

Mohr, Ernst

**Working Paper**

## International borrowing and exhaustible resources: Note on a liquidity creditworthiness conflict

Diskussionsbeiträge - Serie II, No. 2

**Provided in Cooperation with:**

Department of Economics, University of Konstanz

*Suggested Citation:* Mohr, Ernst (1986) : International borrowing and exhaustible resources: Note on a liquidity creditworthiness conflict, Diskussionsbeiträge - Serie II, No. 2, Universität Konstanz, Sonderforschungsbereich 178 - Internationalisierung der Wirtschaft, Konstanz

This Version is available at:

<https://hdl.handle.net/10419/101633>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

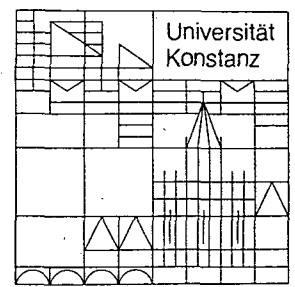
Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



**Sonderforschungsbereich 178**  
**„Internationalisierung der Wirtschaft“**

Diskussionsbeiträge

Juristische  
Fakultät

Fakultät für Wirtschafts-  
wissenschaften und Statistik

---

Ernst Mohr

**International Borrowing  
and Exhaustible Resources:  
Note on a  
Liquidity Creditworthiness Conflict**

INTERNATIONAL BORROWING AND EXHAUSTIBLE RESOURCES: NOTE ON A  
LIQUIDITY CREDITWORTHINESS CONFLICT

Ernst Mohr

Serie II - Nr. 2

A 94728/86 Weltwirtschaft  
Kiel

September 1986

## Abstract

A sovereign debtor facing a credit limit due to unenforceable debt contracts may have an incentive to increase its creditworthiness by making itself subject to more severe sanctions in response to a debt repudiation. It is shown that for a natural resources exporting country this incentive may result in a more resource conserving extraction policy at the expense of current income. A resource exporting LDC thus may face a conflict between creditworthiness and liquidity which would not have to be faced were the source of income not exhaustible.

## 1. Introduction

The smouldering international debt crisis of the 1980s has drawn widespread interest to the problem of sovereign borrowing. Of particular theoretical interest proved that banks may consider a credit contract with a foreign country unenforceable. Repayment of the debt then is deemed to rather hinge upon the debtor's willingness to pay than on his ability to pay. Long before net worth turns negative, a debt crisis may be caused either by a liquidity problem, or else, by a country's unwillingness to pay. Being at the debtor's discretion to keep or breach a credit contract, the debt will be repudiated if the gains from doing so exceed the costs. The gains from repudiation are the avoided future debt services while costs may take the form of future credit embargoes by the banks or trade sanctions by their home governments. Given these costs and given a positive relationship between the magnitude of debt and the gains from repudiation, the banks have an incentive to impose a limit on sovereign debt so as to ensure that the credit contract is self-enforcing (Eaton and Gersovitz (1981), Niehans (1985), Sachs (1982)).

Sachs and Cohen (1982) make an interesting proposition concerning a country facing such a credit limit. They show that a country may have an incentive to subject itself to higher repudiation costs. The underlying idea is that banks will only offer self-enforcing credit contracts which ensure that the country will never default. Hence repudiation costs actually

are never incurred. More severe pending sanctions, however, increase the country's creditworthiness, i.e. entice the banks to extend the credit line.

In Sachs and Cohen (1982) sanctions are proportional to national income, earned in the production of a reproducible consumption cum capital good. A larger credit line then requires a larger national product in the future, which can be achieved by diverting present income from consumption into capital accumulation.

However, many LDC's which have to face a credit limit earn a large proportion of their national income not through the production of reproducible commodities but, instead, through the sale of exhaustible resources. The purpose of this note is to show that a debt ceiling which depends on the magnitude of pending sanctions may cause a country to run a more resource conserving policy at the expense of present income. The country then faces a conflict in its debt management which it would not have to face were the source of income not exhaustible. While conservation is beneficial to creditworthiness it clearly is detrimental to the liquidity target which can be more easily met at a higher current income.

Whether the creditworthiness can be augmented depends on the country's ability to commit itself to an extraction pattern before the credit decision is made. It therefore is useful to compare the commitment pattern of extraction with the pattern which would be optimal were commitment impossible.

## 2. The Non-Commitment Extraction Pattern

Consider the following simple linear two period model. A country draws utility from consumption of a single imported good which can be purchased in both periods at a constant price. Utility,  $U$ , then can be viewed as depending on consumption expenditures in both periods  $C_1$  and  $C_2$ , where

$$U(C_1, C_2) = C_1 + C_2/(1 + \delta) \quad (1)$$

and where  $\delta$  is the social discount rate. Imports are financed through the export of a stock of exhaustible resources,  $Q$ , which has to be divided into period 2 extraction,  $Q_2$ , and period 1 extraction,  $Q - Q_2$ . While the profit per exported unit in period 1,  $P_1$ , is fixed, profit per extracted unit in period 2 hinges on the country's behaviour. If the second period's debt-service obligation is met, per unit profit is  $P_2$ ; if the country repudiates its debt in period 2, the profit per exported resource unit is  $\tilde{P}_2$  with  $P_2 > \tilde{P}_2$ . Per unit profits may best be viewed as the resource price net of constant extraction and transportation costs, which increase as a consequence of sanctions imposed. The country can consume in period 1 in excess of the export value by borrowing the amount  $b$  abroad. In order to derive the conservation incentives under commitment and non-commitment as simple as possible, suppose the country has no debt inherited from the past. Period 1 consumption then is  $(Q - Q_2) \cdot P_1 + b$ . If the country fails to pay back  $(1+r) \cdot b$ , where  $r$  is the interest rate, then sanctions are imposed. Suppose  $\delta > \mu > r$ , where  $\mu \equiv (P_2 - P_1)/P_1$ .

If the country cannot commit itself to an extraction pattern before the credit is given, it will make its extraction decision,  $Q_2$ , in response to the credit obtained, that is  $Q_2 = Q_2(b)$ . Given  $b$  (and  $Q_2$ ), the country's default decision in period 2 depends on

$$Q_2(b) \cdot P_2 - (1+r) \cdot b \succ Q_2(b) \cdot \tilde{P}_2 . \quad (2)$$

The bank, anticipating this decision, will set a credit limit,  $B$ , such that default will not be worthwhile, that is

$$B = (Q_2(b) \cdot (P_2 - \tilde{P}_2)) / (1+r) . \quad (3)$$

Given a self-enforcing credit contract  $b$ ,  $b \leq B$ , the country's extraction problem then is solved by

$$\max_{Q_2} U(Q_2) = (Q - Q_2) \cdot P_1 + b + \frac{1}{1+\delta} \cdot (Q_2 \cdot P_2 - (1+r) \cdot b) . \quad (4)$$

Given  $b$ , a utility loss by one unit, originating in an investment in period 2 resource reserves, must be traded off against a utility gain of  $(1+\mu)/(1+\delta)$ , caused by increased period 2 consumption. Since, by assumption,  $\delta > \mu$ , resource conservation is detrimental to utility and therefore  $Q_2(b) = 0 \forall b$ . From equation (3) it then follows that the optimal credit line is given by  $B^* = 0$ . With no investment in period 2



reserves, debt repudiation can only be avoided if no credit is given. For  $B^* = 0$ , the non-commitment resource extraction optimum is given by

$$\begin{aligned} Q_2^* &= 0, \\ b^* &= 0, \\ C_1^* &= Q \cdot P_1, \\ C_2^* &= 0. \end{aligned}$$

### 3. The Commitment Extraction Pattern

Suppose now, to the contrary, that the country can commit itself to an extraction pattern before the bank's credit line decision is made. In practice, resource extraction often requires front end investments which, once in place, may restrict the set of feasible extraction paths. With commitment, the credit line is a function of reserves in the second period, that is  $B = B(Q_2)$ . The credit limit then is given by

$$B(Q_2) = (Q_2 \cdot (P_2 - \tilde{P}_2)) / (1+r). \quad (3')$$

The country's decision problem is

$$\begin{aligned} \max_{Q_2, b} L &= (Q - Q_2) \cdot P_1 + b + (Q_2 \cdot P_2 - (1+r) \cdot b) / (1+\delta) \\ &+ \alpha \cdot ((Q_2 \cdot (P_2 - \tilde{P}_2)) / (1+r) - b), \quad (4') \end{aligned}$$

where  $\alpha$  is the shadow price associated with the constraint

(3').

Differentiating the Langrangian with respect to  $b$  we obtain

$$1 - (1+r)/(1+\delta) - \alpha = 0. \quad (5)$$

For as long as  $b < B(Q_2)$ ,  $\alpha = 0$ , and hence condition (5) entails  $1 = (1+r)/(1+\delta)$ . Since, by assumption,  $\delta > r$  equation (5) can only hold if  $\alpha > 0$ . It therefore is optimal to fully exploit the credit line, that is  $b = B(Q_2)$ . The shadow price of the credit constraint is given by

$$\alpha = 1 - (1+r)/(1+\delta). \quad (6)$$

Upon differentiation of the Langrangian with respect to  $Q_2$ , some rearrangement, and using equation (6) we obtain

$$\mu + \left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \frac{P_2 - \tilde{P}_2}{P_1} \geq \delta. \quad (7)$$

The first term on the LHS is the return on resource investment due to the price increase. The second term on the LHS, which is strictly positive if  $\delta > r$ , is the return on resource investment due to an extended credit limit. If condition (7) holds with strict inequality it is optimal to conserve the entire initial resource stock for extraction in the second period. For  $Q_2^{**} = Q$  and  $b = B(Q_2)$  the country's credit line is  $B^{**} = Q \cdot (P_2 - \tilde{P}_2)/(1+r)$ . For strict inequality of condition

(7) and  $\delta > \mu > r$ , the optimal commitment extraction and consumption pattern is given by

$$Q_2^{**} = Q,$$

$$b^{**} = B^{**} = C_1^{**} = Q \cdot (P_2 - \tilde{P}_2) / (1+r),$$

$$C_2^{**} = P_2 \cdot Q - (1+r) \cdot B^{**} = \tilde{P}_2 \cdot Q .$$

It can easily be shown that  $U^{**} > U^*$ . From

$$Q \cdot (P_2 - \tilde{P}_2) / (1+r) + \tilde{P}_2 \cdot Q / (1+\delta) > P_1 \cdot Q$$

we obtain after some reformulations

$$\mu \cdot \frac{1+\delta}{1+r} - r \cdot \frac{1+\delta}{1+r} > \left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \frac{\tilde{P}_2}{P_1} . \quad (8)$$

Condition (7) can be expressed as

$$\left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \frac{\tilde{P}_2}{P_1} = \mu + \left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \frac{P_2}{P_1} - \delta - a , \quad (9)$$

where  $a > 0$  if condition (7) holds with strict inequality. Substituting equation (9) for the RHS of condition (8), and upon reformulating, we obtain  $a > 0$  as a necessary and sufficient condition for  $U^{**} > U^*$ .

It therefore follows from a comparison of the optimal commitment and non-commitment extraction plans that the incentive to increase creditworthiness gives rise to a more resource conserving extraction policy at the expense of current income.<sup>2)</sup>

This simple model may shed light on some of the problems resource exporting LDC's are to encounter since the turn of the decade. Tumbling resource prices squeeze the liquidity cushion, thus forcing a country into increased current production and short-term credit demand. A smaller reserve base and doomed price expectations, however, are detrimental to the country's creditworthiness, thus squeezing the liquidity cushion even further. In a situation of falling resource prices, a resource exporting sovereign debtor therefore may be confronted with a conflict which it may find impossible to solve.

Footnotes:

1) If debt repayment could be enforced, for  $\delta > \mu > r$ , the optimum would be given by  $Q_2^* = Q$ ,  $b^* = C_1^* = (Q \cdot P_2)/(1+r)$ ,  $C_2^* = 0$ . Consumption could be completely shifted to the first period and financed exclusively by credits so that the return on reserve investment could be fully exploited for the servicing of the debt. Compared to a perfect credit market, unenforceable contracts combined with non-commitment may cause a resource exporting country to run down its reserves at a faster rate.

2) If income were earned from the production of a reproducible consumption cum capital good, current income would not have to decline in order to increase creditworthiness. Instead, the credit line could be augmented by diverting more of a given current income from consumption into capital accumulation.

References:

Eaton, Jonathan and Mark Gersovitz, 1981, Debt with Potential Repudiation: Theoretical and Empirical Analysis, Review of Economic Studies, 48, 289-309.

Niehans, Jürg, 1985, International Debt with Unenforceable Claims, Economic Review, Federal Reserve Bank of San Francisco, Winter 1985, Number 1, 64-79.

Sachs, Jeffrey, 1982, LDC Debt in the 1980s: Risk and Reforms, in Paul Wachtel, ed., Crises in the Economic and Financial Structure, (Lexington, D.C. Heath) 197-243.

Sachs, Jeffrey and Daniel Cohen, 1982, LDC Borrowing with Default Risk, NBER Working Paper No. 925.

Appendix (for referee's use only)

Derivation of condition (7):

From (4') we obtain the first order condition

$$\frac{\partial L}{\partial Q} = -P_1 + \frac{1}{1+\delta} \cdot P_2 + \alpha \cdot \frac{1}{1+r} \cdot (P_2 - \tilde{P}_2) \geq 0 .$$

Upon replacing  $P_1$  by  $(\frac{1}{1+\delta} + \frac{\delta}{1+\delta}) \cdot P_1$  and multiplication

with  $(1+\delta)$  we obtain

$$-\delta \cdot P_1 + P_2 - P_1 + \alpha \cdot \frac{1+\delta}{1+r} \cdot (P_2 - \tilde{P}_2) \geq 0 ,$$

from which we obtain condition (7) by dividing through by  $P_1$   
and substituting equation (6) for  $\alpha$  .

Comparison of the optimal commitment and non-commitment  
utilities:

Suppose

$$U^{**} = \frac{1}{1+r} \cdot Q \cdot (P_2 - \tilde{P}_2) + \frac{1}{1+\delta} \cdot Q \cdot \tilde{P}_2 > P_1 \cdot Q = U^* .$$

Cancelling out  $Q$ , collecting terms and multiplying both sides  
by  $(1+r)$  we obtain

$$P_2 - \left[ 1 - \frac{1+r}{1+\delta} \right] \cdot \tilde{P}_2 > P_1 + r \cdot P_1 .$$

Rearranging and dividing through by  $P_1$  results in

$$\frac{P_2 - P_1}{P_1} - \left[ 1 - \frac{1+r}{1+\delta} \right] \cdot \frac{\bar{P}_2}{P_1} > r ,$$

from which we obtain condition (8) after multiplying both sides by  $(1+\delta)/(1+r)$  and using the definition of  $\mu$ . Substituting equation (9) into condition (8) we obtain upon collecting terms

$$\mu \cdot \left[ \frac{1+\delta}{1+r} - 1 \right] - \left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \frac{P_2}{P_1} + \delta + a > r \cdot \frac{1+\delta}{1+r} ,$$

$$\mu \cdot \left[ \frac{1+\delta}{1+r} - 1 \right] - \left[ \frac{1+\delta}{1+r} - 1 \right] \cdot \left[ \frac{P_2 - P_1}{P_1} \right] - \left[ \frac{1+\delta}{1+r} - 1 \right] + \delta + a > r \cdot \frac{1+\delta}{1+r} .$$

Using the definition of  $\mu$ , cancelling and collecting terms we obtain

$$1 + \delta + a > (1+r) \cdot \frac{1+\delta}{1+r}$$

from which we obtain  $a > 0$  as a condition for  $U^{**} > U^*$ .