

Stüven, Volker

Working Paper — Digitized Version

International capital transfers with public guarantees: A principal-agent analysis

Kiel Working Paper, No. 376

Provided in Cooperation with:

Kiel Institute for the World Economy – Leibniz Center for Research on Global Economic Challenges

Suggested Citation: Stüven, Volker (1989) : International capital transfers with public guarantees: A principal-agent analysis, Kiel Working Paper, No. 376, Kiel Institute of World Economics (IfW), Kiel

This Version is available at:

<https://hdl.handle.net/10419/46709>

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.

Kieler Arbeitspapiere Kiel Working Papers

Kiel Working Paper No. 376

International Capital Transfers
with Public Guarantees:
A Principal-Agent Analysis

by

Volker Stüven

Institut für Weltwirtschaft an der Universität Kiel

The Kiel Institute of World Economics

ISSN 0342 - 0787

Kiel Institute of World Economics
Department IV
Düsternbrooker Weg 120, D-2300 Kiel

Kiel Working Paper No. 376

International Capital Transfers
with Public Guarantees:
A Principal-Agent Analysis

by

Volker Stüven
C

May 1989

A92180/89
Weltwirtschaftliches
Institut
Kiel

The author himself, not the Kiel Institute of World Economics, is solely responsible for the contents and distribution of Kiel Working Papers.

Since the series involves manuscripts in a preliminary form, interested readers are requested to direct criticisms and suggestions directly to the author and to clear any quotations with him.

Table of Contents

	<u>Page</u>
1. Introduction	1
2. A Principal-Agent Model of International Capital Transfers	4
3. Repayment Maximization by the Principal in International Capital Transfers	8
4. The Effects from Public Guarantees for Private Debt	19
4.1. Public Guarantees without Conversion of Guarantee Payments into Domestic Debt	22
4.2. Public Guarantees with Conversion of Guarantee Payments into Domestic Debt	33
4.3. Investment Incentives of the Public and the Private Agent under the Guarantee Schemes: A Summary	39

Appendices

I. Introduction

The financial needs of corporations are generally met by borrowing in financial markets and equity participation of investors. In a similar way countries are able to obtain necessary external financing through international loans or by attracting foreign direct investment. In the case of developing countries foreign aid constitutes an additional source of foreign capital inflows. Looking at the major borrowers in Latin-America with severe debt service problems it can be stated that foreign borrowing clearly dominates the external financial structure of these countries, with foreign aid flows being negligible. The heavy reliance on foreign debt in these countries has triggered proposals that recommend a stronger role of FDI as a mean for solving the debt problems¹.

These proposals look at the choice between debt financing and foreign direct investment mainly from the viewpoint of restoring and stabilizing the developing countries' ability to meet their repayment obligations. It is assumed that the flexible repayment schedule in the case of foreign investment provides a better fit between the country's ability to pay and its repayments and, thus, helps to alleviate the repayment problems of developing countries. The general availability of FDI is not questioned. For evaluating the potential scope of foreign direct investment versus foreign loans it seems necessary to take also into account the incentives to international investors for providing either foreign loans or FDI. One important determinant for the profitability of loans and direct investment that affects the investors' willingness to engage in these forms of financing is given by the borrowing countries' investment response to debt financing and the amount of additional investment in the case of FDI respectively. The international investor maximizes his investment returns

¹ See e.g. World Development Report 1985. The World Bank, Washington D.C. and H. Robert Heller, "The Debt Crisis and the Future of International Bank Lending". AER, Papers and Proceedings 77 (1987), 2, 171-175.

by providing optimal amounts of debt and FDI subject to the country's investment behavior that can be seen as reflecting the country's or its government's utility function.

Principal-agent analysis seems to be especially appropriate for dealing with those contracts involving incentive problems¹. The principal-agent approach is mainly used in the analysis of sharecropping between a landlord (the principal) and his tenants (the agents) and in the theory of the firm where ownership and management are separated². Thereby, it is noted that the tenant's incentive to produce depends on his contractual obligations to the landlord in terms of variable sharecropping and fixed rent payments. Equivalently, the shares of equity and debt liabilities of a firm influence the managers' incentives to engage in profit maximization and, thus, to invest efficiently. Principal-agent analysis suggests that in the case of a risk-averse agent fixed commitments to the principal strengthen the agent's incentive for production, while agreements on output-sharing meet the agent's demand for risk reduction³. The first application of principal-agent analysis to development finance has been provided by Lächler⁴. Lächler analyses the country's choice between external fi-

¹ See e.g. Oliver Hart, Bengt Holmström, "The Theory of Contracts". In: Truman F. Bewley (Ed.), *Advances in Economic Theory*. Cambridge 1987, 71-155.

² See e.g. Joseph E. Stiglitz, "Incentives and Risk Sharing in Sharecropping". *Review of Economic Studies* 41 (1974), 2, 219-257 and Michael C. Jensen, William H. Meckling, "Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure". *Journal of Financial Economics*, 3 (1976), 4, 305-360. Another early analysis of the principal-agent problem has been provided by James Mirlees, "Notes on Welfare Economics, Information and Uncertainty". In: M. Balch, D. McFadden, S. Wu (Ed.), *Essays on Economic Behavior under Uncertainty*. Amsterdam 1974, 243-258.

³ See e.g. Ray Rees, "The Theory of Principal and Agent, Part I". *Bulletin of Economic Research*, 37 (1985), 1, 3-26 and J. Michael Cummins, "Incentive Contracting for National Defense: A Problem of Optimal Risk Sharing". *The Bell Journal of Economics* 8 (1977), 1, 168-185.

⁴ Ulrich Lächler, *Debt versus Equity in Development Finance*. Kiel Institute of World Economics, Working Paper 248, Dec. 1985.

nancing by foreign debt and foreign direct investment (equity) under the assumption that the country maximizes its welfare function. His conclusion from the theoretical analysis is in line with those proposals that claim a stronger role for FDI in development finance. However, Lächler's as well as other analyses disregard whether there are at all incentives to the international investor (the principal) for providing equity rather than debt to developing countries.

In the following, section 2 introduces the Lächler-model and analyses the problems that arise from the assumption of welfare maximization of the transfer receiving country (the agent). In section 3 the principal-agent model is modified by assuming that the principal maximizes his utility and chooses the optimal structure of debt and equity transfers accordingly. With the principal's calculus being decisive for the debt-equity structure of the transfer to the agent the question arises if the agent is able to reach a more favourable transfer structure by changing the institutional framework that governs the transfer. Public guarantees for private debt obligations may serve as an example for a modified institutional setting that affects the profitability of debt and equity transfers for the principal and, thus, his willingness to provide these two types of transfers. To concentrate on the analysis of guarantee schemes seems to be justified because explicit and implicit public guarantees are a regular feature of the external financing of developing countries. Hence, in section 4 the model is extended to a setting with two agents (the government and the private sector) that allows the analysis of public guarantee schemes for private debt.

2. A Principal-Agent Model of International Capital Transfers

The Lächler model assumes that the principal (the international investor) provides a given transfer (\bar{T}_1) to the agent (the country) in period 1 and receives repayment in period 2. The agent uses the transfer for consumption and investment in period 1 according to his utility function. The agent's investment takes place after the disbursement of the transfer. Investment in the first period (I_1) yields output in second period (Q_2) which is used for consumption and repayment. The repayment consists of two claims: a fixed repayment [B] and a variable payment that is defined as a proportion of the agent's second period output after deducting the fixed repayment $[(1-\pi)(Q_2(I_1)-B)]^1$. The agent's second period output is determined by the agent's investment according to his production function and a stochastic disturbance term as shown by the following expression:

$$Q_2 = \tilde{x} F(I_1) \quad \text{with } F' > 0, \quad F'' \leq 0$$

The random variable \tilde{x} assumes values in the non-negative interval $(0, \bar{x})$, subject to a known probability distribution describe by the density function, $g(x)$. It has a mean equal to 1 and a finite variance². The principal receives full repayment on his fixed claim as long as $\tilde{x} F(I_1) \geq B \Leftrightarrow \tilde{x} \geq F(I_1)/B = b$. In the case of the agent's second period output being lower than his fixed obligation B the principal receives the whole second period output as repayment.

The agent's utility function is of the von Neumann-Morgenstern type. The agent is risk-averse and maximizes his utility over the two periods:

¹ The fixed repayment includes interest and principal of the debt. Thus, an equivalent treatment of equity requires that the variable repayment includes the profit share and desinvestment. Restricting the repayments to the interest payments and the profit-shares would not affect the analysis, but only leave the country with stocks of foreign debt and direct investment at the end of the second period.

² Lächler (1985), p. 4.

$$EU = U_1[\bar{Y}_1 + \bar{T}_1 - I_1] + \beta \int_b^{\bar{x}} U_2[xF(I_1) - B - (1-\pi)(xF(I_1) - B)]g(x) dx$$

$$\Leftrightarrow EU = U_1[\bar{Y}_1 + \bar{T}_1 - I_1] + \beta \int_b^{\bar{x}} U_2[\pi F(I_1)(x-b)]g(x) dx$$

With \bar{Y}_1 denoting the agent's initial endowment and β representing the time preference rate.

The expected value of repayments to the principal calculated in period 1 results from the following expression:

$$T = B \int_b^{\bar{x}} g(x) dx + F(I_1^e) \int_0^b xg(x) dx + (1-\pi) \left[\int_b^{\bar{x}} F(I_1^e)(x-b)g(x) dx \right]$$

$$\Leftrightarrow T = F(I_1^e) \left[1 - \pi \int_b^{\bar{x}} (x-b)g(x) dx \right]$$

The notion of I_1^e refers to the fact that the principal has no information on the agent's investment decision when he provides the transfer. The principal derives expected investment from the agent's utility function.

Lächler assumes that the principal is indifferent with regard to the composition of the repayments in terms of fixed debt and variable equity repayment as long as the expected value of the total repayment stays constant. Under this assumption Lächler derives the properties of a so-called cooperative case where the agent maximizes his utility by choosing an optimal combination of debt and equity transfers subject to the constraint of a constant repayment value. The expected value of the repayments does not only depend on the agreed debt and equity claims, but also on the agent's investment decision. Thus, the cooperative case also requires the ex ante commitment of the agent to a specific first period investment. Precommitment of the first period investment is necessary because after the transfer has taken place the agent

can reach a higher utility level by cutting back investment, thereby reducing the principal's expected repayments. As long as the agent is not able to commit himself ex ante credibly to the higher investment level the principal expects him to reduce investment ex post and does not agree to the proposed debt and equity repayments in the cooperative transfer case.

Basically, the agent's inability to reach a cooperative transfer agreement is a problem of the country's sovereignty. The problem of sovereign risk can be reduced by the use of self-enforcing contracts². For that reason the second, non-cooperative, case analysed by Lächler seems to be more realistic. In this case the principal and the agent agree on a combination of debt and equity repayments with an associated investment level that satisfies two conditions: firstly, the principal's repayment constraint is satisfied, and secondly, the agent's optimal investment level does not change after the transfer has taken place. One may interpret this situation as one where the principal sets the terms of the transfer and thus gains control over the transfer process, as it is done by Lächler¹. But the fact remains that the agent's utility is maximized subject to the additional constraint that the agent's investment level stays constant after the transfer has taken place. Given the constraint that the transfer takes place in a "non-cooperative" setting because of sovereign risk, the debt-equity structure of a transfer chosen by the utility maximizing agent coincides with the transfer structure as it is set by the principal.

The assumption that in every case the expected repayments to the principal stay constant and all benefits from improved repayment terms accrue to the agent appears to be the main problem of the

¹ See Lächler (1985), p. 16.

² See Volker Stüven, Incentive Effects of Self-enforcing Contracts in International Lending. Kiel Institute of World Economics, Working Paper 341, Nov. 1988.

Lächler model. The principal receives just the minimal expected repayment value he requires for providing the transfer at all. This result characterizes the situation of a competitive supply of foreign transfers where the rate of return of every transfer is determined by the market rate. This setting does not seem appropriate for an analysis of the external financing of developing countries, especially if these countries do already face repayment problems. In this case external financing is dominated by bank consortia that are obviously able to set the terms of new debt inflows. But even if the country tries to attract new foreign direct investments e.g. through debt-equity swaps, the swap terms must be favourably enough to induce the banks to provide the necessary "old" debt claims. For debt-equity swaps to be effective the country must pay a subsidy to foreign investors using the debt-equity swap mechanism¹. Higher subsidies enable the foreign investors to pay higher prices for the banks' "old" debt claims and, thus, increases the banks' willingness to participate in the swap. But higher subsidies reduce the profitability of FDI inflows for the country. Modifying the Lächler model by introducing a profit maximizing principal who sets the terms of the transfer, i.e. the debt-equity structure of the repayments, may thus represent a first step towards a more realistic analysis of the external financing of developing countries.

¹ See e.g. D.L. Roberts, E.M. Remolana, Debt Swaps: A Technique in Developing Country Finance. In: Group of Thirty (Ed.), Finance for Developing Countries. New York 1987, 15-40.

3. Transfer Repayment Maximization by the Principal in International Lending

The preceding discussion has shown that the assumed behavior of the creditor and investor who acts as the principal to the transfer receiving country needs some further elaboration. Under the Lächler model the principal does only require the expected repayments to meet a certain target value that is specified by the market interest rate and the borrower's risk-premium. As long as the expected value of the repayments stays constant the principal is indifferent with regard to the structure of the repayments in terms of debt service and profit claims. Specifically, the principal is not interested in maximizing the repayment value by writing appropriate repayment contracts.

Provided that the transfer receiving country, the agent, is risk-averse the principal's indifference with regard to the repayment structure leads to pure equity repayments in the cooperative case. In the non-cooperative case the principal sets the terms of repayment to secure his expected repayment value, but takes into account the utility function of the agent. It follows that higher risk-aversion of the agent induces the principal to choose higher equity shares for the repayment structure. For that reasons the Lächler model does not seem to provide a sufficient explanation for the dominance of debt flows compared to equity in the international financing of developing countries. Alternatively, the strong reliance on debt may reflect the interests of the principal, as a creditor and investor, who maximizes his repayments. In this case the basic model must be modified to allow for profit maximization on the side of the principal¹. The following analysis will elaborate this approach. It will be shown that the recognition of profit maximizing behavior of the principal shifts of the optimal transfer structure towards debt compared to the results of Lächler.

¹ See e.g. James Mirlees, "The Optimal Structure of Authority and Incentives Within an Organization". The Bell Journal of Economics 7 (1976), 105-131 and Mirlees (1974), and Bengt Holmström, "Moral Hazard and Observability". The Bell Journal of Economics 10 (1979), 74-91.

The basic model is modified by introducing utility maximizing behavior on the side of the principal. As in the basic model the principal is risk-neutral and, thus, only interested in the expected value of the transfer repayment. Utility maximization is equivalent to the maximization of the expected repayment for a given transfer. The principal is no longer indifferent with regard to the debt-equity structure of the transfer repayment, but chooses the combination of fixed debt claims and variable equity claims that maximizes the expected value of the repayment, subject to at least constant utility of the borrowing agent. Using the terminology of the basic model the transfer situation is non-cooperative because the principal chooses the terms of transfer under the assumption of utility maximizing behavior of the agent.

In solving the principal's maximization problem, i.e. choosing the optimal combination of debt and equity claims, the utility calculus of the agent must be taken into account for two reasons. Firstly, changes in the debt-equity structure of the transfer repayments must leave the agent with constant utility; secondly, the principal must take into account the agent's investment incentives that result from changing debt and equity obligations.

The calculus for the borrowing country (the agent) is the same as in the Lächler model [F1 - F4]¹:

$$EU = U_1[\bar{Y} + \bar{T} - I] + \beta \int_b^{\bar{x}} U_2[\pi F(I)(x-b)] g(x) dx$$

$$\frac{\delta EU}{\delta \pi} = \beta F(I) \int_b^{\bar{x}} U_2'[\cdot](x-b) g(x) dx \geq 0 \Rightarrow \frac{\delta EU}{\delta(1-\pi)} \leq 0$$

$$\frac{\delta EU}{\delta B} = -\beta \pi \int_b^{\bar{x}} U_2'[\cdot] g(x) dx \leq 0$$

¹ Time-subscripts are suppressed for notational convenience except for the utility function.

$$\frac{\delta EU}{\delta I} = U_1'[\cdot] + \beta F'(I) \pi \int_b^{\bar{x}} U_2'[\cdot] xg(x) dx \quad [F4]$$

Given the terms of the transfer $(B, 1-\pi)$, the agent maximizes his utility by choosing an investment level that leads to $\delta EU/\delta I = 0$. Changes in the debt-equity structure of the transfer affect the agent's optimal investment. The investment incentives that result from variations of the debt and equity claims are derived by differentiating $\delta EU/\delta I$ with respect to "B" and "1- π ":

$$\frac{\delta^2 EU}{\delta I \delta B} = -\beta \pi^2 F'(I) \int_b^{\bar{x}} U_2''[\cdot] xg(x) dx \geq 0 \quad [F5]$$

$$\frac{\delta^2 EU}{\delta I \delta (1-\pi)} = \underbrace{-\beta F'(I) \int_b^{\bar{x}} U_2'[\cdot] xg(x) dx}_{\leq 0} - \underbrace{\beta \pi F'(I) \int_b^{\bar{x}} U_2''[\cdot] F'(I) (x-b) xg(x) dx}_{\geq 0} \quad [F6]$$

While an increase of the fixed debt claim always leads to positive investment incentives for the agent [F5], the effect of an increased variable equity claim is indeterminate. The first term of [F6] refers to the negative substitution effect on investment due to the reduced marginal productivity of investments that results from an increased equity share. The second term characterizes an income effect and is clearly positive. Higher variable equity claims result in lower income of the agent and at the lower income level the marginal utility of investment is higher because marginal utility is decreasing in income. Thus, the income effect from an increased equity share on the agent's investment incentives works along the same line as in the case of higher debt that does also reduce the agent's income level.

Turning to the expected repayments to the principal, its value is equivalent to the basic model¹:

$$T = F(I^e) [1 - \pi \int_b^{\bar{x}} (x-b) g(x) dx] \quad \text{with } I^e = I^* = I$$

We proceed by calculating first the partial derivatives of T with respect to B and $(1-\pi)$ ²; subsequently these results are combined with the condition for constant expected utility of the agent.

$$\begin{aligned} \frac{\delta T}{\delta B} &= \pi \int_b^{\bar{x}} g(x) dx + F'(I) \frac{\delta I}{\delta B} [1 - \pi \int_b^{\bar{x}} (x-b) g(x) dx] \\ &\quad + F(I) \left[-\pi \int_b^{\bar{x}} - \frac{db}{dF(I)} g(x) dx \cdot F'(I) \frac{dI}{dB} \right] \\ &= \pi \int_b^{\bar{x}} g(x) dx + F'(I) \frac{dI}{dB} [1 - \pi \int_b^{\bar{x}} xg(x) dx] \geq 0 \quad [F7] \end{aligned}$$

¹ The effect of higher investments on the expected value of the repayments is clearly non-negative:

$$T = F(I) [1 - \pi \int_b^{\bar{x}} (x-b) g(x) dx]$$

$$\frac{\delta T}{\delta I} = F'(I) [\cdot] - F(I) \pi \int_b^{\bar{x}} - \frac{db}{dI} g(x) dx$$

$$b = \frac{B}{F(I)} \Rightarrow \frac{db}{dI} = - \frac{B}{(F(I))^2} F'(I) = - \frac{b}{F(I)} \neq F'(I)$$

$$\Rightarrow \frac{\delta T}{\delta I} = F'(I) [1 - \pi \int_b^{\bar{x}} xg(x) dx] \geq 0$$

² For the applicability of the first-order approach see William P. Rogerson, "The First-Order Approach to Principal-Agent Problems". *Econometrica* 53 (1985), 1357-1367.

$$\begin{aligned}
\frac{\delta T}{\delta(1-\pi)} &= F(I) \int_b^{\bar{x}} (x-b) g(x) dx + F'(I) \frac{dI}{d(1-\pi)} [1-\pi \int_b^{\bar{x}} (x-b) g(x) dx] \\
&\quad + F(I) \left[-\pi \int_b^{\bar{x}} - \frac{b}{F(I)} g(x) dx \cdot F'(I) \frac{dI}{d(1-\pi)} \right] \\
&= \underbrace{F(I) \int_b^{\bar{x}} (x-b) g(x) dx}_{\geq 0} + \underbrace{F'(I) \frac{dI}{d(1-\pi)} [1-\pi \int_b^{\bar{x}} xg(x) dx]}_{\begin{matrix} > \\ < \end{matrix} 0} \quad [F8]
\end{aligned}$$

The sign of the derivative [F8] seems to be indeterminate if $dI/d(1-\pi) < 0$. However, the analysis of the agent's optimal behavior shows that the case of $dI/d(1-\pi) < 0$ is only possible if the derivative [F8] is negative, too. Otherwise, i.e. $\delta T/\delta(1-\pi) > 0$, the agent's new consumption pattern would be characterized by lower investments and higher expected repayments. This pattern cannot be optimal for the agent because utility maximization requires that an exogenous increase of the expected repayment leads to increased investments as it is shown in the following:

$$EU = U_1 [\bar{y} + \bar{T} - I] + \beta U_2 [F(I) - T]$$

$$\frac{\delta EU}{\delta I} = -U_1' [\cdot] + \beta U_2' [\cdot] (F'(I) - \frac{\delta T}{\delta I})$$

Comparison with [F4] shows that $F'(I) - \frac{\delta T}{\delta I} \geq 0$.

$$\frac{\delta^2 EU}{\delta I \delta T} = \beta (F'(I) - \frac{\delta T}{\delta I}) U_2'' [\cdot] (-1) \geq 0$$

The case of $dI/d(1-\pi) < 0$ is thus only consistent with $\delta T/\delta(1-\pi) < 0$. This, in turn, signifies a situation where the principal

does not maximize the expected repayments because he relies too heavily on equity claims. The reduction of $(1-\pi)$ which increases both the expected repayments value and, because of $\delta EU/\delta(1-\pi) \leq 0$, the agent's utility represents a pareto improvement that is always realized. Therefore, the case of $dI/d(1-\pi) < 0$ can be ruled out. In the case of a positive investment response of the agent after an increase of $(1-\pi)$ the expected repayments are clearly non-decreasing.

The analysis of the principal's maximization calculus alone leads to the results that the expected repayments are strictly increasing with the fixed debt and variable equity claims. Both variations induce higher investments by the agent. The optimal structure of debt and equity claims can only be determined if it is taken into account that the principal needs to preserve a specific minimum utility level of the agent. This minimum utility may be derived from the agent's utility without any transfer or from his utility before the adjustment of the terms of transfer takes place.

The condition of at least constant utility of the agent leads to a constraint for changes in the debt-equity structure of repayments:

$$dEU = \frac{\delta EU}{\delta B} dB + \frac{\delta EU}{\delta(1-\pi)} d(1-\pi) = 0$$

$$\Rightarrow \frac{d(1-\pi)}{dB} = - \frac{\delta EU/\delta B}{\delta EU/\delta(1-\pi)} = - \frac{\beta \pi \int_b^{\bar{x}} U_2'[\pi F(I)(x-b)] g(x) dx}{\beta F(I) \int_b^{\bar{x}} U_2'[\cdot](x-b) g(x) dx} \quad [F9]$$

$$-1 \leq \frac{d(1-\pi)}{dB} \leq 0$$

Combining this constraint and the partial derivatives of the expected repayment value with respect to 'B' and '(1- π)' [F7 and F8] allows to evaluate the profitability of shifts in favour of the fixed debt claim. For an increase of B and the associated

reduction of $(1-\pi)$ to increase the expected repayments the following inequality must be met:

$$\frac{\delta T}{\delta B} - \frac{\delta T}{\delta(1-\pi)} \frac{\delta EU/\delta B}{\delta EU/\delta(1-\pi)} > 0 \quad [F10]$$

Substituting the respective terms into this condition leads to very extensive formulas that make the identification of valid parameter values rather improbable. We thus try to ease the problem by solving for a more specific inequality.

The simplification of the inequality [F10] takes advantage of the fact that the partial derivatives $\delta T/\delta B$ and $\delta T/\delta(1-\pi)$ contain very similar terms that are only different with regard to the agent's investment response to variations of the fixed and variable claims $[\delta I/\delta B, \delta I/\delta(1-\pi)]$. In the case of an increased variable equity claim the substitution effect is contrary to the income effect; whereas no substitution effect occurs in the case of an increased fixed debt claim. Thus, the agent's investment response to an increase in B should be stronger than the one resulting from an increase of $(1-\pi)$, given that both variations in the terms of transfer have the same effect on the expected value of the transfer repayments.

Under this condition the following difference is always positive and favours the shift of the debt-equity structure towards a higher debt claim.

$$F'(I) \frac{dI}{dB} [1-\pi \int_b^{\bar{x}} xg(x)dx] - F'(I) \frac{dI}{d(1-\pi)} [1-\pi \int_b^{\bar{x}} xg(x)dx] \frac{\delta EU/\delta B}{\delta EU/\delta(1-\pi)} > 0 \quad [F11]$$

Removing the terms of [F11] from condition [F10] gives a more specific inequality [F12] with the property that each parameter constellation that meets this inequality does also fulfill the general condition [F10].

$$\Pi \int_b^{\bar{x}} g(x) dx - F(I) \int_b^{\bar{x}} (x-b)g(x) dx \frac{\delta EU/\delta B}{\delta EU/\delta(1-\Pi)} \geq 0 \quad [F12]$$

[F12] allows to identify a subsample of cases in which the principal maximizes his expected repayments by raising the fixed debt claim and reducing the variable equity claim, subject to constant utility of the agent.

As a point of reference the analysis starts with the optimal structure of transfers to an agent who has not received any transfer yet and has thus no repayment obligations [$\Pi = 1, B = 0$]. From this it follows that the difference [F11] is zero and condition [F12] is fully equivalent to condition [F10]. Moreover, with ($B = 0, \Pi = 1$) [F12] can be reduced substantially and it is shown that the condition [F12] is not met in the initial situation of ($B = 0, \Pi = 1$), which means that pure equity financing is optimal in this case.

After replacing $[\delta EU/\delta B]/[\delta EU/\delta(1-\Pi)]$ by the extended formula from [F9] the substitution of ($B = 0, \Pi = 1$) into [F12] leads to the following results

$$\Pi \int_b^{\bar{x}} g(x) dx - F(I) \int_b^{\bar{x}} (x-b)g(x) dx \frac{-\beta \Pi \int_b^{\bar{x}} U_2'[\cdot]g(x) dx}{-\beta F(I) \int_b^{\bar{x}} U_2'[\cdot](x-b)g(x) dx}$$

$$\Leftrightarrow \underbrace{\int_0^{\bar{x}} g(x) dx}_{=1} - \underbrace{\int_0^{\bar{x}} xg(x) dx}_{=1} \frac{\int_0^{\bar{x}} U_2'[\cdot]g(x) dx}{\int_0^{\bar{x}} U_2'[\cdot]xg(x) dx} < 0$$

>1

The fulfillment of [F12] is necessary for debt transfers to be optimal in the case of an agent who has not received transfers up to this point. The analysis shows that for the first transfer the condition [F12] is never met and the principal maximizes his expected repayments by relying on pure equity financing.

Positive equity claims of the principal from past transfers with debt still zero ($\pi < 1$ at the time of the new transfer) reduce the profitability of further equity transfers relative to debt if the following condition is met: In the initial situation ($B = 0$, $\pi = 1$) the general condition [F10] is clearly negative and [F11] is equal to zero. With the beginning of equity transfers ($\Delta(1-\pi) > 0$) [F11] takes on its positive value and, thus, works in favour of a higher profitability of debt relative to equity. At the same time the equity transfers increase the negative value of [F12] by reducing the value of $\pi \int_0^{\bar{x}} g(x) dx$. This effect strengthens the relative profitability of equity transfers. The overall effect on the general condition [F10] must increase the value of [F10] to be favourable for future debt transfers instead of equity transfers. This requires that the increase in the positive difference of [F11] must compensate the reduction of $\pi \int_b^{\bar{x}} g(x) dx$. The partial derivative of [F11] with respect to $(1-\pi)$ must be larger than one¹:

$$1 - \frac{d}{d(1-\pi)} \left[\pi \int_0^{\bar{x}} g(x) dx \right] = 1.$$

The term

$$\frac{\int_0^{\bar{x}} U_2' [\pi F(I) (x-b) g(x) dx]}{\int_0^{\bar{x}} U_2' [\cdot] x g(x) dx}$$

is decreasing in $(1-\pi)$ and, thus, leads generally to an increased profitability of fixed debt claims as part of the repayment structure.

$$F'(I) \left[\frac{dI}{dB} - \frac{dI}{d(1-\pi)} \frac{\delta EU/\delta B}{\delta EU/\delta(1-\pi)} \right] > 1 \quad [F13]$$

$$\text{with } 0 < \left[\frac{\delta I}{\delta B} - \frac{\delta I}{\delta(1-\pi)} \frac{\delta EU/\delta B}{\delta EU/\delta(1-\pi)} \right] \begin{matrix} > \\ < \end{matrix} 1$$

$$F'(I) \begin{matrix} > \\ < \end{matrix} 1$$

Rising equity claims decrease the principal's incentive to provide further equity financing the higher the agent's marginal productivity of investment. Countries with high investment productivities and, consequently, good growth prospects can be expected to show high investment ratios, too. Lenders should be more willing to provide debt financing for these countries than equity financing.

If the decision on the relative profitability of debt and equity transfers is made in a situation with already existing fixed debt obligations of the agent ($b > 0$), this does also result in a more favourable judgement of further debt claims as part of the repayment structure irrespective of the scale of existing equity claims. Certainly an increase of b reduces the first term of [F12] but the decrease of $\int_b^{\bar{x}} (x-b)g(x)dx$ in the second term of [F12] is even larger. Furthermore the increase of b does also reduce

$$\frac{\int_b^{\bar{x}} U_2'[\cdot]g(x)dx}{\int_b^{\bar{x}} U_2'[\cdot](x-b)g(x)dx}$$

which represents the remaining part of the second term of [F12]. Finally, a higher b increases the positive difference [F11]. The total effect of a higher b is, thus, favourable for the fulfillment of the general condition [F10]. The positive effect of

higher debt-output ratios on the principal's incentive to shift the structure in favour of debt is remarkable. It implies a self-strengthening effect of debt financing that makes the existence of an optimal mixed transfer structure with debt and equity unlikely. The initial transfers to an agent are optimally supplied as equity financing. However, the increase of the outstanding equity claims from past transfers strengthens the principal's incentive to switch towards debt. The incentive effects from the initial debt claims may be strong enough to displace equity financing fully. In this case two different patterns of development finance may evolve: the first one with low transfer amounts and pure equity financing, and the second with high transfers that are fully supplied through debt financing¹.

In summary, the model outlined in this section differs from the basic model in considering that the structure of the external financing of developing countries is also determined by the willingness of foreign creditors and investors to provide the transfers. In this connection the incentives for profit maximizing capital suppliers to shift from equity to debt finance under certain conditions may explain the rapid increase of external debt in LDC financing in the 1970s and early 1980s.

¹ A further note is possible with respect to the case of a risk-neutral agent (see Appendix I).

4. The Effects from Public Guarantees for Private Debt

Obviously, the simple principal-agent model that has been analysed in the preceding sections is only a rough picture of the incentive structure prevailing in international finance. One important simplification is the omission of the private sector in the borrowing country. The government of a borrowing country surely does not have full control over the domestic investment ratio. The total investments are simultaneously determined by the investment decisions of the public and the private sector, and international financial flows are also directed to both sectors. Under the assumption that one creditor makes transfers to both sectors the creditor acts as the principal of two agents and aims at maximizing the total expected repayments from both agents. The principal uses three instruments for maximizing repayments: the distribution of the given total transfer to the private and the public agent, and the transfer structure in terms of debt and equity for each agent. The parameters relevant for the principal's transfer decision include the agents' relative risk-aversion and time-preference rates as well as the production functions and the covariance of the stochastic outputs of the two agents¹. Moreover the investment and output of one agent may generate external benefits that lead to higher investment or more productive investment of the other agent, i.e. infrastructure investments of the public agent. In this case it can be expected that the principal provides "easier" terms of transfer to the public agent because the induced higher public investments maximize the overall transfer repayments from both agents. The provision of guarantees by the public agent that cover the private agent's transfer obligations constitutes another interdependence between the two agents that may influence the principal's transfer decision.

¹ For an extension of the principal-agent problem to many agents see Dilip Mookherjee, Optimal Incentive Schemes with Many Agents, Review of Economic Studies 51 (1984), 433-446.

The following analysis focuses on the existence of public guarantees for the repayments on private external debt. This case is relevant for LDC-financing because public enterprises play an important role in these countries and do often operate in the commercial sector¹. The reduction of the risk associated with external debt-financing of the private sector in LDCs through public guarantees has probably contributed to the rise of debt and fall of foreign direct investments in development finance. Moreover the guarantee involves an incentive for the government to monitor the economic performance of the private firms that received the guarantee. This public monitoring of private investment decisions under the domestic legal framework should increase the private investment incentives. Generating sufficient investment incentives for the borrowing agent is important for the principal in maximizing repayments because the investment returns constitute the basis for the repayments. Thus, consideration of guarantee schemes seems to be worthwhile.

As already mentioned the analysis is limited to the interdependence between the public and the private agent that results from the guarantee. For that reason, it is assumed that the public and the private agent use identical production technologies which are subject to the same stochastic disturbances. Both agents try to maximize their expected utility by making an investment decision

¹ As an example may serve the large share of publicly owned enterprises in the mining and oil industries of LDCs. Providing public guarantees to private debtors can also take the form of onlending of external loans to private firms by public institutions, as it seems to be in the case of the Mexican Pemex. The lending behavior of the creditors may be even changed if public guarantees are assumed to be implicitly approved by the government. In Chile international creditors forced the government to take over private banks that were unable to meet their external debts. The international banks argued that the loans to the Chilean banks had been granted under the assumption of effective public monitoring of the banks' business policies. The public guarantee increases the expected value of loans to private borrowers as long as the government is able to meet its obligations from the guarantee.

as in the one-agent model. Differences arise from the investment incentives of the public guarantee. The guarantee covers all fixed debt repayments from private borrowers. The first period transfers to the public and the private sector are taken as given and fixed. Thus, the principal solves an maximization problem that is similar to the one in section 3 with the additional features of the public guarantee and the existence of two agents. The principal is only interested in the total expected repayments from both agents and debt-equity shifts in one agent's repayment structure must leave the utility of each agent constant¹.

The analysis proceeds by first analysing the investment incentives of the public and the private agent under the guarantee scheme. These incentive structures are taken into account by the principal when he chooses the terms of transfer for the two agents. The principal's incentives to provide debt and equity transfers to the public and the private agent are compared to the principal's incentives in the one-agent model of section 3. Without the public guarantee the principal would set the terms of transfer for each agent according to the one-agent model. Thus, comparison of the resulting incentives with the one-agent model determines if the guarantee scheme biases the transfers to the public and the private agent in favour of debt or equity and if the bias runs into the same direction for both agents.

Public guarantees may differ with respect to the contractual obligation of the private firm against the public guarantor if the principal calls on the guarantee. Two different forms of guarantee contracts are taken into account. In the first case, the public guarantee does not involve any future obligations for the private firm against the government. If the private firm is unable to meet its fixed debt repayment and the principal calls on the guarantee, the public payment is in effect an earmarked

¹ Thus, the analysis focuses on pareto improvements in a setting with three parties, i.e. each agent is treated separately.

grant to the private firm. In the second case, the government acquires an equal claim in domestic currency against the private firm by making payments in the framework of the guarantee scheme. In effect the public guarantor buys the foreign debt claim from the principal using foreign exchange. The foreign claim is converted into a debt claim against the private firm that has to be repaid in domestic currency. For both cases it is assumed that guarantee payments are only made after the government has met its fixed debt obligation, but that they are privileged against the government's variable equity obligation¹.

4.1. Public Guarantees without Conversion of Guarantee Payments into Domestic Debt

Without the creation of a domestic public claim against the private agent guarantees do not change the private agent's calculus with regard to utility maximization. The model disregards reputational effects from contractual debt service that would influence the agent's utility in the case of repeated transfers. The private agent services his external debt as far as he is able to do so. Partial repudiation in the case of low investment returns does not reduce his utility. For that reason, the compensation of the principal by the guarantee payments in times of low investment returns does not influence his utility, too. The analysis for the private agent is equivalent to the model in section 3. Specifically, the guarantee does not lead to more risky investments.

For the public agent the guarantee implies expected payments in the second period that reduce his second period consumption (EC_{G2}). The expected guarantee payments (PG) are dependent on the private agent's fixed debt obligation (D) and the private agent's expected second period output.

¹ A government may have equity obligations from joint ventures of public enterprises with foreign firms that have already taken place in some LDCs.

$$EC_{G2} = EQ_G - T_G - PG$$

$$PG = \int_0^d g(x) dx [D - xF(I_P^e)]$$

$$PG = F(I_P) \int_0^d (d-x)g(x) dx \geq 0 \quad [G1]$$

$$d = \frac{D}{F(I_P^e)}, \quad I_P^e = I_P^* = I_P$$

The expected guarantee payments vary with changes in the structure of the private debt and equity obligations. Obviously, higher private fixed debt (D) directly increases PG. Contrary, the private investment response to more debt has a reducing effect on PG because the higher debt obligation increases the private agent's investment incentives.

$$\begin{aligned} \frac{\delta PG}{\delta D} &= \frac{\delta PG}{\delta D} \Big|_{I_P \text{ const.}} + \frac{\delta PG}{\delta I_P} \Big|_{D \text{ const.}} \cdot \frac{\delta I_P}{\delta D} \\ &= F(I) \int_0^d \frac{1}{F(I_P)} g(x) dx \\ &\quad + F'(I_P) \frac{\delta I_P}{\delta D} \left\{ \int_0^d (d-x)g(x) dx + F(I_P) \int_0^d -\frac{d}{F(I_P)} g(x) dx \right\} \end{aligned}$$

$$\frac{\delta PG}{\delta D} = \int_0^d g(x) dx - \underbrace{F'(I_P) \frac{\delta I_P}{\delta D}}_{\geq 0} \int_0^d xg(x) dx \stackrel{>}{<} 0 \quad [G2]$$

Changes in the principal's equity share of the private agent's output $(1-\Omega)$ cause only an indirect effect working along the private investment response.

$$\frac{\delta PG}{\delta(1-\Omega)} = -F'(I_p) \underbrace{\frac{\delta I_p}{\delta(1-\Omega)}}_{\geq 0} \int_0^d xg(x)dx \leq 0 \quad [G3]$$

The private agent's investment response to variations of D and $(1-\Omega)$ is equivalent to the model in section 3 [F5 and F6] because the public guarantee without debt conversion does not change the private agent's utility maximization calculus. The indeterminate sign of $\delta PG/\delta D$ can be resolved by economic reasoning with regard to the private agent's second period consumption under pure debt finance ($\Omega=1$).

$$\begin{aligned} EC_{P2} &= \int_d^{\bar{x}} F(I_p) (x-d) g(x) dx \\ &= F(I_p) \left\{ \left[1 - \int_0^d xg(x) dx \right] - d \left[1 - \int_0^d g(x) dx \right] \right\} \\ &= F(I_p) - B_p - \underbrace{F(I_p) \int_0^d (x-d) g(x) dx}_{= PG \geq 0} \end{aligned}$$

The private agent's positive investment response to an increase of D implies the reduction of the agent's first period consumption. The second period consumption is determined by the direct negative effect from the increased debt and the indirect effect from the agent's investment response. Assuming that $\delta PG/\delta D < 0$ leads to the result that the agent's investment response reduces second period consumption even further because of the induced decrease of PG . An investment decision that decreases consumption in both periods is clearly non-optimal. Thus, the increase of fixed private debt results in higher expected guarantee payments of the public agent.

The effect of the expected guarantee payments on the public agent's investment behavior corresponds to the one from fixed debt obligations. The guarantee payments are privileged against the variable equity obligation and are subject to repudiation as the fixed debt if the public agent's second period output is too low. An increase or decrease of PG has the same incentive effects as the corresponding movement of B, the fixed debt claim against the public agent.

The analysis of the principal's calculus deals in the first place with the determination of the value of the guarantee for the principal. This value is different from the expected guarantee payments of the public agent. For the principal the guarantee value is determined by the probability of full or partial repudiation by the private agent and the probability of a sufficient ability to pay on the side of the public guarantor in these cases. Furthermore, the principal must take into account the expected losses on the variable equity claim against the public agent in the case of guarantee payments. In the following, the expected values of the fixed and variable claims against the public and the private agent are derived and separated into basic terms that are equivalent to the one-agent model of section 3 and additional terms that are due to the introduction of the public guarantee.

Expected value of the private fixed debt claim:

$$VD = D \left[\int_d^{\bar{x}} g(x) dx + \int_{b+pg}^{\bar{x}} g(x) dx \right] + F(I_p) \int_0^d xg(x) dx + F(I_G) \int_b^{b+pg} (x-b)g(x) dx$$

$$pg = \frac{PG}{F(I_G)}$$

The first term represents the expected value of full repayment of the private fixed claim by either the private agent [$x_p \geq d \Leftrightarrow x_p F(I_p) \geq D$] or the public guarantor [$x_G \geq b + pg \Leftrightarrow x_G F(I_G) \geq B + PG$]. The public agent's output $x_F(I_G)$ must exceed $B + PG$ to ensure that the guarantee covers the expected shortfall of the private agent's output in times when the guarantee is called on. The private agent's output falls short of the fixed debt claim with the probability $\int_0^d g(x)dx$ and the expected output in this case is equal to $D - PG$; thus, the existence of the public guarantee leads with probability $\int_{b+pg}^{\bar{x}} g(x)dx$ to an expected full repayment of the private fixed debt. The second and third term describe the partial repayment of the private fixed debt with the private agent contributing all of his output and the public agent serving the guarantee with the output that exceeds his own fixed debt obligation.

Expected value of the private variable equity claim:

$$V\Omega = (1-\Omega) F(I_p) \int_d^{\bar{x}} (x-d) g(x)dx$$

The private equity claim is not affected by the introduction of the public guarantee because this claim is only relevant in times when the private agent's output is sufficiently high to meet the fixed debt claim and, thus, the guarantee does not come into effect.

Expected value of the public fixed debt claim:

$$VB = F(I_G) \left[1 - \int_b^{\bar{x}} (x-b) g(x)dx \right]$$

The guarantee does not change the value of the public debt claim because the public agent is obliged to meet his debt obligation first before making payments with respect to the guarantee. For that reason the term is equivalent to the basic model.

Expected value of the public variable equity claim:

$$V\pi = (1-\pi) F(I_G) \int_b^{\bar{x}} (x-b)g(x)dx - (1-\pi)F(I_P) \int_0^d (d-x)g(x)dx$$

Guarantee payments affect the public agent's ability to pay in the same way as fixed debt repayments. The expected output that remains after the debt service provides the basis for the equity claim in the basic model (first term); this term must be reduced by the expected public guarantee payments in the modified model (second term). If the principal calls on the guarantee because of the private agent's inability to pay, he gains the full guarantee payments on the side of the private agents, but loses $(1-\pi)$ times the guarantee payments on the side of the public agent.

The expected values of the total repayments from the private and the public agent are derived by adding the respective terms:

$$VT_P = F(I_P) \underbrace{\left[1 - \pi \int_b^{\bar{x}} (x-d)g(x)dx \right]}_{\text{term from the basic model}} + F(I_G) \underbrace{\left[\int_0^{b+pg} (x-b)g(x)dx + D \int_{b+pg}^x g(x)dx \right]}_{\text{effect of the guarantee } \geq 0} \quad [G4]$$

$$VT_G = F(I_G) \underbrace{\left[1 - \pi \int_b^{\bar{x}} (x-b)g(x)dx \right]}_{\text{term from the basic model}} - (1-\pi) F(I_P) \underbrace{\int_0^d (d-x)g(x)dx}_{\text{effect of the guarantee } \leq 0} \quad [G5]$$

The principal tries to maximize the expected value of the overall repayments by choosing optimal combinations of fixed and variable claims against the private and the public agent. Thereby, variations in the repayment structure of one agent must leave the expected utility of the public and the private agent constant. The principal can approach this maximization problem by first choosing the private structure that maximizes the private claim subject to the utility constraint. Based on this first step the

optimal transfer structure for the public claim is determined. This sequential approach is possible because only variations of the private fixed and variable claim affect the utility of both agents, with the expected guarantee payments serving as the link between the private repayment obligations and the utility of the public agent. Changes in the equity obligation of the private agent influence the expected guarantee payments because of the private agent's investment response. On the other hand, changes of the fixed and variable claim against the public agent leave the private agent's utility unchanged. The maximization of the principal's public claims does not interfere with the expected value of the private transfer repayments. Thus, the principal's incentives for choosing the fixed debt and variable equity claim against the public agent in the second step of the maximization procedure are equivalent to the preceding one-agent model.

For that reason the following paragraphs concentrate on the additional effects from the public guarantee with regard to the optimal debt-equity structure of the private repayments. Without the guarantee the private debt-equity structure is also determined by the principal's incentives as derived from the one-agent model¹. The change in the relative profitability of debt and equity claims for the principal can only result from the additional terms that are due to the introduction of the guarantee. Thus, the first step identifies the value increasing effect from the guarantee on the principal's private claims and analyses the impact of changes in the principal's debt and equity claims against the private agent on the guarantee value. Changes of the guarantee value for the principal imply changes in the expected guarantee payments for the public agent, who's utility must stay constant. The second step deals with the necessary compensation that must be provided by the principal to the public agent to keep his utility level in the case of changing expected guarantee

¹ This fact is reflected in the first term of VT_p , which is equivalent to the general formulation of the expected value of the combined fixed and variable claim in the one-agent model.

payments. The last step summarizes the effects from the guarantee and the compensation on the principal's profit maximization calculus and draws some conclusions on the principal's incentives for debt and equity financing.

The effect of the public guarantee on the expected value of the principal's combined fixed and variable claims against the private agent is given as

$$GE_P = F(I_G) \int_b^{b+pg} (x-b) g(x) dx + D \int_{b+pg}^{\bar{x}} g(x) dx \quad [G6]$$

The analysis again focusses on conditions that provide incentives for the principal to shift the private debt-equity structure in favour of debt claims. If high debt-equity ratios raise the value of the public guarantee for the principal (GE_P), the conditions are more favourable for an increase of private debt to have also a positive impact on the value of the whole private repayments. Shifts towards higher debt claims are accompanied with reductions of the equity claim to ensure constant utility of the private agent. The guarantee effect makes an increase of D more likely to increase the expected private transfer repayments if the following inequality is met:

$$\frac{\delta GE_P}{\delta D} - \frac{\delta GE_P}{(\delta(1-\Omega))} \frac{\delta EU_P / \delta D}{\delta EU_P / \delta(1-\Omega)} > 0 \quad [G7]$$

As it is shown in Appendix II [G7] reduces to

$$b+pg \int_{b+pg}^{\bar{x}} g(x) dx > 0 \quad [G8]$$

This inequality is met, as long as the public agent's fixed debt obligation and his expected guarantee payments does not fully exhaust the maximal possible second period output of the public agent [$b+pg < \bar{x} \Leftrightarrow B+PG < \bar{x}F(I_G)$]. As far as the utility from pri-

vate repayments is concerned the introduction of the public guarantee is a favourable precondition for the principal to shift from variable equity claims to fixed debt claims.

This favourable effect is opposed by the reduction of the principal's fixed debt claim against the public agent that is necessary to compensate the public guarantor for the increase of the expected guarantee payments resulting from higher private fixed debt. The reduction of the public fixed debt is given by the effect of the increase in D and the associated reduction of $(1-\Omega)$ on PG , the expected guarantee payments.

$$\begin{aligned}
 \frac{\delta PG}{\delta D} \Big|_{U_p \text{ const.}} &= \frac{\delta PG}{\delta D} - \frac{\delta PG}{\delta(1-\Omega)} \frac{\delta EU_p / \delta D}{\delta EU_p / \delta(1-\Omega)} \\
 &= \int_0^d g(x) dx - F'(I_p) \frac{\delta I_p}{\delta D} \int_0^d xg(x) dx \\
 &\quad - \left[-F'(I_p) \frac{\delta I_p}{\delta(1-\Omega)} \int_0^d xg(x) dx \right] \frac{\Omega \int_d^{\bar{x}} U'_{p2} [\Omega F(I) (x-d)] g(x) dx}{F(I_p) \int_d^{\bar{x}} U'_{p2} [\cdot] (x-d) g(x) dx} \quad [G9]
 \end{aligned}$$

In section 3 it has been argued that the agent's investment response to an increase of the variable claim is smaller than in the case of increased debt because of the substitution effect. Combining this consideration with the fact that the ratio of the marginal utilities is smaller than one allows to state that

$$\frac{\delta PG}{\delta D} \Big|_{U_p \text{ const.}} = \int_0^d g(x) dx - H > 0, \quad \text{with } H > 0, d > 0$$

The overall effect on PG from a shift of the private debt-equity structure towards guaranteed debt must be positive. Otherwise the principal would gain by restructuring the private repayment structure and, in addition, would be able to increase the public

agent's fixed debt leaving the public agent's utility unchanged. In the case of no private debt ($d = 0$) the above derivate is equal to zero.

The principal raises the expected value of the private repayments by substituting guaranteed fixed debt claims for variable equity claims as long as the reduction of the public fixed claim does not exceed the increase of the claim against the private agent.

The increase of the private claim is derived in [G8]. The loss on the side of the public agent is given by

$$\begin{aligned}
 & - \frac{\delta T_G}{\delta B} \frac{\delta PG}{\delta D} \Big|_{U_p \text{ const.}} \quad \text{with } I_G \text{ constant because of compensation.} \\
 & = -\Pi \int_b^{\bar{x}} g(x) dx \cdot \left(\int_0^d g(x) dx - H \right) \quad \text{with } \Pi = 1 \quad [G10]
 \end{aligned}$$

The evaluation of the principal's loss requires that Π is set equal to one because the reduction of the fixed debt claim does not increase the public agent's ability to pay in terms of the variable equity claim. The expected equity repayments are calculated on the basis of the agent's second period output after allowing for the fixed repayment obligations of the agent (fixed debt and expected guarantee payments). In the case of the reduction of the public agent's fixed debt as a mean of compensation for the increase of the expected guarantee payments the deduction from the second period output stays constant and the expected value of the variable equity claim remains unchanged. Thus, the effect is equivalent to the reduction of the fixed debt claim under the assumption that no variable equity claim exists ($\Pi = 1$).

It must be kept in mind that these effects are additional to those already derived in the one-agent model of section 3. Comparing the terms of [G8] and [G10] the following conclusions can be drawn:

- From the model without a public guarantee in section 3 it has been derived that the first transfer to the agent is optimally provided as an equity transfer. Further equity transfers decrease the profitability of equity relative to debt transfers. For the first transfer to the private agent under the guarantee scheme the inequality [G8] is strictly positive and [G10] is equal to zero. Thus, the guarantee leads to more favourable conditions for the first debt transfer. Unfortunately, it is not possible to determine if the higher profitability of debt transfers will motivate the principal to stop equity transfers at all and provide already the first transfer to the private agent in the form of debt. If this is not the case, the guarantee at least causes the shift from equity to debt transfers to occur at a lower level of equity transfers.

- In the case of debt transfers being more favourable for the principal than equity transfers the model in section 3 leads to the result that the emerging debt transfers strengthen the profitability of debt even further. Contrary, under the public guarantee scheme the profitability of shifts from private equity to debt claims by the principal is decreasing with the increase of private debt and the effect can even be reversed when the private debt claim becomes too high. Thus, the incentive for the principal in the one-agent to increase further debt transfers at the expense of equity after debt transfers have taken place is weakened under the guarantee scheme.

- The above reasoning with regard to the structure of transfers to the private agent is independent from the debt-equity structure of the transfer to the public agent. According to the sequential approach the principal determines the optimal structure of his public claims after the maximization of his private claims including the compensation of the public agent. The principal's incentives for choosing the structure of transfers to the public agent are given by the analysis of the one-agent model of section 3.

4.2. Public Guarantees with Conversion of Guarantees Payments into Domestic Debt

The guarantees that have been analysed in the preceding section had rather common contractual features. Because the guarantee did not take the form of an insurance with a fee that covers the expected costs, it was like an earmarked grant that lowers the utility of the guarantor. Furthermore, this guarantee did not affect the investment calculus of the private agent. The model analyses only a single transfer/repayment process and leaves no room for the agent's reputation from past transfer repayments, possibly by guarantee payments. The private agent does not care whether or not the principal gets the repayment. He is only interested if the inability to meet the transfer obligation leaves him with any obligation to repay in the future. The private agent's investment calculus may change if public guarantee payments lead to the creation of a new domestic claim against the private agent that compensates the public agent for his guarantee payments. Under this condition the private agent must consider all possible outputs of his investment and cannot disregard the low outputs that result in full or partial default on the transfer repayments.

The following paragraphs discuss the scheme of a public guarantee that is characterized by the special feature that the guarantor receives a domestic claim against the private agent in the case of guarantee payments. The claim takes the form of a fixed debt denominated in domestic currency with the value being equivalent to the effected guarantee payments in foreign currency. This domestic claim serves to compensate the guarantor for the guarantee payments and may leave the public agent without any loss from the guarantee if the expected value of the domestic claim fully meets the value of the guarantee payments in domestic currency. This extreme result takes place if the private agent's inability to pay is purely due to temporary illiquidity. Because international lenders find it difficult to differentiate between illiquidity, insolvency, and unwillingness to pay when they have to assess the reason for the borrower's inability to pay, the lend-

ing principal may not be willing to reschedule repayments even in cases of temporary illiquidity. Under this condition the principal can call on the public guarantee irrespective of the reason for the private agent's inability to pay. Thus, in the presence of differences between the lending principal and the public agent with regard to the available information on the true reason for the private agent's default or the technology for enforcing claims, public guarantees can serve as an instrument to deal with this asymmetries.

In the following it is assumed that the expected value of the domestic claim is equivalent to the guarantee payments measured in domestic currency. With perfect domestic capital markets the public agent is able to transform this domestic claim into present consumption that is equivalent to the forgone consumption resulting from the guarantee payments. Thus, the funds available to the public agent from his domestic point of view are not affected by the guarantee payment made in foreign currency. But a transfer problem emerges with regard to the public variable equity obligation. The variable equity claim is based on the borrower's ability to pay in foreign currency after the deduction of his fixed foreign currency obligations. The guarantee payment reduces the public agent's foreign exchange position and represents a fixed obligation in the case of a call on the public guarantee by the principal. The domestic claim is sufficient to keep the public agent's utility constant, that depends on his domestic consumption opportunities, but does not restore the public agent's foreign exchange position. Thus, the public agent enjoys a shelter for his domestic claim against the variable equity obligation. Given these repayment characteristics guarantee payments do not only leave the public agent with a constant utility, but increase his utility because the guarantee payment in foreign currency reduces his variable equity obligation. This applies as long as the principal does not take measures that "compensate" the public agent in a negative sense to keep his utility constant. It can be stated that an increase of the expected guarantee payments of the public agent ($PG > 0$) has the same effect as a reduction of the fixed debt claim ($-B = PG$)

with the absolute variable equity repayment staying constant. In terms of the public agent's expected utility this results in

$$\frac{\delta EU_G}{\delta PG} = - (1-\pi) \left[\frac{\delta EU_G}{\delta B} \right]_{\pi=1} \geq 0 \quad [G11]$$

On the side of the private agent the conversion of guarantee payments into domestic fixed debt claims modifies the utility in the second period. In the case of public guarantee payments the private agent ends up with a negative end-of-period wealth because of the existence of the domestic claim against him. It is assumed that the disutility of the negative end-of-period wealth is equivalent, but with the opposite sign, to the utility from second-period consumption of equal seize. The expected second-period consumption can thus be written as

$$\begin{aligned} EC_{P2} &= EQ_P - D - (1-\Omega) \int_d^{\bar{x}} (x-d)g(x)dx \\ &= F(I_P) \left[\int_0^{\bar{x}} (x-d)g(x)dx - \int_d^{\bar{x}} (x-d)g(x)dx + \Omega \int_d^{\bar{x}} (x-d)g(x)dx \right] \\ EC_{P2} &= F(I_P) \left[\int_0^{\bar{x}} (x-d)g(x)dx + \Omega \int_d^{\bar{x}} (x-d)g(x)dx \right] \end{aligned} \quad [G12]$$

Under the previous guarantee scheme without conversion the private agent's consumption and utility were equivalent to the basic one-agent model ([F1]-[F4]). The conversion of guarantee payments into domestic debt reduces the private agent's expected second-period consumption as long as fixed debt is positive. Consequently, the utility of the private agent is lower than under the previous guarantee scheme. Comparing the partial derivatives of the private agent's expected utility with respect to '1-Ω' and 'D' under the two guarantee schemes (4.1 and 4.2) the following conclusions can be derived:

- Because the utility level is lower and the marginal utility is decreasing, the marginal disutility of an increase of the variable equity claim with the fixed debt claim constant is greater under the guarantee scheme with conversion into domestic debt (4.2) than under the public guarantee without conversion (4.1):

$$\left. \frac{\delta EU_P}{\delta(1-\Omega)} \right|_{4.2} < \left[\left. \frac{\delta EU_P}{\delta(1-\Omega)} \right|_{4.1} \right] \leq 0$$

- For increased fixed debt claims with constant equity claims the same reasoning applies. Additionally, higher fixed debt increases the expected guarantee payments of the public agent and, thus, the domestic claim against the private agent. This effect increases the disutility resulting from higher fixed debt claims even further.

$$\left. \frac{\delta EU_P}{\delta D} \right|_{4.2} < \left[\left. \frac{\delta EU_P}{\delta D} \right|_{4.1} \right] \leq 0$$

- To keep the private agent's utility constant in the case of shifts of the terms of transfer the principal must combine the increase of the fixed debt claim with a reduction of the variable equity claim. The necessary reduction for the private agent's equity obligation follows from the ratio of the marginal disutilities $[\delta EU_P / \delta D] / [\delta EU_P / \delta(1-\Omega)]$ (see condition [G7]). It is assumed that the ratio of the marginal disutilities increases under the guarantee scheme with conversion. It is likely that the reduction of $\delta EU_P / \delta D$ dominates the decrease of $\delta EU_P / \delta(1-\Omega)$. The decrease of the absolute utility level is the same in both cases and the effect on the marginal utilities should be comparable, too. Therefore, the additional effect from the domestic debt claim should be decisive:

$$\frac{\delta EU_P / \delta D}{\delta EU_P / \delta (1-\Omega)} \Big|_{4.1} < \frac{\delta EU_P / \delta D}{\delta EU_P / \delta (1-\Omega)} \Big|_{4.2}$$

Up to this point the effects of the guarantee scheme with a conversion of guarantee payments into domestic claims of the guarantor on the utilities of the public and the private agent have been discussed. The lending principal's incentive to maximize his expected repayments in a sequential process as it was described in section 4.1 is not affected by the new guarantee scheme. For that reason the analysis proceeds by looking again at the principal's incentives to substitute private fixed debt for the private equity claim when the new incentives and marginal utilities of the public and the private agent are taken into account. The shift in the transfer structure must leave the utility of both agents constant. As in section 4.1 the analysis covers only the additional effects from the public guarantee and must be combined with the incentives from the basic one-agent model of section 3 to form a full picture of the relative profitability of fixed debt versus variable equity claims for the principal.

In section 4.1 the incentive for substituting guaranteed private debt for equity claims results from the increase of the expected private transfer repayments and is always positive as the inequality [G8] shows. Clearly, the terms of this inequality are not affected by the introduction of the conversion of the guarantee payments into domestic private debt. Therefore, differences between the two guarantee schemes must result from the opposite effect of reducing the public fixed debt in order to compensate the public agent for the increased expected guarantee payments that has been captured by the inequality [G10] in section 4.1. Given the assumptions about the expected value of the domestic claim against the private agent the public agent's utility is increased by higher expected guarantee payments. The domestic claim does fully compensate for the guarantee payments and it is excluded from calculation of the variable equity repayments (see [G11]).

Consequently, the principal must increase the public fixed debt to ensure constant utility of the public agent. The incentive to shift from equity towards debt claims against the private agent, as it is given by [G8], is thus not opposed by the disincentive from the necessary compensation of the public agent as in section 4.1, but even strengthened because constant utility of the public agent requires higher public debt. This leads to the conclusion that the guarantee scheme with conversion does always increase the incentive for the principal to substitute debt claims for equity claims on the side of the private agent compared to the basic one-agent model.

Summing up, the principal's sequential maximization of his total, private and public, expected transfer repayments leads to the following results:

- The maximization of the combined fixed and variable claims against the private agent, which constitutes the first step in the sequential process, causes a higher debt-equity ratio on the side of the private agent than in the case of the guarantee scheme without conversion into domestic claims or without any guarantee scheme.
- Under the guarantee scheme with conversion of public guarantee payments into domestic debt claims the higher private debt increases the public agent's utility if there is no "compensation". Keeping the public agent's utility constant requires an increase of public debt. Thus, after the first step of the principal's sequential maximization the public agent's repayments are characterized by higher fixed debt with an unchanged equity claim compared to the result under the public guarantee scheme without conversion after this first step and the optimal public debt-equity ratio in the one-agent model.
- The second step of the sequential solution to the principal's maximization problem requires that the expected value of the combined fixed and variable claim against the public agent is

maximized according to the analysis of the one-agent model. The analysis in section 3 (without guarantees) has shown that higher debt obligations of the agent have a positive effect on the judgement of further restructuring the debt-equity structure towards the debt claim. The increased public debt obligation that results from the first step of the principal's maximization calculus strengthens the principal's incentive to rely on fixed debt rather than variable equity claims when choosing the debt-equity ratio that maximizes his expected repayments from the public agent. The resulting public debt-equity ratio is also higher than in the case with a guarantee without conversion of guarantee payments into domestic claims, because in this case the maximization of the private claims induces a reduction of the public agent's fixed debt in the first step.

4.3. Investment Incentives of the Public and the Private Agent under the Guarantee Schemes: A Summary

The principal-agent model by Lächler provided a first analysis of the agent's investment incentives under debt and equity finance. It was found that debt finance generally leads to higher investment than equity finance with the marginal effects of higher debt and equity shares on the agent's investment being both positive. The derivation of the result was based on the assumption that the agent maximizes his utility by choosing the optimal investment subject to the constraint that the principal's expected transfer repayment value stays constant. This result does also apply to the case of the principal maximizing his expected transfer repayment value subject to constant utility of the agent as economic reasoning in section 3 showed.

Returning to the problem of development finance it can be concluded that developing countries should be able to increase domestic investment and growth by offering in renegotiations on their repayments public guarantees that increase the incentives of the international creditors and investors (the principals) to

provide higher debt financing relative to equity. The improvement that can be achieved by introducing public guarantees has to be evaluated against the principal's transfer decision in a setting without guarantees.

A short review of the Lächler model shows that the transfer structure as it is determined in this model does not provide the appropriate point of reference. In the Lächler model the agent's investment response to changes in the structure of finance is only relevant in the non-cooperative principal-agent situation¹. In this case the principal accepts only a restricted set of terms of transfer. The possible combinations of debt and equity repayments are derived from the constraint that each debt-equity structure must lead to the same value of expected repayments. Additionally, the expected investment used in the calculation of the expected repayment results from maximizing the agent's utility function given the terms of transfer. The agent chooses from the restricted set the debt-equity structure that maximizes his utility. Thereby the agent faces the risk sharing growth trade-off mentioned by Lächler because each debt-equity ratio implies a specific optimal investment. It is important to note that gains from changes in the debt-equity structure fully accrue to the agent. Thus, in the Lächler model the principal has no incentive to engage in renegotiations on the terms of transfer that may lead to increased investments.

The introduction of guarantees that change the relative profitability of debt and equity transfers can only influence the transfer structure if the principal aims at maximizing repayments. Therefore, the reference for evaluating the guarantee effect's on the agent's investment incentives is given by the principal-agent framework of section 3. The restructuring of the repayments towards debt results in increased investments. The introduction of guarantee schemes is favourable in this respect if it increases

¹ In the cooperative case the risk-averse agent relies on pure equity finance and, thus, the principal has no means to influence the investment decision.

the profitability of debt claims for the principal compared to equity claims. Thereby the debt-equity ratios of the public and the private agent must be judged separately with reference to the one-agent model with a profit maximizing principal.

The public guarantee without the conversion of guarantee payments (section 4.1) into domestic claims does not lead to a clear-cut result on this issue. Starting with the private agent who has not received any transfers yet the guarantee increases the profitability of debt claims for the principal. But the one-agent model of section 3 results in pure equity finance being optimal for the principal in this situation. If the principal provides equity financing in the beginning, the analysis of section 3 shows that the relative profitability of further pure equity finance decreases. This process in favour of additional debt finance is strengthened by the guarantee scheme in the beginning. The increase of private fixed debt diminishes the favourable influence from the guarantee on shifts towards a higher debt-equity ratio. In the case of high private debt the guarantee effect can even run in favour of increased equity claims. While in the one-agent model high equity and high debt claims both lead to more favourable conditions for further debt finance by the principal, the introduction of the public guarantee à la 4.1 creates an indefiniteness with respect to the direction of the principal's incentives when the agent's repayment obligations are increasing or already high. Because the effect on the private agent's debt-equity structure is indeterminate, the resulting debt-equity structure of the public agent cannot be determined too.

The investment effects of the guarantee scheme with the conversion of guarantee payments into domestic claims can be derived from the summary of section 4.2. The principal chooses higher debt-equity ratios for the repayments of both agents as in the one-agent model. Each agent increases investment under this condition because the utility maximization calculus that determines

the single agent's investment in the two agent model does not differ from the one-agent model. On the side of the private agent the potential conversion of guarantee payments strengthens the investment incentives that result from higher international debt. The failure of investment projects in the one-agent model lead to the partial repudiation of the debt claim and the maximal loss of the agent is represented by second period consumption of zero. Thus, the costs of an investment strategy with low investment that implies higher probability of an insufficient second period output are reduced. The introduction of the domestic claim eliminates the cost reducing effect from repudiation. The agent bears the full costs of his investment decision. This fact strengthens his investment incentives.

The analysis indicates that governments can use the instrument of public guarantees to promote higher investment of the private sector. Additionally, the resulting higher debt-equity ratio of the public agent's repayments creates a credible incentive for the government to increase its own investments too. These developments should have a favourable effect on growth prospects and the country's creditworthiness.

Appendix I:

The case of a risk-neutral agent

In this case the agent's investment stays constant after an increase of the fixed debt claim and responds negatively to an increase of the variable equity claim ([F5] and [F6] with U' constant and $U'' = 0$). The second term of [F12] reduces to

$$\int_b^{\bar{x}} g(x) dx \geq \pi \int_b^{\bar{x}} g(x) dx.$$

Because of the additional positive term from [F11] all debt finance is preferred by the principal in every case. This indicates that also with risk-averse agents the fact of low risk-aversion should make it more likely that the principal's repayments are maximized by choosing higher fixed debt instead of variable equity claims.

Appendix II:

The effects of changes in the principal's private debt and equity claims on the value of the public guarantee for the principal (GE_p) in [G7]

The single terms are derived in the following:

$$\begin{aligned} \frac{\delta GE_p}{\delta D} = & F(I_G) \left[pg \cdot g(b+pg) \frac{\delta(b+pg)}{\delta D} \right] + F'(I_G) \frac{\delta I_G}{\delta D} \int_b^{b+pg} (x-b) g(x) dx \\ & + \int_{b+pg}^{\bar{x}} g(x) dx + B_p \left[-g(b+pg) \frac{\delta(b+pg)}{\delta D} \right] \end{aligned} \quad [G7.1]$$

The effect of private debt on public investment $\delta I^G / \delta D$ is indirect and runs over the changes of the expected guarantee payments (PG) that are caused by the variations of the private debt claim. This effect affects the public agent's utility. The sequential solution requires that the changes of the expected guarantee payments are offset by opposite changes of the public agent's fixed debt to keep the public agent's utility constant. Expected guarantee payments and fixed debt obligations have the same utility and incentive effects. Hence, the overall position of the public agent remains unchanged and the investment response $\delta I_G / \delta D$ is equal to zero in the case of compensating fixed debt adjustment.

The same reasoning applies to $\delta(b+pg) / \delta D$ with

$$b+pg = \frac{B+PG}{F(I_G)} .$$