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Amnon Levy

University of Wollongong, levy@uow.edu.au

THE UNIVERSITY OF WOLLONGONG

DEPARTMENT OF ECONOMICS

THE ROLE OF REPUDIATION AND TRADE AND CREDIT SANCTIONS IN THE ACCUMULATION OF SOVEREIGN DEBT, PRODUCTION CAPITAL AND REPUTATION

Amnon Levy*

Department of Economics
The University of Wollongong
Northfields Avenue
Wollongong NSW Australia

ABSTRACT

This paper analyses the optimal accumulation of capital stock, external debt and reputation by explicitly incorporating the inclination of a sovereign country to service its external liabilities and the adverse effects of not meeting foreign loans' commitments on the country's trustworthy reputation. Repudiation and loss of reputation might limit the country's access to international markets of credit, consumer and capital goods; and subsequently might result in a higher average cost of servicing the country's future external liabilities, less favorable terms of trade with the rest of the world and accelerated depreciation of capital stock.

*   Amnon Levy is an Associate Professor in the Department of Economics, University of Wollongong, New South Wales, Australia.

1. INTRODUCTION

Since 1973 the external debts of the developing countries have been growing at an unprecedented rate. This has led to a heightened concern about these countries' ability and commitment to service and repay their liabilities. This concern is rooted in the fact that a country's external debt is a sovereign debt and, unlike a private debt, it is not subject to laws regarding bankruptcy and enforcement of collateral. Thus, when the potential penalties on default are insufficient, a rise in the country's degree of indebtedness increases the country's inclination to repudiate some, or all, of its external liabilities. However, as has been suggested by Jonathan Eaton and Mark Gersovitz (1981) and Kenneth Keltzer (1984), it is possible that the extent of repudiation is limited by the country's concern about the adverse effect of a default on its trustworthy reputation and, subsequently, on its access to foreign loans. The role of reputation, in conjunction with the desire for continued access to external loans, as a deterrent for repudiation have been analysed further by Herschel Grossman and John Van Huyck (1988), who distinguished between justifiable and excusable defaults and unjustifiable and inexcusable defaults and derived a reputation equilibrium in which the lenders' expectations about contingent debt servicing are validated. By assuming that small countries face competitive foreign investors, Jeremy Bulow and Kenneth Rogoff (1989) have disputed the role of the 'reputation for repayment' as a support for extending loans to small countries and have argued that lending to these countries should be supported by direct sanctions.

The present paper incorporates both the reputational argument and the possibility of an implementation of trade sanctions against a defaulting country into the analysis of external debt and capital accumulation within an intertemporal utility maximisation framework. In this framework, the indebted country choses the paths of consumption, import, export and repudiation of external liabilities so as to maximise the sum of the discounted utilities from consumption over an infinite planning horizon while taking into account the evolution of its production capacity, external debt and reputation. In addition to

the potentially adverse effect of a deterioration in its trustworthy reputation on access to foreign loans, the motion equations of the indebted country's capital stock and external debt also incorporate the possibility of lenders' retaliation by limiting the country's access to international markets. Trade sanctions against the defaulting country are likely to reduce the revenues from export, increase the payments on imports and accelerate the depreciation of capital items whose maintenance depends on foreign spare parts and skill.

The details of this analysis are presented in the following sections. Section 2 displays the indebted country's intertemporal utility maximisation as an optimal control problem in which the control variables are consumption, import, export and rate of repudiation; and the state variables are capital, external debt and reputation. It also derives the necessary conditions for maximum. Section 3 analyses the characteristics of the optimal trajectories of the control and state variables. Section 4 describes the steady-state levels of repudiation, reputation, import, capital, output and external debt.

2. DYNAMIC MODEL OF OPTIMAL DEBT ACCUMULATION AND REPUDIATION WITH CONSIDERATION FOR RETALIATION

The analysis of capital, external debt and reputation accumulation is based on the assumption that the indebted country choses the paths of consumption, import, export and the rate of repudiation of external liabilities so as to maximise the sum of the discounted utilities from consumption during an infinite horizon, while taking into account the effects of repudiation and retaliatory sanctions on the country's capital stock, external debt and reputation. The choice of an infinite time interval is to enable the assessment of long-run (steady state) effects.

In mathematical notations, the sovereign's decision problem is portrayed as

$$\text{maximising} \int_0^\infty e^{-\rho t} u(c_t) dt \qquad (1)$$
$$(c,m,x,v)$$

subject to state-transition equations:

$$\dot{K}_t = f(K_t, m_t) - c_t - x_t - \delta(R_t)K_t \qquad (2)$$

$$\dot{D}_t = q(R_t)m_t - p(R_t)x_t + r(R_t)\,(1 - v_t)\,D_t \tag{3}$$

$$\dot{R}_t = -\beta\,(v_t - v^*). \tag{4}$$

Here,

u	=	the sovereign's instantaneous utility,
ρ	=	the sovereign's rate of time preference, $\rho \geq 0$,
K	=	the country's capital stock in physical units,
D	=	the country's amount of external debt in dollars,
R	=	the sovereign's trustworthy reputation — $R \geq 0$, and larger values of R indicate higher reputation,
c	=	the country's consumption level in physical units,
m	=	the country's import level in physical units,
x	=	the country's export level in physical units,
v	=	the rate of repudiation of external liabilities, $0 \leq v \leq 1$,
v^*	=	the excusable rate of repudiation,
β	=	the reputational loss' parameter, $\beta > 0$,
δ	=	the rate of capital's depreciation,
f	=	the aggregate production function (aggregate production is measured in physical units),
q	=	the aggregate price of imported goods in dollars,
p	=	the aggregate price of exported goods in dollars,
r	=	the average cost of servicing the external debt, and
t	=	the time index.

It is assumed that:

1. The instantaneous utility is a concave function of consumption: $u' > 0$ and $u'' < 0$, $u'(0) = \infty$ and $u'(\infty) = 0$.

2. The aggregate production is a concave function of capital and imported inputs: $f_K >$

$0, f_m > 0, f(0,m) = f(K,0) = 0, f_{KK} < 0, f_{mm} < 0$ and $f_{KK}f_{mm} - f_{Km}f_{mK} > 0$.

3. The average cost of servicing the external debt rises as the indebted country's reputation declines, i.e. $r_R < 0$.

4. The rate of capital depreciation increases as the country's reputation declines due to retaliatory measures implemented by lending countries including a spare-part embargo, i.e. $\delta_R < 0$;

5. Due to a greater degree of isolation and loss of world markets, the prices of imported goods rise and the prices of exported goods go down as the indebted country's reputation declines, i.e. $q_R < 0$ and $p_R > 0$.

6. There exists an interior solution to the optimal-control problem. This assumption is compatible with the empirical evidence that, in most cases, repudiation is partial and retaliatory sanctions are limited rather than total or nil.

In this optimal-control problem, $c(t)$, $m(t)$, $x(t)$ and $v(t)$ are the control functions; and $K(t)$, $D(t)$ and $R(t)$ are the state variables. The maximum principle developed by Pontryagin *et al* (1962) implies that if the control functions and the corresponding trajectories of the state variables maximise the objective function 1 subject to the state-transition equations 2-4, there exist continuously differentiable co-state functions $\lambda_1(t)$, $\lambda_2(t)$ and $\lambda_3(t)$, such that the optimal control functions and the corresponding state and co-state functions simultaneously satisfy the state-transition equations, the co-state transition (or adjoint) equations and the optimality conditions. These transition equations and optimality conditions can be derived by considering the Hamiltonian (H) associated with the constrained intertemporal decision problem described by equations 1 to 4:

$$H = e^{-\rho t}u(c) + \lambda_1[f(K,m)-c-x-\delta(R)K]+\lambda_2[q(R)m-p(R)x+r(R)(1-v)D]-\lambda_3\beta(v-v^*)$$

$$(5)$$

where, for convenience, the time index t is omitted. In this context, the co-state variables λ_1, λ_2 and λ_3 can be interpreted as the shadow values (in utiles) of infinitesimal increments in the country's capital stock, amount of external debt and level of international reputation,

respectively. The first term on the right-hand side (r.h.s.) indicates the direct contribution of current consumption to the overall level of utility, whereas the second, third and fourth terms on the r.h.s. display the indirect contributions of current net investment, borrowing and repudiation of external liabilities, respectively, to the sovereign's overall utility level through altering future consumption possibilities.

In addition to the state-transition equations, the necessary conditions include the adjoint equations

$$\dot{\lambda}_1 = -\lambda_1 \left[f_K (K,m) - \delta(R) \right] \tag{6}$$

$$\dot{\lambda}_2 = -\lambda_2 \, r(R)(1-v) \tag{7}$$

$$\dot{\lambda}_3 = \lambda_1 \, \delta_R \, K - \lambda_2 \left[q_R - p_R \, x + r_R (1 - v)D \right] \tag{8}$$

and the optimality conditions

$$H_c = e^{-\rho t} u' (c) - \lambda_1 = 0 \tag{9}$$

$$H_m = \lambda_1 \, f_m (K,m) + \lambda_2 \, q(R) = 0 \tag{10}$$

$$H_x = - \lambda_1 - \lambda_2 \, p(R) = 0 \tag{11}$$

$$H_v = - \lambda_2 \, r(R) \, D - \lambda_3 \, \beta = 0. \tag{12}$$

Finally, the transversality conditions require that, from the sovereign's perspectives, there is no value to the terminal levels of capital, external debt and reputation. As long as the sovereign's rate of time preference is positive, these conditions are also satisfied in the case where the terminal levels of the state variables are positive.

The time differentials of the optimality conditions 9-12 yield singular-control equations describing the transitions of the control variables. The singular-control equations, the adjoint equations 6-8 and the state-transition equations 2-4 constitute a system of non-linear differential equations. Due to its size and complexity, it is impossible to solve this system and identify its asymptotic properties without additional strong assumptions and a

substantial loss of generality. Thus, the following sections present only some essential features of the optimal paths of the control and state variables and the steady-state levels of these variables.

3. CHARACTERISTICS OF THE OPTIMAL TRAJECTORIES

The adjoint equation 6 requires that, along the optimal path, the rate of change in the shadow price of capital is equal to the difference between the capital's rate of depreciation and the marginal product of capital. The optimality condition 9 indicates that at any instance within the planning horizon the shadow price of capital should be equal to the marginal utility from current consumption and thus reflect the trade-off between current consumption and future consumption.

The adjoint equation 7 requires that along the optimal path the rate of change in the shadow value of external debt is equal, in absolute terms, to the repudiation-free interest rate $(1 - v)r$. Furthermore, the optimality condition 11 implies that the ratio of the shadow prices of capital and external debt should be equal to the price of the country's export, and in recalling the optimality condition 9:

$$\lambda_2 = - e^{-\rho t} u'(c)/p(R). \tag{13}$$

By substituting 13 and 9 into the optimality condition 10 for λ_1 and λ_2 we obtain further that along the optimal path the marginal product of the imported inputs should be equal to the country's import-export price ratio:

$$f_m(K,m) = q(R)/p(R). \tag{14}$$

Note further that since the country's import-export price ratio declines with R and since the marginal product of imported inputs is diminishing, the greater the country's trustworthy reputation the larger the amount of imported goods along the optimal path.

The optimality condition 12 implies that along the optimal path the rate of repudiation of external liabilities is such that the marginal gains (in utiles) from lowering the costs of

servicing the country's external debt are offset by the adverse effect of the loss of reputation on present and future consumption and utility levels. By substituting equation 13 into the optimality condition 12, the shadow value of an infinitisimal increase in the country's reputation can be expressed as

$$\lambda_3 = r(R)De^{-rt} u'(c)/\beta p(R). \tag{15}$$

By differentiating the optimality condition 9 with respect to t it can be shown

$$-\rho e^{-\rho t} u'(c) + e^{-\rho t} u''(c) \, \dot{c} - \dot{\lambda}_1 = 0 \tag{16}$$

and in recalling conditions 6 and 9 we obtain

$$\dot{c} = -[f_K (K,m) - \delta(R) - \rho]u'(c)/u''(c). \tag{17}$$

Similar to the optimal growth theory's proposition (e.g. Cass, 1965), equation 17 implies that, given that the sovereign's marginal utility is diminishing, the consumption increases, remains the same, or decreases over time if the marginal product of capital is greater, equal, or smaller than the rental (or user) cost of capital ($\delta + \rho$). This effect of the marginal net return on capital is amplified by the degree of concavity of the sovereign's utility function. Note that in this framework, the marginal product of capital increases (decreases) with the amount of the imported inputs when K and m are complementaries (substitutes) in production, and the rental cost of capital declines with the country's level of reputation.

By taking the time differential of the optimality condition 11

$$-\dot{\lambda}_1 - \dot{\lambda}_2 \, p(R) - \lambda_2 p(R) \, \dot{R} = 0 \tag{18}$$

and in recalling conditions 6, 7, 9 and 11 it can be shown that the transition of the country's international reputation is given by

$$\dot{R} = \{(1 - v)r(R) - [f_K (K,m) - \delta(R)] \, p(R)\}/p_R(R). \tag{19}$$

Since p_R is assumed to be positive, whenever the repudiation-free interest rate is greater,

equal, or smaller than the foreign exchange receipts from exporting the net marginal product of capital, the country's reputation increases, remains the same, or decreases, respectively. The change in the country's reputation is amplified by the vulnerability of the country's export to retaliatory measures implemented by the lending countries as indicated by the export price's derivative w.r.t. R. Note that for given levels of K and m, the higher the country's reputation the lower the repudiation-free interest rate and the greater the foreign exchange receipts from exporting the net marginal product of capital and hence the greater the country's inclination to repudiate and lower its reputation.

The time differential of the optimality condition 12 implies

$$-\dot{\lambda}_2 r(R)D - \lambda_2 [r_R(R) D\dot{R} + r(R)\dot{D}] - \dot{\lambda}_3 \beta = 0 \tag{20}$$

and by substituting conditions 7 and 8 into equation 20 for $\dot{\lambda}_2$ and $\dot{\lambda}_3$, respectively, and in recalling that along the optimal path λ_1 and λ_2 behave in accordance with condition 11, it can be shown that

$$r(R)^2(1-v)D - r_R(R)D\dot{R} - r(R)\dot{D} + \beta[q_R m - p_R x + r_R (1-v)D + p(R) \delta_R(R)K] = 0. \tag{21}$$

By dividing both sides of equation 21 by r(R)D and rearranging terms, it can be shown that along the optimal path the instantaneous rate of change in the country's external debt is given by

$$\frac{\dot{D}}{D} = \frac{\beta}{r(R)} [(1-v)r_R + p(R) \delta_R (K/D) + (q_R m - p_R x)/D - r_R \dot{R}/\beta] + (1-v) r(R). \tag{22}$$

Equation 22 and the assumptions that $\delta_R < 0$, $q_R < 0$ and $p_R > 0$ indicate that the higher the country's leverage (D/K) and the lower the sensitivity of the country's import and export prices to changes in reputation, the higher the optimal rate of external debt accumulation.

4. STEADY-STATE LEVELS OF REPUDIATION, REPUTATION, IMPORT, CAPITAL STOCK OUTPUT AND EXTERNAL DEBT

By setting $\dot{R}=0$ in equations 4,19 and 22, $\dot{c}=0$ in equation 17, and $\dot{D}=0$ in equation 22, we obtain that in steady state (ss):

$$V_{ss} = v^* \tag{23}$$

$$(1 - v_{ss})\, r(R_{ss}) - [f_K(K_{ss}, m_{ss}) - \delta(R_{ss})]p(R_{ss}) = 0 \tag{24}$$

$$f_K(K_{ss}, m_{ss}) = \delta(R_{ss}) + \rho \tag{25}$$

$$\frac{\beta}{r(R_{ss})}[(1 - v_{ss})r_R(R_{ss}) + p(R_{ss})\delta_R(R_{ss})\,(K_{ss}/D_{ss}) + (q_R(R_{ss})m_{ss} - p_R(R_{ss})x_{ss})/D_{ss}]$$
$$+ (1 - v_{ss})\, r(R_{ss}) = 0. \tag{26}$$

The steady-state levels of repudiation and reputation

Equation 23 indicates that in steady state the country's rate of repudiation of external debt should be equal to the excusable rate. The substitution of 23 and 25 into equation 24 implies that the steady-state level of the country's reputation should be such that the repudiation-free interest rate is equal to the sovereign's rate of time preference times the stationary price of the country's export:

$$(1 - v^*)\, r(R_{ss}) = \rho p(R_{ss}) \tag{27}$$

By taking the total differential of equation 27 and in recalling that $0 \le v^* \le 1$, $r_R < 0$ and $p_R > 0$ we obtain that the higher the excusable repudiation rate and the rate of time preference, the lower the country's reputation in steady state:

$$\frac{dR_{ss}}{dv^*} = \frac{r(R_{ss})}{(1 - v^*)\, r_R(R_{ss}) - \rho p_R(R_{ss})} < 0 \tag{28}$$

and

$$\frac{dR_{ss}}{d\rho} = \frac{p(R_{ss})}{(1 - v^*)\, r_R(R_{ss}) - \rho p_R(R_{ss})} < 0. \tag{29}$$

The above derivatives suggest further that the more sensitive the average cost of servicing the external debt and the price of export to changes in the country's reputation, the smaller the effect of an increase in either the excusable reputation rate or the rate of time preference on the steady-state level of the country's reputation.

In order to explore further the effects of the responses of r and p to changes in R on the country's reputation in steady state let us consider the following linear forms:

$$r = r_{max} - r_1 R \; r_{max}, r_1 > 0 \tag{30}$$

and

$$p = p_{min} + p_1 R \; p_{min}, p_1 > 0 \tag{31}$$

where r_{max} and p_{min} are the average cost of servicing the external debt and the aggregate price of export when the country's reputation reaches the lowest level (i.e., R=0), respectively, and r_1 and p_1 indicate the sensitivities of the average contracted interest rate and price of export to changes in the country's reputation, respectively. The substitution of these forms into equation 27 leads to the following close-form solution to the country's stationary level of reputation:

$$R_{ss} = \frac{(1 - v^*)r_{max} - \rho p_{min}}{\rho p_1 + r_1(1 - v^*)}. \tag{32}$$

This solution implies

$$\frac{dR_{ss}}{dr_{max}} = \frac{(1 - v^*)}{\rho r_1 + r_1(1 - v^*)} > 0 \tag{33}$$

$$\frac{dR_{ss}}{dp_{min}} = \frac{-\rho}{\rho r_1 + r_1(1 - v^*)} < 0 \tag{34}$$

$$\frac{dR_{ss}}{dr_1} = \frac{-(1-v^*)\,[(1-v^*)r_{max} - \rho p_{min}]}{[\rho p_1 + r_1(1 - v^*)]^2} \lesseqgtr 0 \text{ as } (1-v^*)r_{max} \gtreqless \rho p_{min} \tag{35}$$

$$\frac{dR_{ss}}{dp_1} = \frac{-\rho[(1 - v^*)r_{max} - \rho p_{min}]}{[\rho p_1 + r_1(1 - v^*)]^2} \lesseqgtr 0 \text{ as } (1-v^*)r_{max} \gtreqless \rho p_{min}. \tag{36}$$

The steady-state levels of import, capital and production

In order to find the steady-state levels of import (m_{ss}), capital (K_{ss}) and production (y_{ss}), consider the following Cobb-Douglas aggregate production function

$$y = K^{\alpha_1} \, m^{\alpha_2} \quad 0 < \alpha_1, \alpha_2 < 1 \tag{37}$$

Then, in recalling equations 14 and 25 it can be shown that the marginal products of imported inputs and capital in steady state should be equal to:

$$\alpha_2 \, K_{ss}^{\alpha_1} \, m_{ss}^{\alpha_2-1} = q(R_{ss})/p(R_{ss}) \tag{38}$$

$$\alpha_1 \, K_{ss}^{\alpha_1-1} \, m_{ss}^{\alpha_2} = \delta(R_{ss}) + \rho. \tag{39}$$

Equations 38 and 39 indicate that the steady-state levels of import and capital are such that:

$$\frac{K_{ss}}{m_{ss}} = (\alpha_1/\alpha_2) \frac{q(R_{ss})/p(R_{ss})}{\delta(R_{ss}) + \rho} \tag{40}$$

$$m_{ss} = \left(\frac{\delta(R_{ss}) + \rho}{\alpha_1}\right)^{\frac{\alpha_1}{1-\alpha_2+\alpha_1\,\alpha_2}} \left(\frac{q(R_{ss})}{\alpha_2\,p(R_{ss})}\right)^{\frac{1-\alpha_1}{1-\alpha_2+\alpha_1\,\alpha_2}} \tag{41}$$

$$K_{ss} = \left(\frac{\delta(R_{ss}) + \rho}{\alpha_1}\right)^{\frac{1-\alpha_2}{1-\alpha_2+\alpha_1\,\alpha_2}} \left(\frac{q(R_{ss})}{\alpha_2\,p(R_{ss})}\right)^{\frac{2(1+\alpha_1\,\alpha_2)-\alpha_1}{\alpha_1\,(1-\alpha_2+\alpha_1\,\alpha_2)}}. \tag{42}$$

The steady-state level of output can be found by substituting equations 41 and 42 in the aggregate production function.

Equation 40 implies that, for a given level of reputation, the steady-state ratio of capital to imported inputs in production:

1. increases with the capital-import's production elasticities ratio,
2. increases with the import-export price ratio in steady state,
3. decreases with the rate of depreciation of capital in steady state, and
4. decreases with the sovereign's rate of time preference.

Moreover, equations 41 and 42 indicate that, for a given level of reputation, K_{SS}, m_{SS}, and subsequently y_{SS}, increase with: 1. the depreciation rate of capital, 2. the rate of time preference, and 3. the import-export's price ratio.

Note, however, that the effect of the country's steady-state reputation level on the capital-import ratio is not clear, since both the import-export's price ratio and the capital's depreciation rate—appearing in the numerator and denominator of equation 40, respectively—decline with R_{SS}. Therefore, if the import-export's price ratio is more (less) sensitive than the capital's depreciation rate to changes in R, the lower the country's reputation the more (less) capital intensive the country's production process in steady state.

Note further that the effect of the rate of time-preference (i.e. the degree of myopia) on the capital-import ratio in steady state is not obvious once the country's reputation is not held constant. On the one hand, and as indicated above, an increase in the rate of time-preference *directly* raises the rental costs of capital and hence moderates the steady-state's capital-import ratio. On the other hand, and in view of equation 32, an increase in the rate of time preference lowers the country's reputation and hence *indirectly* affects the capital-import ratio in accordance with the relative sensitivity of the capital's depreciation rate and the import-export's price ratio. Thus, the *full* effect of the rate of time preference is clear only in the case where the import-export price ratio is less sensitive than the rate of capital depreciation to changes in the country's reputation. In this case, both the direct and indirect effects of an increment in the rate of time preference are negative and hence reduce the stationary capital-import ratio. When the import-export's price ratio is more sensitive than the depreciation rate to changes in the country's reputation, the indirect effect of an increment in the rate of time preference on the stationary capital-import ratio in the production process is positive and offsets the direct effect.

The steady-state level of external debt

By setting $\dot{D}$ and $\dot{R}$ to be equal to zero in equation 21 the country's external debt in steady state (D_{SS}) is given by

$$D_{ss} = \frac{[p_R(R_{ss})x_{ss} - q_R(R_{ss})m_{ss}] - p(R_{ss})\,\delta_R(R_{ss})\,K_{ss}}{(1 - v^*)\,[r_R(R_{ss}) + r(R_{ss})^2/\beta]}.$$
(43)

In recalling the assumptions that p_R is positive and q_R and δ_R are negative, it is clear that the numerator is positive. However, in view of the assumption that the contracted interest rate decreases as the country's reputation rises (i.e. $r_R < 0$), the sign of the denominator of the term on the r.h.s. of equation 43 is not clear and hence

$$D_{ss} \gtreqless 0 \text{ as } r(R_{ss}) \gtreqless \frac{\beta E_{ss}}{R_{ss}}$$
(44)

where E_{ss} is the stationary elasticity (in absolute terms) of the contracted interest rate with respect to the indebted country's reputation. As can be expected, the more sensitive the country's reputation to repudiation (i.e. the larger the β) the smaller the country's external liabilities in steady state, and for a sufficiently large β and contracted interest rate elasticity it is possible that the initially indebted country will be a net creditor in steady state, provided that the steady-state is reached. Equation 43 indicates further that the size of D_{ss}, in absolute terms, increases with: 1. the country's steady-state levels of import, export, capital stock and the price of export; and 2. the sensitivity of the export's price, import's price and capital depreciation rate to changes in the country's reputation. It is important to note further that an increment in the excusable rate of repudiation directly increases the stationary level of external debt if $r_{ss} > bE/R_{ss}$. However, in recalling equation 28, the direct effect of v^* on D_{ss} is likely to be indirectly moderated by the deterioration in the country's stationary level of reputation.

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