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## The half and the full debt cycle

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# The Half and the Full Debt Cycle

By

Horst Siebert

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## I. Introduction

A country may incur debt in order to build up capital and to allow earlier consumption. In a half debt cycle, a country borrows both for consumption and for capital accumulation. Debt increases initially and is reduced eventually, but the country remains a debtor. In a full debt cycle, however, a country borrows for capital accumulation only. Low consumption in the initial periods helps to finance capital accumulation, and eventually with debt being repaid, the debtor country becomes a creditor.

The concept of the debt cycle has been presented in an intuitive fashion in the literature, for instance in the World Development Report of 1985 [World Bank, 1985, p. 47] and by Kindleberger [1968]. A country changes from a young to mature debtor and debt reducer, until eventually it becomes a young and lastly a mature creditor. The stages of debt and assets, however, are not derived in a formal model. Incidentally, the concept of the debt cycle is already well established in the German literature of the twenties, for instance in Eulenburg [1929] and Wagemann [1931].

In this paper, we present such a model of the cyclical behavior of debt and we establish conditions for half and full debt cycles. Apparently, in a half debt cycle, the problem of default is more prevalent whereas in a full debt cycle, the problem of indebtedness is solved over time in a natural sort of way. Emphasis is put on the derivation of both the time profile of debt and the balance of payments.<sup>1</sup>

In Section II, the model is specified. The half debt cycle with the time profiles of debt, consumption and the balance of payments is discussed in

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*Remark:* I appreciate comments from Knut Borchardt, Ngo Van Long, Jesko Hentschel, Murray C. Kemp, Ernst Mohr, Peter Nunnenkamp, Michael Rauscher and Joachim Scheide.

<sup>1</sup> On steady state discussions of capital movements for an open economy which contain implicit or explicit information on the debt profile compare Wan [1971], Onitsuka [1974] and Lee [1982].

Section III. The intertemporal properties of the full debt cycle are analyzed in Section IV. In Section V, historical examples of the half and of the full debt cycle are given. Finally some conditions are specified that may make a full debt cycle more likely.

## II. The Model

Except for the transversality condition, we use the model specified in Siebert [1987, p. 619]. The country maximizes the present value of utility for a planning period  $[0, T]$  with a given terminal time  $T$

$$\omega = \int_0^T e^{-\delta t} W(C) dt, \quad (1)$$

where  $C$  is consumption and  $\delta$  is a given time preference rate. As restraints we have a production function

$$Q = F(K), \quad (2)$$

with  $Q$  denoting output and  $K$  the capital stock. Both the utility and the production function have the usual properties. The capital stock changes by gross investment  $I$  and the depreciation of the capital stock where  $m$  is the rate of depreciation.

$$\dot{K} = I - mK. \quad (3)$$

The balance-of-payments restraint, i.e. the budget restraint, is given by

$$\dot{B} = C + I - Q + rB, \quad (4)$$

where  $B$  is the stock of debt and  $r$  is the interest rate given in the world capital market.

An important property of the model is the transversality conditions. Here the distinction between finite and infinite time is crucial. For *finite* time, we have a transversality condition

$$K(T) - B(T) \geq \bar{K}, \quad (5)$$

where  $K(T)$  and  $B(T)$  are the stock of capital and debt, respectively, in terminal time  $T$  and  $\bar{K}$  is the capital stock to be handed over to future generations after  $T$ . This condition implies that debt has to be repaid in terminal time. For simplicity, it is assumed that the capital stock to be handed over to future generations,  $\bar{K}$ , happens to be the optimal capital stock,  $K^*$ ,<sup>2</sup> being defined by

$$F_K(K^*) - m = r. \quad (5a)$$

<sup>2</sup> If  $K^* > \bar{K}$ , see Van Long and Siebert [1989].

For *infinite* time, it does not make sense to require that debt is repaid. It is more convincing that, in the limit, interest on the stock of debt must not exceed net national product:

$$\lim_{t \rightarrow \infty} [rB(t)] \leq \lim_{t \rightarrow \infty} [F(K(t)) - mK(t)]. \quad (6)$$

### III. The Half Debt Cycle

From the optimality conditions [Siebert, 1987, p. 621] it follows that capital will be accumulated if the net marginal productivity of capital is greater than the interest rate ( $F_K(K_0) - m > r$ ). Capital accumulation is financed by debt. With the optimal capital stock  $K^*$  being determined, net output  $\tilde{Q} = F(K^*) - mK^*$  is constant over time. Equation (4) can be rewritten as

$$\tilde{Q} = C + rB - \dot{B} = C + Z, \quad (4a)$$

where  $Z$  is the trade account.

The behavior of debt over time depends crucially on the difference between the time preference rate and the interest rate. If

$$F_K(K_0) - m > r \quad \text{and} \quad (7a)$$

$$\delta > r, \quad (7b)$$

the country will borrow for capital accumulation and consumption. Since there are no restraints on investment, the country will accumulate the capital stock instantaneously according to condition (5a). Investment in the initial period is given by  $K^* - K_0$ . In Figures 1 and 2  $OK$  is the optimal capital stock  $K^*$ ;  $HK$  is the initially given stock  $K_0$  and  $OH$  is debt incurred for capital accumulation. In terminal time  $T$ , the optimal capital stock  $TK$  is handed over to future generations.

According to condition (7b), the country has a high time preference rate, so that it also borrows for consumption. Since the shadow price of consumption rises in absolute terms over time, consumption is reduced over time. The consumption profile is smooth over time, therefore the country will borrow for consumption not only in the first period but in some of the earlier periods after initial time. In these early periods, new debt is used to pay interest. Note that whereas debt incurred for capital accumulation ( $OH$ ) can be interpreted as a stock variable, debt for consumption is a flow variable (4). As has been shown in Siebert [1987, p. 623], debt will increase for some time, and eventually reach a maximum (Fig. 1a).

Figure 1 – Half Debt Cycle

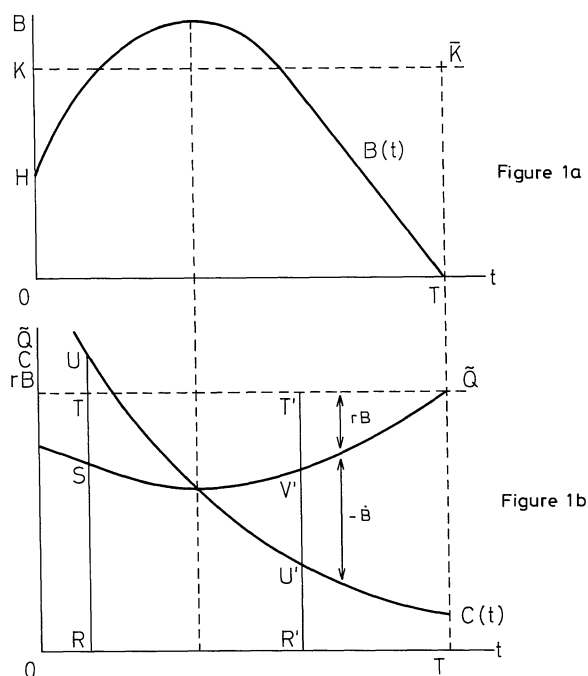


Figure 1 illustrates the half debt cycle with the accompanying balance of payments. With debt increasing initially, consumption ( $RU$ ) is higher than net national product ( $RT$ ) by the amount  $TU$ . This is the trade deficit. Interest payments are  $TS$ . Consequently,  $US$  denotes the deficit in the current account, or alternatively capital imports or new debt ( $\dot{B} > 0$ ). In later periods, consumption ( $R'U'$ ) is lower than net national product ( $R'T'$ ). The trade surplus  $U'T'$  is used for interest payment ( $T'V'$ ) and the repayment of debt ( $V'U'$ ). Note that depending on the initial capital stock and on the capital output ratio, debt incurred for capital accumulation  $OH$  may be greater than the net output  $OK$ .

In the half debt cycle, the debtor country remains a debtor until the last minute – because of the high time preference rate. This result holds when terminal time is extended into the future [Van Long, Siebert, 1989, p. 9]. A larger planning horizon will shift the debt curve upward and to the right because more time is available to pay back debt. Debt incurred for consumption is increased.

If terminal time is extended to infinity, the country still remains a debtor. From the transversality condition (6) the stock of debt converges to  $\tilde{Q}/r$ , the

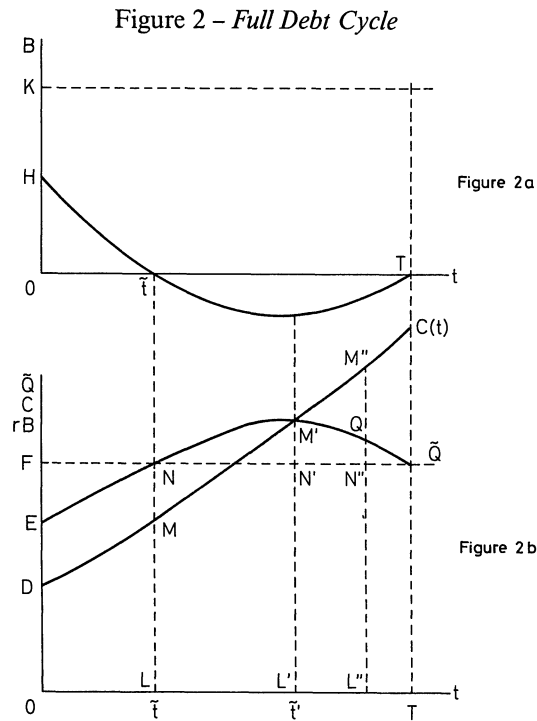
capital value of net output.<sup>3</sup> From (4a), consumption will approach zero in infinity, and net output  $\tilde{Q}$  is used for interest payments. The positive trade balance, equal to  $\tilde{Q}$ , is eaten up by the negative service account. In Figure 1,  $B(t)$  and  $rB(t)$  rise over time. The time paths of consumption and of interest payments do not cross, but approach each other asymptotically in infinity. The time path does not reach a maximum, but approaches an upper limit in infinity being given by net output.

#### IV. The Full Debt Cycle

If contrary to condition (7) we have

$$F_K(K_0) - m > r > \delta, \tag{8}$$

the country will again borrow for capital accumulation instantaneously the amount  $K^* - K_0$ . With  $r > \delta$ , consumption will increase over time. The country puts a high penalty on consumption initially, and it does not borrow for consumption from abroad.



<sup>3</sup> Note that the right-hand side of (6) is equal to  $\tilde{Q}$ . Also note that from (4a) that consumption will approach zero for  $T \rightarrow \infty$ .

In Figure 2, the full debt cycle is illustrated. The country borrows OH (in Fig. 2a) for capital accumulation giving rise to a debt service EF. Consumption rises over time as shown by the curve DMM'M'. In the initial period, consumption OD is lower than net national product OF (Fig. 2b). Debt is repaid by the amount DE. Over time, debt and debt service are reduced.

Since capital accumulation being financed by external borrowing occurs instantaneously, the very first period is characterized by a capital import and a deficit in the trade balance. This situation is not depicted in Figure 2. In a more realistic version of our model, capital accumulation cannot occur instantaneously but will be stretched over a number of periods. Then the country will borrow for a number of periods, and the trade balance will be negative in this time. The initial periods of the full debt cycle can be modelled more realistically if technical progress is explicitly introduced and the marginal productivity of capital rises for some time. Then the optimal capital stock rises over time, and borrowing may actually increase.

In period  $\tilde{t}$ , debt is zero, and the country turns into a creditor position. Debt service is zero, and net output LN equals consumption LM plus capital exports MN. The country accumulates foreign assets generating a positive service account.

In period  $\tilde{t}'$ , financial assets abroad and interest income ( $N'M'$ ) reach a maximum. The accumulation of foreign assets stops: capital exports turn into capital imports. Consumption  $L'M'$  is made possible by the net national product  $L'N'$  and interest income  $N'M'$ .

After  $\tilde{t}'$ , financial assets and interest income become smaller, and the country has to live from depleting its assets ( $M''Q$ ), that is from importing capital. The trade deficit  $N''M''$  cannot be fully financed by interest income ( $N''Q$ ).

Extending terminal time  $T$  into the future, i.e. shifting  $T$  to the right in Figure 2a, gives the country more time to postpone consumption; it therefore can contribute a little more in the first period to finance its capital stock. Consequently, the debt curve in Figure 2a will shift downward allowing the country to become a creditor a little earlier.<sup>4</sup>

If  $T$  approaches infinity and if the transversality condition (8) applies, the stock of debt tends to minus infinity, and the country is a long-run creditor. Consumption will approach infinity. With production remaining constant, consumption is mainly financed from interest income.<sup>5</sup>

<sup>4</sup> If we release the assumption  $\bar{K} = K^*$  and allow the country to repay part of its debt in terminal time by selling its capital stock, then  $T$  has an impact on the level of debt incurred for consumption even if  $\delta < r$ . The country may borrow for consumption initially because it can repay debt by selling part of its capital stock.

<sup>5</sup> For utility out of consumption to converge with  $r > \delta$ , it is necessary to have a specific property of the utility function  $W(C) = C^{1-\eta} / 1 - \eta$  where  $\eta$  is a constant. We must have  $(r - \delta)/\eta < r$ .

### V. Historical Examples of Half and Full Debt Cycles

Some countries succeeded in going through the full debt cycle and in changing their debtor position into a creditor status. An example is the U.S. who was a debtor during the 19th century and turned into an international creditor after 1914. Economic development in the U.S., mainly driven by the new frontier of the railroad boom between 1840–1870 [Wandel, 1978, p. 379] attracted foreign capital. Eventually, the U.S. was able to repay its debt from its production and to become a net creditor during the period 1914–1985.<sup>6</sup> The balance of trade was favorable between 1873 and 1914, financing dividends and interest payments abroad (and keeping the current account in balance). Figure 3 reports the net foreign debt position of the U.S. during the period 1870–1986.

At a given moment of time, the mirror image of a young debtor putting foreign funds into productive use is the mature creditor. Prior to 1914, this role was played by some European countries, especially Great Britain who received 10 percent of national income from foreign interest and dividend income in 1914.<sup>7</sup>

Other examples of a full debt cycle may be found in resource-exporting countries that successfully use export earnings to repay debt and eventually become creditors. It is the metamorphosis of Mexicans into Saudis [Siebert, 1985, Ch. VII]. For the United Kingdom, foreign debt increases up to 1975, and from then on assets are accumulated. An interesting case is Norway showing an increase in debt up to 1979; from then on debt is reduced as shown in Figure 3.

Korea may be a candidate for the full debt cycle to be cited in the future. Public and publicly guaranteed debt in absolute terms remained almost constant from 1985 (U.S. \$ 29 billion) to 1986 and fell in 1987 (U.S. \$ 24.5 billion). As a percentage of GDP it is falling since 1985 (Figure 4). When the debt position is corrected for total reserves, Taiwan is another example of a country reaching a positive asset position (since 1983).

The stimulus to the start of the full debt cycle – an increase in the marginal productivity of capital – must be interpreted in a rather broad sense as “a parametric shift or exogenous shock that draws attention to a new opportunity for profit” [Kindleberger, 1981, p. 373].

The full debt cycle is reminiscent of the concept of boom lendings proposed by Kindleberger [ibid., p. 373]. Historical examples of “boom lending” are the withdrawal of the Portuguese royal family to Brazil [1808], the boom in South

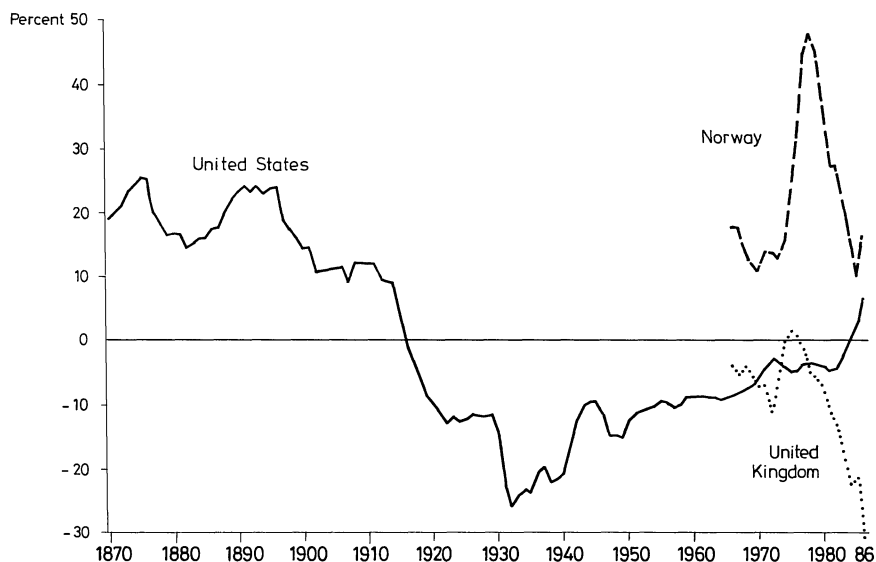
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<sup>6</sup> On data for the net foreign position of the U.S. between 1914–1966 compare table 24.4 in Kindleberger [1968].

<sup>7</sup> On data for net foreign positions prior to 1914 see Wandel [1978, p. 379] and Woodruff [1973, p. 707].



Figure 3 – Net Foreign Debt Outstanding in the United States, United Kingdom and Norway (in percent of GDP)



Source: U.S. Department of Commerce [a; b; c]; Holtfrerich, Schötz [1988]; Bank of England [various issues]; Central Bureau of Statistics of Norway [various issues]; IMF [various issues].

America after independence from Spain (1824–25), and the boom in Turkey after the Crimean War and in Egypt due to cotton demand in the U.S. Civil War, both in the 1860's, and a peak in Argentina securities in 1865 started off by reclamation of land from the native inhabitants [ibid., p. 373].

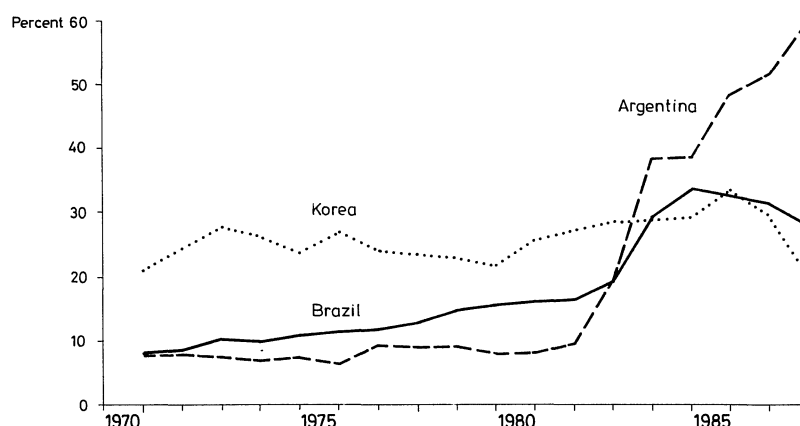
Whereas in the full debt cycle, the debtor becomes a creditor, “boom lendings” may represent a bubble that eventually bursts. Poland in the 1970's is an example where the marginal productivity of capital assumed in the foreign borrowing calculus did not materialize. In some developing countries, foreign funds were used to finance budget deficits, not being used for investments (Mexico after 1978). Under these conditions, a boom loan takes the property of a consumption loan, and the potential full cycle turns into a half cycle. Recent examples of the eighties are the worsening terms of trade, especially for resource(oil)-exporting countries and the rise in the real interest rate. Historically, boom loans have turned into consumption loans in the United States in the 1830's and in Argentina in the 1880's [ibid., p. 375].

Quite a few countries seem to be locked into a half debt cycle; they continue to be a debtor, at least for a long time. The crucial distinction between a full and a half debt cycle hinges on  $\delta \geq r$ . With a low time preference rate relative to the

world interest rate, the country puts foreign funds into productive use and tends to eventually become a creditor. A high time preference relative to the world interest rate, however, – or great impatience – makes the country a debtor. Foreign funds are used for consumption. In the half debt cycle, future generations must repay debt that financed consumption of earlier generations. It is rather likely that debt is repudiated and default occurs.<sup>8</sup>

Historical examples for the half debt cycle or of consumption loans are the 12 million-debt obtained by the viceroy of Egypt in 1868 (bankruptcy of the Egyptian government in 1876) and of the Ottoman Empire between 1859 and 1875 [ibid., p. 374]. For the typical Latin American country (Argentina, Brazil, Mexico) debt, measured in U.S. \$, rises during the 1970s and – partly with an increasing rate – in the early 1980s so that these countries seem to be on the first quarter of a debt cycle.

Figure 4 – *Foreign Debt Outstanding in Argentina, Brazil, and Korea, 1970–1987*  
(in percent of GDP)<sup>a</sup>



<sup>a</sup> Only public and publicly guaranteed long-term debt. Note that direct investment is not included in the net debt position since data are not available.

Source: World Bank [1988]; IMF [various issues].

<sup>8</sup> The half cycle of debt may actually turn into a cycle of debt and default. Historical examples are Latin America, the Middle East and Czarist Russia. Kindleberger [1981, p. 375] mentions Guatemala “with borrowing in 1825, default in 1828, settlement in 1856, new very small loans in 1863, these defaulted in 1864, new loans in 1869, all loans defaulted in 1876, settlement in 1884, new loans in 1888, defaulted in 1894, new arrangement in 1895, which was not carried out, new agreement in 1901–1902, new agreement in 1903, new agreement in 1904, new loan in 1908, agreement of 1895 resumed in 1912, railway loan in 1924, new loans in 1927 and 1928, defaulted in 1931”.

The time profiles of debt, consumption, and the balance of payments derived from the intertemporal optimization model are rather delicate in the sense that the decisions are taken in an initial period, and in later periods the decisions are effectuated. In the half debt cycle, future generations may not be willing to honor the pledges of earlier generations. The question is, which institutional arrangements reveal the user costs of foreign debt to individuals and by which institutional arrangements decentralized decisions of individuals are made consistent with the time profiles generated by the model.<sup>9</sup>

### VI. Favorable and Unfavorable Conditions for the Full Debt Cycle

Our analysis suggests some conditions that may make it more likely or more unlikely that a country goes through a full debt cycle. Apparently, it is mandatory that debt incurred for investment is used for investment purposes and that the expected marginal productivity of capital is realized. Then a constant stream of output (exports) is provided to service the debt. Of course, an increase in the productivity of capital in later periods helps to generate a positive trade balance. Moreover, in a growing economy, the inflow of equity capital alleviates the rigidity of a debt model.

In the model, the time preference rate of society has been considered as given. In reality, we have to look at the time preference rates of individuals. If the time preference rate becomes lower over time, the full debt cycle will be more likely. Then savings would increase. However, we do not have a convincing theory on changes in the time preference rates of individuals.<sup>10</sup> A more relevant aspect is that institutional arrangements to aggregate the time preferences of individuals may vary over time, and that a country as a whole represented by the political process may become more patient or impatient.

It is an open question whether the policymaker can make a full debt cycle more likely by keeping the effective time preference rate of a country low. For instance, one could attempt to reduce the effective time preference rate by raising income or expenditure taxes. A condition for such an approach, however, is that tax revenues are transferred into productive capital. Or one may stimulate investment at home by preferential tax treatment. A precondi-

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<sup>9</sup> The small country case with a given interest rate in the world capital market should be extended to consider a world containing two large countries where the interest rate is determined endogenously. The advantage of such a model is to explicitly introduce the capital market and to illustrate the creditor and debtor position of different countries at a given moment of time, that is Walras' Law of debt. I owe this idea to Murray C. Kemp.

<sup>10</sup> If prosperous periods give rise to a higher rate of time preference as put forward by Neumann [1985], the full debt cycle becomes less likely, and the creditor or potential creditor will tend to become a debtor.

tion here is to prevent capital flight due to taxation<sup>11</sup> or unstable monetary conditions.

A potential debtor country may be induced to become a creditor, if for a given time preference rate of a debtor country the interest rate in the world economy rises. This may be due to a higher productivity in other countries, for instance new frontiers, or it may be due to a higher preference rate in the world. Historically, such a case may have happened, for instance when a country obtained new access to the international capital market or to the segmented capital market of a specific country.<sup>12</sup>

For empirical research, it is tempting to analyze the time profiles of foreign debt of countries over longer time spans and to look for episodes in which either the half debt cycle or the full debt cycle were the dominating forces.<sup>13</sup>

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<sup>11</sup> Segmenting the national capital market from the international market, if it can be effectively done at all, may bring about a higher interest rate at home and consequently higher savings. But at the same time, the country has higher opportunity costs in terms of foregone consumption by not borrowing. Moreover, if segmentation induces capital flight, less funds are available at home.

<sup>12</sup> A case in point may be the capital market of former colonies being segmented in favor of the mother country and eventually being opened to other countries as well.

<sup>13</sup> Empirical data for the major indebted developing countries show a time profile with progressively rising debt (for instance Korea 1965–1985; Argentina 1970–1982), or a time profile where the rate of increase of debt is reduced (Argentina for the period 1982–1986 relative to 1978–1982). For data see World Bank [1988]. It would be interesting to find historical cases where debt actually was reduced (for instance Argentina reduced its foreign debt from 390 million to 290 million gold dollars at the beginning of this century [Tang, 1921, p. 131]).

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**Zusammenfassung:** Der halbe und der ganze Schuldenzyklus. – In dem Beitrag wird ein Modell der zyklischen Variation der Auslandsschuld entwickelt. Ein halber und ein ganzer Schuldenzyklus werden unterschieden. In einem halben Schuldenzyklus wird zwar die Schuld reduziert, aber das Land bleibt ein Schuldner. In einem ganzen Schuldenzyklus zahlt das Land seine Schuld zurück und wird schließlich zum Gläubiger. Das Zeitprofil der Zahlungsbilanz wird analysiert. Die Unterscheidung zwischen halbem und ganzem Schuldenzyklus hängt an dem Unterschied zwischen Zeitpräferenzrate und Zinssatz auf dem Weltkapitalmarkt. Historische Beispiele für den halben und ganzen Schuldenzyklus werden erwähnt, und es werden Bedingungen genannt, die einen der beiden Fälle wahrscheinlicher machen.

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**Résumé:** Le cycle de dette complet et demi-complet. – Dans cet article l'auteur développe un modèle du cycle de la dette étrangère. Il distingue entre un cycle de dette demi-complet et complet. En cas d'un cycle demi-complet, la dette est réduite avec le temps, mais le pays reste un débiteur. En cas d'un cycle de dette complet, le pays repaie la dette définitivement et change dans une position de créateur. Les implications pour le profil temporel de la balance des paiements sont analysées. La distinction entre le cycle de dette demi-complet et complet dépend de la différence entre le taux de préférence du temps et le taux d'intérêt mondial. L'auteur présente des exemples historiques pour les cycles demi-complets et complets et mentionne quelques conditions qui rendent un des cas le plus probable.

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**Resumen:** El ciclo parcial y entero de la deuda. – En este trabajo se desarrolla un modelo de comportamiento cíclico de la deuda externa. Se distingue entre un ciclo de deuda parcial (medio ciclo) y uno entero. En el medio ciclo la deuda se reduce en el tiempo pero el país permanece deudor. En el ciclo de deuda entero el país en última instancia paga la deuda y pasa a ser acreedor. Se analizan las implicaciones para el perfil temporal del balance de pagos. La distinción entre al ciclo parcial y el entero se basa en la diferencia entre la tasa de preferencia temporal y la tasa de interés mundial. Se dan ejemplos históricos de ciclos medios y enteros, y se mencionan algunas de las condiciones para que uno de los casos pueda darse con mayor probabilidad.

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