutes'. The solid dot stands for the situation that an economy only produces the former but none of the latter. The hollow dot represents the consumption bundle (in terms of domestic labor and 'foreign labor or import substitutes') with the minimal utility a country will ever settle for. That is because such a utility level is attainable under autarky. The positively sloped line in heavy dots indicates 'the income-consumption curve' of that country. This line denotes a 3:1 ratio. Should all labor in both countries command the same wage rate, then half of income will be spent on housing, the other half on computers. Out of the latter, there is a 50% share using inputs the country has natural comparative advantage. The rest will be spent on imports or import substitutes. Positive gains from trade can be secured if the country can consume along that locus.

Trading equilibrium between the equals.

One can now proceed by 'Meade geometry' to decide the three equilibrium, as is done in Figure 4.

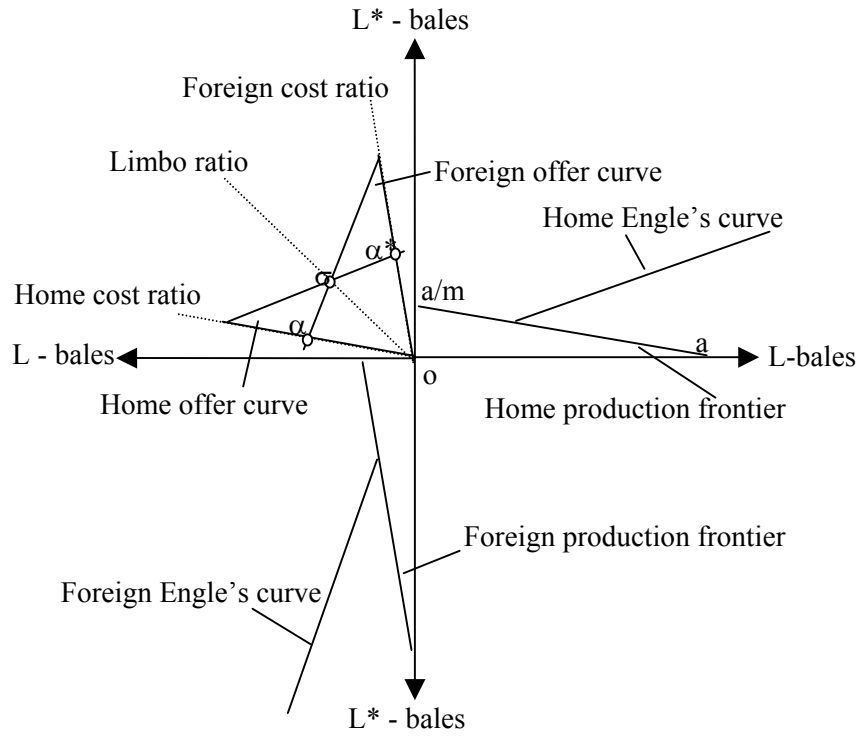


Figure 4 Trading among equals – Meade geometry

By routine analysis, one can summarize the symmetric and asymmetric equilibrium patterns in Figure 5, with a trade vector for each economy, leading from the production vector to the consumption vector. The trading and autarkic indifference curves are drawn for comparison.

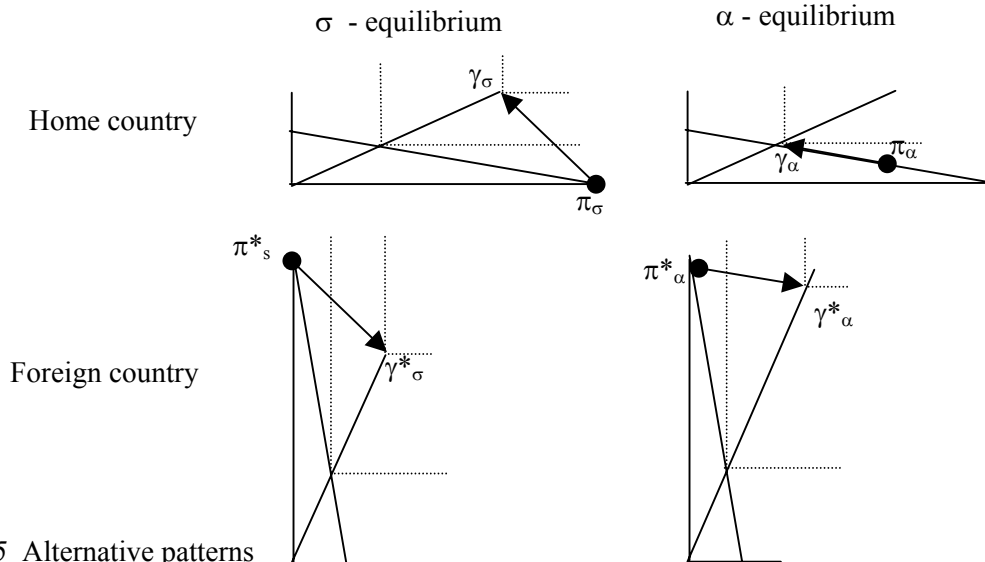


Figure 5 Alternative patterns

More specifically, details about the three equilibrium in Fihure 4 may be tabulated.

Equilibrium	Symmetric equilibrium: σ	Asymmetric equilibrium	
		α	α^*
Home production	π_σ	π_α	π_{α^*}
Home consumption	γ_σ	γ_α	γ_{α^*}
Foreign production	π^*_σ	π^*_α	$\pi^*_{\alpha^*}$
Foreign consumption	γ^*_σ	γ^*_α	$\gamma^*_{\alpha^*}$
Terms of trade	Limbo ratio	Home cost ratio	Foreign cost ratio
Home specialization	Complete	Incomplete	Complete
Foreign specialization	Complete	Complete	Incomplete
Home trade gain	Positive	Zero	Positive
Foreign trade gain	Positive	Positive	Zero

Trading equilibrium between unequals

Consider now Figure 3. Let other things remain the same but the value of a assume a far smaller positive value than unity. This implies there is only a single intersection between the two offer curves, an α^* - equilibrium with the terms of trade equal to the foreign cost ratio. Hence all trading gain accrues to the home country.

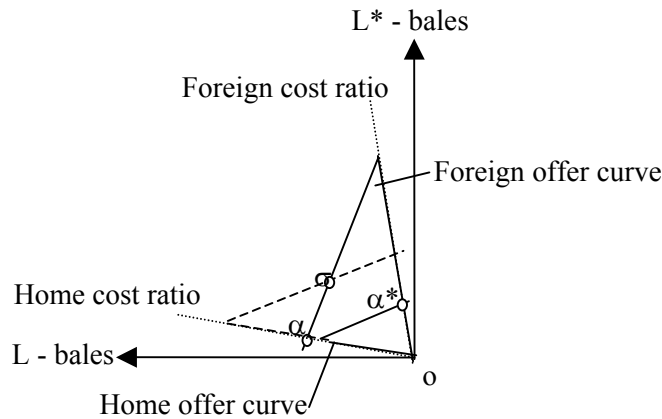


Figure 6 Trading among unequals – offer curves

We now choose the foreign good (micro-processor) as the numeraire, and denote the price of the home good (memory chip) as p . Construct a ray from the origin, with the negative slope p . Find its intersection with the offer curves of the two countries. The difference of the

abscissas of the two intersection points is the excess demand of the home good. Figure 7 presents schematically¹¹, the two patterns of such a schedule.

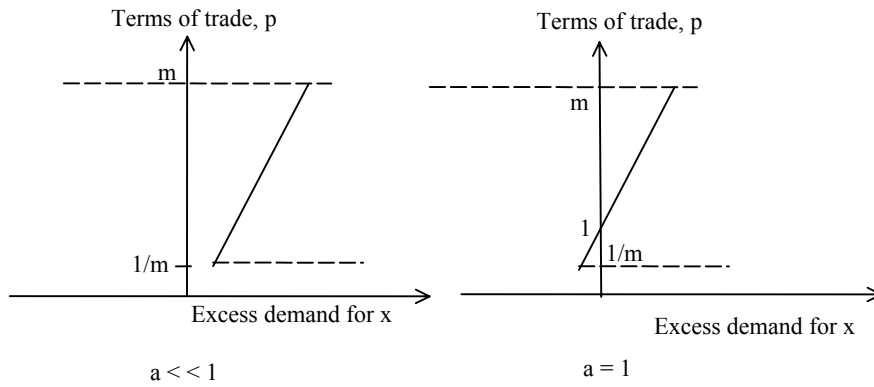


Figure 7 World excess demand curves

In conjunction with Figure 1, we have the equilibrium dynamics with a 'phase transition', displayed in Figure 8 below.

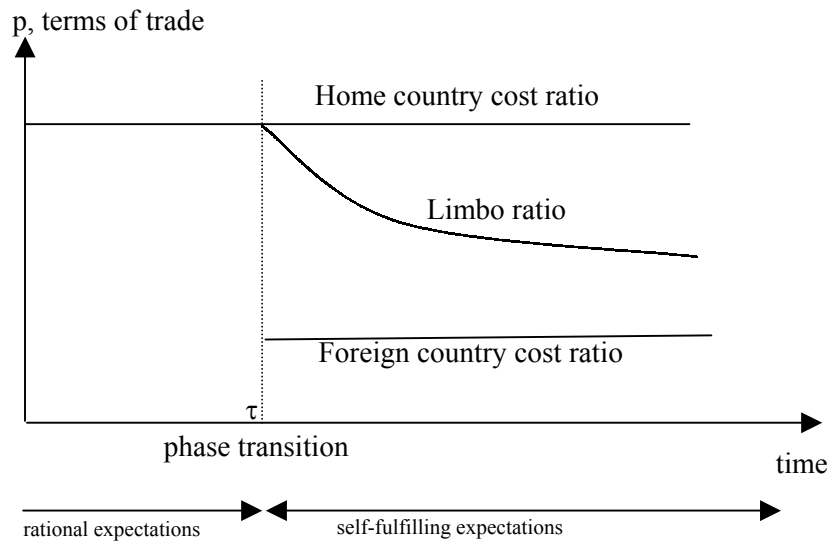


Figure 8 Phase transition

We can now summarize our analysis as follows.

¹¹ They are not drawn to scale.

1. As the catching up process proceeds beyond a critical point τ , the fundamentals of the world economy undergoes a phase transition so that multiple terms of trade coexist as self-fulfilling equilibria.

2. Prior to this point, the (the developing) home country satisfies the 'small open economy' condition, and the equilibrium terms of trade remains unique. As the Mill's Paradox indicates, all trading gain goes to the small country in the competitive equilibrium.

3. After the phase transition, the former equilibrium pattern may still hold for indefinite length of time, but then it may not. The world economy becomes a model with 'two large trading countries'. The former developing country may suffer a sudden loss of trading gain, along with a sharp deterioration in the terms of trade. Whether, when and how such a change may occur, as well as for what length of time are not decidable from economic theory, even in probability.

4. Foreign debt might be negotiated under the self-fulfilling expectation that the historical terms of trade will hold. When such expectations fall through, a debt crisis will emerge.

5. The presence of multiple equilibria is caused by the fact that the income effect induced by a change of the terms of trade can offset the substitution effect at the limbo ratio. This causes the Marshall-Lerner condition to fail, as evidenced in Figure 7. For such a situation to occur, there must be a 'home-good' bias in the demand pattern. The demand for local housing is the ultimate case of the 'home good bias', which was present in the Keynes-Ohlin debate.

6. Although the debt crisis is both avoidable and may be resolved over time, the recovery from such a shift in equilibrium must necessarily be of uncertain extent and duration.

The above thesis is consistent with a sequence of stylized facts for Crisis 1997. This includes for example: (a) the victims of the crisis were economies with a successful growth record, (b) the deteriorating terms of trade was what triggered the crisis, (c) the real estate bubble, the debt crisis, and the weak and a recovery uncertain in magnitude and duration.

For the ease of exposition, we have deduced qualitative insight from a single simple example. Please see Appendix for possible generalization.

4. Connectedness over Disjoint Subsystems

Crisis 1997 affected many economies. The major victims of the financial storm came in the following chronological order: The Czechlands, Thailand, Malaysia, Indonesia, Korea, Brazil, and Russia. This is often explained with some theory of contagion¹², where by logic, any pair of afflicted entities must be connected by at least one 'path of contagion', made up exclusively with afflicted entities, within some financial (or trading) network. For institutional reform, the implication is that future crises can best be contained with 'firewalls' for compartmentalization.

However, how can this explanation fit Crisis 1997 is less than clear. The time path appears highly random. Linking some pair of victims, say, Brazil and Russia, any chain of transactions is likely to pass through some advanced economies, say, America, Japan or some European economies, none of these were ever seriously affected in the Crisis.

As an alternative, we illustrate below the ‘inductance hypothesis’, (Wan and Wong, 2001). Consider a world of two disjoint ‘credit chains’. The ‘Latin’ (or respectively, the ‘Greek’) chain consists of a debtor d (or respectively, δ), a creditor c (or respectively, γ), a banker b (or respectively, β), and an additional investment A . The debtor borrows from the creditor, The creditor owes a loan from the banker. One of the banker invests in A . Which one has invested in A is known to the bankers and A , but nobody else. All loans are short term, but used to finance some long-term projects. Their periodic extensions keep the systems afloat. Presently, concurrent applications for all loan extensions are under simultaneous review. To save oneself, any banker suffering a loss in investment must reject credit extension to the creditor. Any creditor who extends credit to the debtor but gets rejected by one’s own banker will become insolvent. A debtor goes bankrupt if the creditor denies the loan extension. Denoting a real (conjectured) relation with double lines, (single line), Chart 3.1 shows that when A defaults, the equilibrium outcome is a subsystem crisis, under complete information, but possibly a ‘world-wide crisis’, under incomplete information.

Chart 4.1 Crisis under Alternative Information Structures

<u>Information Structure</u>	<u>Complete Information</u>	<u>Incomplete Information</u>
Additional Investment	A //	A // \
Banker	b //	β b // //
Creditor	c //	γ c // //
Debtor (italicized if bankrupt)	<i>d</i>	δ <i>d</i>

This exercise highlights the desirability of ‘system transparency’. If it is common knowledge that a particular bank is not affected by any failure in investment, then all those borrowing from it have no cause to tighten the credit and decimate that local system. More

¹² See for example, Allen and Gale (2000).

generally, 'firewall' may be desirable but not fail-safe. In addition, should monetary authorities count upon the IMF as the final resort in their risk management, that fact may cause 'inductance', when simultaneous local crises have stretched the resources of the IMF thin, as in Crisis 1997.

5. A Concluding Remark

It is time to relate our study here to the literature of international finance¹³, where multiple equilibria emerge in the presence of money, and the 'soundness of fundamentals' describes the macro-economic balance of individual economies. These concerns are undoubtedly important. Latin American history is replete with financial crises caused by government deficits, inflation, etc. What we have shown is that financial crisis like Crisis 1997, can also arise from other causes¹⁴. In the evolving world, instability may arise from the interaction between individual economies. Such difficulties can develop even if trade takes place exclusively by barter¹⁵.

Regarding Crisis 1997, some word should be added about cronyism, the reliance on a 'hard State' for economic development and the role of the IMF.

Quite contrary to the popular view, cronyism seems to be neither necessary nor sufficient to account for the government behavior that led to the financial crisis¹⁶. The prime motive of politicians is *libido dominani*. The urge to benefit one's favorites certainly pales before the need to hold power by courting support. Under either democracy or authoritarianism, the ultimate source for vainglory remains to be the same *vox populi*. The urge for over ambitious growth is in tune with the unfurling of the world's largest flag. Cronyism has little to do with the latter.

In development economics, the advocates for bringing the State back in, must reckon that the State is run by human beings with human emotions. Behind a forceful State lurks the 'dark side of the force'. The ultra decisive Yushing Regime that launched the Korean Heavy-Chemical Industry Drive also ended it for political motivations (Stern et al., 1995). The 'speed and flexibility' that characterized the policy making under President Park also reflects the irrelevance of both the legislature and the court, so that the KCIA could be dispatched to kidnap Kim Daejung in Japan for a watery demise¹⁷.

The IMF was never designed to bail out governments tripped up by their own over-ambition. Nor did it have nearly enough resources to rescue all the stricken economies in 1997-

¹³ For an authoritative survey see Obstfeld and Rogoff (1996).

¹⁴ As an analogy, the visibility of a driver may be reduced either by a fogged up windshield (issues related to money, like inflation) or the fog outside the vehicle (a plunging real exchange rate for the borrower of loans denominated in foreign currency).

¹⁵ So that money-related difficulties are ruled out along side with any circulating money.

¹⁶ No body asks why did cronyism cause debt crisis in Korea but not in Taiwan,

¹⁷ In that event, the timely arrival of the American CIA spelled the difference.

98, single-handedly and at once. Far from being the ultimate master of world finance, it had to wheel and deal and appeal for foreign creditors' cooperation. In such maneuvers, it is too much to expect that the statements and measures of the IMF form a paragon of fairness and coherence. An unfortunate example is that to win creditors' support, the deeply traumatized Koreans were asked amid their unprecedented financial crisis to end the import ban against Japanese small cars,¹⁸.

There are many different aspects one can explore about Crisis 1997. We focus on aspects not yet quite adequately addressed in the literature. The last chapter is certainly not yet written. At the present, regarding policy concerns, the words of caution in Bhagwati (1998) deserve as much attention as we can devote to.

Appendix A Sketch for Generalization

To establish the existence of multiple equilibrium, we have adopted Spartan assumptions specifically, (a) the catching up process narrows down the income gap, (b) comparative advantages exist between North and South, (c) there is 'home good bias' in demand and (d) there is no substitutibility between the exports of the two countries and between the two final consumption good. The derivation is simple but the assumptions may appear too strong to some readers.

Among the four assumptions, (a) has to hold true for any successful development effort. (b) is a generic assumption. The knife-edge case of proportional absolute advantage can be safely dismissed. (c) is generally valid if 'housing in one's own country' is more important than 'housing abroad' to consumers. Thus, condition (d) of non-substitutibility needs relaxation most.

Reassuringly, such relaxation yields the results that one would expect. Multiple equilibrium may exist even with substitutibility, but also it may not. The criterion depends upon the trade off between the degree of substitutibility and the degree of home good bias. Both of these degrees can be parametrized when the elasticity of substitution is constant.

At the limit of the catching up process, factor price (wage) is equalized between the two symmetric countries. The natural trade pattern reflects comparative advantage. Denote the limit import propensity as $1/(A+1)$, then $A > 1$ measures the degree of home-good bias. Since our purpose is to introduce substitutibility, simplicity is achieved by assuming that the elasticity of input substitution for household production, takes the same constant value, σ , as the constant elasticity of consumption substitution between housing and the output of household production. We first summarize our findings below.

¹⁸ The matter is not principle. But under all the publicity, that request was the most dubious as an effective means to promote car sales. Nor was it likely to gain any more Korean cooperation on other issues.

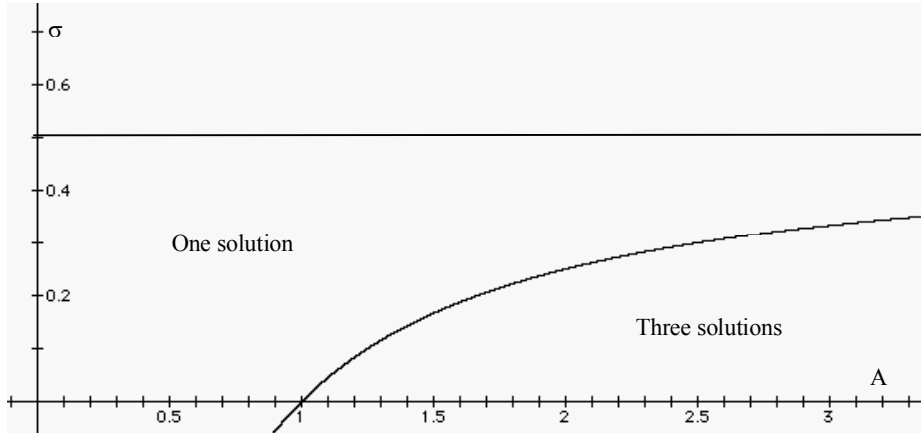


Figure 9 The parameter map

For derivation, we first observe that our specification admits a telescoped version. Households consume three goods, housing, the exportable input and the importable input (or its substitute, produced at home), with a CES utility index:

$$u = [\alpha h^{-\beta} + x^{-\beta} + (y + \zeta)^{-\beta}]^{-1/\beta}, \quad u^* = [\alpha h^{*-\beta} + x^{*-\beta} + (y + \zeta^*)^{-\beta}]^{-1/\beta},$$

where $\alpha = (A - 1)^{1/\sigma}$, $\beta = (1 - \sigma) / \sigma$.

In a Ricardian world, both housing h and the consumed exportable x are produced with the same domestic labor. The homotheticity and separability of the CES utility function implies their usages bear the same proportion to each other under all terms of trade. That proportion is the $A-1:1$, as it is the assumed value under the terms of trade, $1:1$.

Now for the home country, the unit cost for import y^* is 1 and the unit cost for export is,

$$w/a.$$

This also determines the price ratio between the produce of both countries. Now if:

$$w = a,$$

(with the latter given by history at any period), then the unit cost of the exportable input is also 1. As the inputs for the household production function T are symmetric,,

$$x = y^*, \quad \text{or} \quad y^*/x = 1.$$

By assumption,

$$h/x = A - 1 = h^*/x^*.$$

Thus,

$$(h + x)/y^* = A = (h^* + x^*)/y.$$

Along the intersection between any indifference surface and the plane,

$$h/x = A - 1 \quad (\text{or} \quad h^*/x^* = A - 1),$$

one can integrate with respect to the cost ratio from the point where the household production function use the two inputs in equal amounts. Using the property of the C. E. S. utility indices,

$$\log[(h+x)/y^*] - \log A = \sigma(\log a - \log w) = \log A - \log [(h^* + x^*)/y],$$

or, taking anti-log,

$$(h+x)/y^* = A(a/w)^\sigma, \quad (h^* + x^*)/y = A(a/w)^{-\sigma}.$$

By the full employment condition,

$$(h+x) + y = a,$$

$$(h^* + x^*) + y^* = 1.$$

After eliminating h , h^* , x and x^* , we get,

$$a - y = A(a/w)^\sigma y^*, \quad 1 - y^* = A(a/w)^{-\sigma} y,$$

or,

$$A(a/w)^\sigma y^* + y = a, \quad y^* + A(a/w)^{-\sigma} y = 1.$$

Next, multiply the second equation with a and eliminating the constant term between these two, one obtains,

$$[A(a/w)^\sigma - a] y^* = [aA(a/w)^{-\sigma} - 1] y.$$

The excess demand for home country export is:

$$y^*/w - y = y \{ [aA(a/w)^{-\sigma} - 1]/w[A(a/w)^\sigma - a] - 1 \}.$$

At any equilibrium, excess demand must be zero, which means,

$$aA(a/w)^{-\sigma} - 1 = w[A(a/w)^\sigma - a].$$

This condition is satisfied, if,

$$A = [(1/w)-a]/[(a/w)^{1-\sigma} - (a/w)^\sigma].$$

Write $\omega = \log(1/w)$, $\lambda = \log a$ and rearrange, one finally obtains,

$$\begin{aligned} A &= [e^{(\omega-\lambda)/2} - e^{-(\omega-\lambda)/2}]/[e^{(1-2\sigma)(\lambda+\omega)/2} - e^{-(1-2\sigma)(\lambda+\omega)/2}] \\ &= \sinh [(\omega-\lambda)/2]/\sinh[(1-2\sigma)(\lambda+\omega)/2]. \end{aligned}$$

As $n \rightarrow \infty$, $a_n \rightarrow 1$, $\lambda \rightarrow 0$, and the above condition approaches,

$$A = \sinh(\omega/2)/\sinh[(1-2\sigma)\omega/2], \text{ (The Rule of Hyperbolic Sine).}$$

which is a positive, convex, even function of ω .

This function is undefined at $\omega = 0$, implying that there is always a solution for wage-equalization.

In addition, as $|\omega| \rightarrow 0$, the value of the minimum value of the function can be evaluated by the L'hospitale Rule. The result is:

$$(1/2) \cosh 0 / [(1-2\sigma)/2] \cosh 0 = 1/(1-2\sigma).$$

This is the basis for Figure 9, above.

In addition, the formula for the Rule of the Hyperbolic Sine allows us to find the multiple equilibria by quadrature. This is illustrated in Figure 10, for the value of $\sigma = 1/4$, $A = 5/2$.

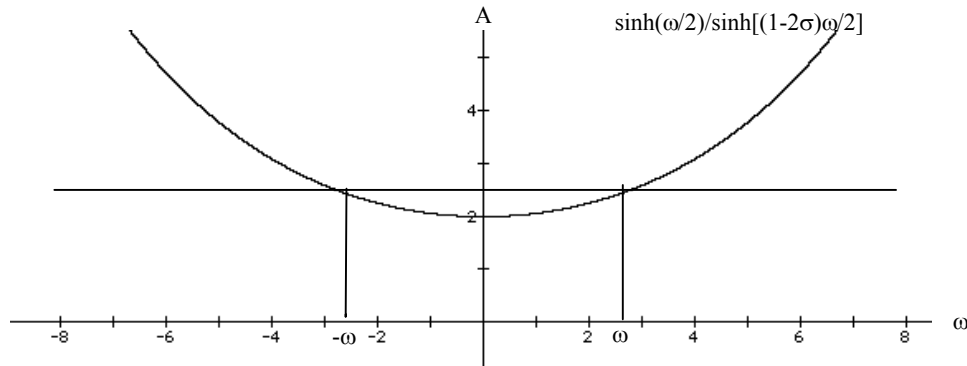


Figure 10 Multiple solutions $\sigma = 1/4$, $A = 5/2$ $\omega = \ln 16 = 2.77259$

So far we have assumed that complete specialization prevails for both countries. Otherwise, the equilibrium range of the real exchange rate must be confined to a narrower range. The situation is similar to the case of non-substitutibility which is studied in Section 3. .

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