Financial Intermediation, Moral Hazard, And Pareto Inferior Trade

Bodil O. Hansen[a], Hans Keiding[b]

[a] *Copenhagen Business School, Denmark*
[b] *Institute of Economics, University of Copenhagen, Denmark*

Abstract

We consider a simple model of international trade under uncertainty, where production takes time and is subject to uncertainty. The riskiness of production depends on the choices of the producers, not observable to the general public, and these choices are influenced by the availability and cost of credit. If investment is financed by a bond market, then a situation may arise where otherwise identical countries end up with different levels of interest and different choices of technique, which again implies differences in achieved level of welfare. Under suitable conditions on the parameters of the model, the market may not be able to supply credits to one of the countries.

The introduction of financial intermediaries with the ability to control the debtors may change this situation in a direction which is welfare improving (in a suitable sense) by increasing expected output in the country with high interest rates, while opening up for new problems of asymmetric information with respect to the monitoring activity of the banks.

Keywords: Capital Outflow, Financial Intermediaries, Moral Hazard
JEL Classification: F36, D92, E44

Revista EconomiA *July 2004*

Resumo

Nós consideramos um modelo simples de comércio internacional com incerteza, onde a produção envolve tempo e está sujeita à incerteza. A natureza arriscada da produção depende das escolhas dos produtores, não observável ao público em geral, e essas escolhas são influenciadas pela disponibilidade e custo do crédito. Se o investimento é financiado no mercado de títulos, então pode acontecer a situação em que países idênticos, em tudo o mais, acabam com níveis diferentes de taxas de juros e diferentes escolhas de tecnologia, que implica novamente em níveis diferentes de bem estar. Sob condições adequadas dos parâmetros do modelo, o mercado pode não ser capaz de ofertar créditos para um dos países.
A introdução de intermediários financeiros com a habilidade de controlar os devedores pode mudar esta situação em uma direção que melhora o bem estar (em um sentido adequado) pelo crescimento do produto esperado no país com elevadas taxas de juros, enquanto enfrenta novos problemas de informação assimétrica com respeito a atividade de monitoramento dos bancos.

1 Introduction

One of the great challenges of the Latin American economies in the era of globalization is to secure healthy financial institutions which may attract both local and foreign capital to domestic investments. The negative consequences of many of the policies which have been predominating in the latter years have

⋆ The authors are grateful to two anonymous referees for pointing out several errors and shortcomings in a previous version.
Communicating author: Hans Keiding, Institute of Economics, University of Copenhagen, Studiestræde 6, DK-1455 Copenhagen K, Denmark. *Email address:* Hans.Keiding@pop.oko.ku.dk

been pointed out in the debate, for example in connection with the economic crisis in Argentina (cf. e.g. Mussa (2002), Ferrer (2003)).

The problems connected with capital outflow have been investigated also from a theoretical viewpoint (see e.g. Tornell and Velasco (1992), Collier et al. (2001)). It may be argued, as indeed it has been, that many of the problems reside in the banking sector of the less developed countries, which may not be adapted to the actual situation of free capital movements. However, it may be argued that the working of the banking sector in the context of international trade and finance is not very well understood, or at least it is only sparsely treated in the literature, which largely stays within the framework of perfect foresight and perfect competition. Yet banks as such owe their existence to imperfections of the competitive mechanism, due to uncertainty combined with asymmetric information and the consequent lack of markets for all contingent commodities.

Over the last decades, considerable progress has been made in direction of achieving a better understanding of how banks function in a closed economy; the work by e.g. Diamond and Dybvig (1983), Leland and Pyle (1977), Diamond (1984) have pointed to fundamental roles of banks as providing liquidity insurance, counteracting adverse selection, or monitoring debtors (for a survey of the field, see Freixas and Rochet (1998)). A common feature of all these approaches is that the uncertainty pertaining to intertemporal transactions is an important feature which, combined with some aspects of asymmetric information, results in equilibrium behaviour which differs from that of a perfectly competitive economy, even with uncertainty taken into account. Since the presence of asymmetric information takes us from the first-best world of competitive equilibrium to that of market failures and second-best equilibria, we must expect that im-

provement does not always result from conventional policy measures; indeed we shall argue that some of the problems connected with capital outflow and scarcity of capital might be tackled by strengthening domestic banking, which otherwise might look like a step backwards from overall free international capital movements and competition in financial markets.

In the present paper, we investigate the role of banks - or rather, one of their roles, since, as mentioned above, modern banking theory suggests many different roles – in a model with several countries and free trade, not only in commodities but also in bonds, so that we come as close as possible within the framework of the model to real world situation of globalized capital markets. The model is deliberately kept simple; we do not aim to studying commodity trade patterns but only the way in which a financial intermediary may make a difference. As it turns out, a financial intermediary may improve the situation of a country treated adversely in the global financial equilibrium.

The intuition behind the model is as follows: We consider a world with two countries, one commodity, and two periods of time. Firms in each country may choose to produce the output using either a risky or a less risky technique, and they finance the purchase of inputs in the first period by issuing bonds, which are contingent claims giving a certain repayment in case of success (of the risky production project) and nothing in case of failure. The public can observe whether the project fails or not but the choice of technique is known only to the firm. In the money market, bonds can be distinguished according to country of origin, so that the repayment rates of bonds may differ between countries. We show that an equilibrium may occur where the firms of one country must pay a higher price for their investment than those of the other country, resulting in more risky projects being chosen and expected production being lower. This situation is an

example of what is known in the literature as welfare-diminishing international trade (cf. Newbery and Stiglitz (1984)).

The introduction of financial intermediaries or banks with the ability to monitor firms' choices of investment projects may considerably remedy this disadvantage, since banks may provide loans to the firms against bonds sold in the market on equal conditions with those issued by the other country; consequently, credit is only marginally more expensive (by the amount of the monitoring cost) in this country, and indeed the banks achieve a general improvement of welfare (most markedly in the country which was at a disadvantage in the original equilibrium, but also to some extent spreading to the rest of the world).

The main message to be obtained from our analysis is that unsatisfactory performance or slow development in some countries may be caused by the system of credit allocation rather than by specific circumstances of economic or political nature. Even in cases where the countries are identical in economic structure, circumstances connected with the credit market may result in very different performance in the two countries. The situation may be partially remedied by a financial intermediary ("bank") in the country which is most adversely effected, since the inspection carried out by such an institution will make it possible to reduce the price of credits.

The paper is organized as follows: In Section 2, we introduce the model and we discuss the basic moral hazard problem in the choice of investment by firms. This is carried further in Section 3, where we add a consumption sector and consider the international equilibria which obtain in the model. This section also contains our first main result about disadvantageous free trade, showing that there are equilibria where the countries, though identical in their economic characteristics, are treated differently, with one of the countries subject to capital outflow. The follow-

ing Section 4 introduces financial intermediaries with the ability of monitoring the firms' investment policies, and this is shown to have a positive effect on welfare since (expected) production increases; in addition production increases in the adversely affected country as its capital outflow is reduced.

In Section 5, we discuss some extensions of the model, adding national labor markets and considering the role of capital stocks in international credit. We conclude in Section 6 with a discussion of the insights obtained as well as some directions of future research suggested by the results. Finally, proofs of the propositions and theorems stated in the text are collected in a separate section at the end of the paper.

2 The Model: Choice of Technique and Financing Investments

In the present section, we introduce the basic model, starting with the choices of investment. Our model is one of two countries which are followed over two periods, 0 and 1. In the first period, the firms choose an investment which has the form of a commodity input in a suitably chosen technique, and in the second period, the resulting output is obtained and sold. In our model, the investment decision consists of two parts, namely (1) choice of technique of production, and (2) quantity of input (and, assuming efficient production, output).

Since the main point of introducing the model is to show that technologically identical countries may end up in very different positions as a result of the financial institutions, we assume that the techniques to be chosen are the same in the two countries. Also, and for the same reason, we assume that the countries have

the same number of identical consumers, so that the asymmetries that will emerge are caused strictly by the institutions described in the model.

We assume that there is only one good in the model, to be consumed in either of two periods. Production is subject to uncertainty in the productive sector; there is a possibility of failure of the investment project at time 1, depending on the choice of technique. While success or failure is observable, the choice of technique is known only to the firm itself, giving rise to a moral hazard problem.

We assume that in each firm, there are two distinct types of techniques G and B for producing goods in period 1 from inputs in period 0; each of these is characterized by a production function $\gamma_j : \mathbb{R}_+ \to \mathbb{R}, j \in \{G, B\}$, describing the output to be obtained from a given input if the project succeeds; in case of failure, the output is 0; the production functions are assumed to be differentiable and concave, so that there is decreasing returns to scale in investment.

The successes or failures of the projects are formalized as follows: There are three states of nature in period 1, $s = 1, 2, 3$, with associated probabilities π_1, π_2, π_3, such that both techniques succeed in state 1, only G in state 2, and none of them in state 3. We assume that in state 1, the technique B is superior to G in the sense that it gives more output for each input m at period 0, something which of course must be weighted against its smaller probability of success. For later use we formulate this condition using a parameter λ_B, so that

$$\gamma_B(m) \geq \gamma_G(m), \gamma_B(m) \leq \lambda_B \gamma_G(m) \tag{1}$$

where the parameter λ_B satisfies

$$1 < \lambda_B < 1 + \frac{\pi_2}{\pi_1}. \tag{2}$$

An example of such a pair of techniques is that where production in the technique B is found as a constant times the production in technique G, so that $\gamma_B(m) = \lambda_B \gamma_G(m)$ for all m; we have chosen the slightly more general formulation with a view to the interpretation of the two-factor production function to be proposed in Section 5.

From (1) and (2) it follows that expected output in technique G exceeds that of technique B; indeed, if input m is inserted, then expected output in G is $(\pi_1 + \pi_2)\gamma_G(m)$ and expected output in B is

$$\pi_1 \gamma_B(m) \leq \pi_1 \lambda_B \gamma_G(m) < (\pi_1 + \pi_2)\gamma_G(m). \tag{3}$$

It should be noticed that the simple structure of uncertainty as formulated here means that success or failure is something which hits all firms (in both countries) simultaneously, being industry-specific rather than firm-specific. This structure has been chosen so as to exclude asymmetries between economically 'large' and 'small' countries, relying on the law of large numbers (cf. e.g. Keiding and Knudsen (2003)).

In order to finance the investment in inputs at period 0, firms may issue bonds (whether or not the market will accept the bonds is a problem which will be looked into later) or possibly use a bank. The bonds are to be repaid in period 1 if the investment succeeds; if it fails there is no repayment. The bond market is characterized by a repayment rate R, which is what the firm pays in case of success.

As it was mentioned above, we assume that only success or failure of the investment is generally observable, but that the firms' choices of technique cannot be observed by others. This means

that we have a problem of *moral hazard*: At the bond repayment rate R, the firm will prefer G if expected profits (given that the input has been chosen optimally for this technique) is better with G than with B:

$$\max_m \left[\pi_1 \left(\gamma_G \left(m\right) - Rm\right) + \pi_2 \left(\gamma_G \left(m\right) - Rm\right)\right] > \max_m \left[\pi_1 \left(\gamma_B \left(m\right) - Rm\right)\right], \tag{4}$$

where we have assumed without loss of generality that the (contingent) price of the commodity is 1 in each state $s, s = 1, 2, 3$, and similarly, technique B is chosen if

$$\max_m \left[\pi_1 \left(\gamma_B \left(m\right) - Rm\right)\right] > \max_m \left[\pi_1 \left(\gamma_G \left(m\right) - Rm\right) + \pi_2 \left(\gamma_G \left(m\right) - Rm\right)\right]. \tag{5}$$

Note that we have assumed that input chosen by the firm remains concealed to the general public as well, since otherwise the input choice would reveal the choice of technique.

The incentive compatibility conditions in (3) and (4) mean that the choice of technique depends on the current repayment rate in the bond market, so that firms may choose G at low repayment rates and B at higher repayment rates. We shall exploit this fact in our model when we introduce the two-country aspect which has not yet been used. Indeed, we assume that bonds can be differentiated by the general public according to the country of origin, so that bonds issued in the first country have repayment rate R and bonds issued in the second country R^*.

Once we have two different repayment rates, there are several cases to investigate. The repayment rates may be such that firms in both countries choose the same technique which may be G or B; these cases are not particularly interesting, since the bonds

will then be considered as equal in the market, so that the two-country aspect disappears. However, if the bond rates differ, say $R < R^*$, so that country 1 chooses G and country 2 B, then, as we shall see in the next section, the countries will end up in very different positions even if they were identical in their economic characteristics. Finally, it may be the case that the bond market does not accept bonds issued in one of the countries, say country 2, opening up for the activities of private banks, a possibility to be investigated in Section 4 below.

Before we proceed with the study of the situation with two different bond repayment rates, we return to the choices of the firm in period 0 which involves not only a choice of technique but also the level of operation of the technique, that is the input level which maximizes intertemporal profits. For firms in country 1, having access to investment at the repayment rate R the optimal choice of m is that for which expected profits $(\pi_1 + \pi_2)(\gamma_G(m) - Rm)$ are maximal, so that optimal input level m_R satisfies the first order condition

$$\gamma'_G(m_R) = R. \tag{6}$$

For the firms in country 2 being exposed to repayment rate R^* and choosing technique B, we get the similar expression

$$\gamma'_B(m_{R^*}) = R^*, \tag{7}$$

so that

$$\frac{R^*}{R} = \frac{\gamma'_B(m_{R^*})}{\gamma'_G(m_R)} \tag{8}$$

The expression (8) and our assumption that $R^* > R$ now tell us that

$$\gamma'_B(m_{R^*}) > \gamma'_G(m_R). \tag{9}$$

For later use we state this trivial but useful result.

Proposition 1. *Assume that* $\gamma'_B(m) \leq \lambda_B \gamma'_G(m)$ *for all* m. *If* $R^* > R$, *then the optimal input choices in country 1 and 2 satisfy* $m_R > m_{R^*}$.

Summing up so far, the workings of the financial sector, which to this moment consists only of a bond market, can – provided the equilibrium in the bond market results in sufficiently different repayment rates for bonds originating in two countries – result in one country choosing risky investment with lower expected productivity, and moreover employing less input, than the other country choosing the less risky investment. As a result the level of activity in the two countries will differ, and, as we shall see, there will be lower levels of consumption in one country than in the other.

In the next section we shall show that the situation described is compatible with equilibrium behaviour of consumer-savers in the two countries.

3 Consumer Choice and Equilibrium

In this section, we introduce the consumer demanding bonds for the purpose of transferring value from period 0 to period 1. As it was mentioned above, we deliberately keep the specification identical in the two countries (something which by the way is in line with classical trade theory as well) in order to focus on asymmetries arising from financial institutions.

We assume that there are two types of consumers, savers and entrepreneurs, differing in their endowment, each endowed with a von Neumann-Morgenstern utility function u defined on consumption in period 1 (of the single commodity). The consumer-saver has an initial endowment of 1 unit in period 0 and no

access to production, whereas the consumer-entrepreneur owns a firm, which in turn is described by the two techniques G and B as discussed in the previous section. Since all consumers are alike and have the same possibilities of choice, their number is not important, all that matters is their total endowment, which we set to 1. In the following we investigate the representative consumer having this endowment.

In the case of most interest, where there are two different types of bonds, with repayment rates R and R^*, in the market, the consumer-saver (in either country) faces the budget constraint

$$x_1 \leq Rz + R^*z^*, \quad x_2 \leq Rz, z + z^* = 1, \quad x_3 = 0, \tag{10}$$

where x_s is the consumption in state s, for $s = 1, 2, 3$, and z and z^* are the investments in the bonds of country 1 and 2, respectively. The budget constraint of the consumer-entrepreneur is rather trivial, since consumption in state s is given by the output in this state minus repayment if output is positive.

Now we describe the equilibrium of the model. For this we need the demand for bonds of the consumers performing saving, found as the values of z and $z^* = (1 - z)$ which maximize expected utility

$$\pi_1 u\left(Rz + R^*z^*\right) + \pi_2 u\left(Rz\right) = \pi_1 u\left(Rz + R^*\left(1 - z\right)\right) + \pi_2 u\left(Rz\right), \tag{11}$$

to be equal to the supply of bonds. The first order condition for a maximum of (11) is

$$\frac{R^*}{R} = 1 + \frac{\pi_2}{\pi_1}\frac{u'\left(x_2\right)}{u'\left(x_1\right)}, \tag{12}$$

assuming that the maximum is attained for z in the interior of $[0, 1]$, which means that both bonds are demanded by the savers, the case which will interest us most in the sequel. Conversely,

since u is concave, an interior solution of (12) entails that the consumer-saver will demand bonds from both countries.

Conditions for both bonds to be bought in equilibrium is given in the following proposition; we insert the expressions $x_1 = Rz + R^*(1-z)$, $x_2 = Rz$ in (12) to get

$$\frac{\gamma'_B(1-z)}{\gamma'_G(z)} = \left[1 + \frac{\pi_2}{\pi_1}\frac{u'(\gamma'_G(z)\,z)}{u'(\gamma'_G(z)\,z + \gamma'_B(1-z)(1-z))}\right], \quad (13)$$

and check whether this equation may be satisfied for some $z \neq 0$.

Proposition 2. *Assume that the production functions γ_G and γ_B satisfy the following well-behavedness conditions:*

(i) $\gamma'_j(0) \geq K\gamma'_k(1)$, where $K > \left(1 + \frac{\pi_2}{\pi_1}\right)$, $j,k \in \{B,G\}$, $j \neq k$,
(ii) the function $z \mapsto z\gamma'(z)$ is continuous in $[0,1]$ with value 0 at $z = 0$.

If π_2 is small, then there is an equilibrium with savings z_0 such that $0 < z_0 < 1$.

The assumption (i) in Proposition 2 connects the marginal products of the different techniques taken in different input combinations; it implies that the production must display decreasing returns to scale, and it will be satisfied if both production functions exhibit sufficiently high marginal productivity at 0; part (ii) rules out that marginal productivity is infinitely large at 0.

Our next task is to investigate the supply side of the bond market. For the two types of bonds to exist simultaneously, we must have that firms in country 1 choose technique G and firms in country 2 choose B. For this we need to check that the incentive compatibility conditions (4) and (5) are satisfied, something which in its turn will depend on marginal products (equal to repayment rates in equilibrium) in the two techniques. The

proposition stated below gives conditions on the technology under which there will indeed be different choices of technique in the two countries.

Proposition 3. *Assume that the production functions of the model satisfy*

(i) $\gamma'_G(z) \leq \frac{\pi_1(1-\lambda_B)+\pi_2}{\pi_2}\frac{\gamma_G(1-z)}{1-z}$,
(ii) $\frac{\gamma_B(z)}{z} \leq \gamma'_B(1-z)$

for all $z \in [0,1]$ *satisfying (11). Then the model admits an equilibrium with* $R < R^*$*, where firms in country 1 choose* G *and firms in country 2 choose* B*.*

The assumptions on the production functions γ_j made in Proposition 3 relate average and marginal products of the production functions. Since production functions are concave, marginal product to be smaller than average product at any fixed input; we need however to compare marginal product at some input with average product at another (the two input levels which are optimal at the two repayment rates). Thus the assumption (i) states that marginal product in technique G at input z (which equals R, the cost of credits) is smaller than average product at $1-z$, when the latter is scaled down by a factor capturing that B gives more output but with smaller probability; thus (i) says that the cost of credit in G is smaller than what could possibly be paid in B. The assumption (ii) amounts to stating that average product at the input level m_R is smaller than marginal product at m_{R^*}, which seems reasonable in view of Proposition 1. In both cases, the assumptions will be fulfilled if the input level in country 2 is small compared to that of country 1.

Using the results obtained we may now summarize the discussion in the following main theorem.

Theorem 1. *Under the assumptions stated in Propositions 1 – 3, there is an equilibrium with two types of bonds having different repayment rates. This equilibrium is Pareto inoptimal in the following strong sense: There is another allocation with no transfers of commodities between countries which gives higher expected utility to every consumer in every country.*

It should be noted that one of the distinctive features of the asymmetric equilibrium is that some of the endowment in country 2 is taken to the country 1 for investment; thus, we have an equilibrium with capital outflow. This happens even though the two countries are identical with respect to their characteristics – they have the same number of identical consumers and identical firms. This identity of countries has of course been assumed to stress that the asymmetry which occurs in the equilibrium is a phenomenon brought about by the economic institutions rather than by objective causes (it is a 'sunspot' phenomenon). Consequently, the institutions (which are the generally approved institutions of liberalized trade and capital movements) need to be blamed, or rather, need to be revised.

One way in which a welfare improvement might be achieved would be to allow firms of country 2 to apply for credit directly in country 1; while this will indeed represent a Pareto improvement in our situation, it is not quite in line with the logic of our model, where credit so far is to be obtained only through the bond market which discriminates against country 2 firms. The introduction in the next section of a financial intermediary does however take us in some way in the same direction.

Although the existence of equilibria with asymmetry in investment conditions has been our primary concern, it should be mentioned that the model admits also another, symmetric equilibrium; there are two types of such equilibria:

(1) Bonds of the two countries have the same repayment rate and the choice of technique is identical in the two countries. Whether this choice is G or B will depend on the marginal products in the two techniques at the symmetric input levels $z = \frac{1}{2}$. Intuitively, one would expect this choice to be G, and this will be the case if λ_B is not too big. In this case, going from the asymmetric to the symmetric case would represent a welfare improvement; however, in the model there is no obvious way of moving from one equilibrium to another.

(2) Bonds are distinguishable but consumers demand only one type. In this case production is concentrated in one country, and by our parameter choices, the technique chosen is G. The concentration of production in one country represents an efficiency loss. In the following section, we consider situations where this loss may be avoided by introduction of a financial intermediary.

4 Financial Intermediation

In this section, we consider the case where the bond market does not sustain two types of bonds; this may happen if $\gamma'_B(0)$ is smaller than the smallest repayment rate R^* for which the consumer will want to hold a bond giving R^* in state 1 and nothing in the other states. The lack of a market for bonds from firms in country 2 means that investment in the country's firms will not be forthcoming, so that output at period 1 as well as the income of the consumer-entrepreneurs of this country is 0. All investment takes place in country 1.

Following the suggestions of contemporary microeconomic theory of banks, there is in this situation room for another type of financial institution in country 2. This financial intermediary

(or 'bank') will obtain loans from the general public, possibly by issuing bonds, and offer credits to firms in country 2; the new aspect of this situation is that the financial intermediary has the possibility of monitoring the investment of the firm. We shall assume that this monitoring may be carried out to different degree according to the choice of the bank: We assume that what is chosen is the proportion $\rho \in [0,1]$ of firms to be controlled; if a firm is controlled, it will choose technique G independent of the repayment rate R_b^* which it has accepted with the bank; otherwise we assume that R_b^* is sufficiently high so that the firm will choose B. The cost to the bank of controlling the proportion ρ of firms is ρc, where $c > 0$ is a constant.

Denote by R_b the repayment rate offered to the consumer-savers. Given R_b and ρ, the consumer-saver will choose the proportion z invested in bonds of country 1 so as to maximize expected utility

$$\pi_1 u\left(Rz + R_b\left(1-z\right)\right) + \pi_2 u\left(Rz + \rho R_b\left(1-z\right)\right), \tag{14}$$

giving the first order conditions

$$\frac{R_b}{R} = \frac{\pi_1 u'\left(\tilde{x}_1\right) + \pi_2 u'\left(\tilde{x}_2\right)}{\pi_1 u'\left(\tilde{x}_1\right) + \rho\pi_2 u'\left(\tilde{x}_2\right)}, \tag{15}$$

with $\tilde{x}_1 = Rz + R_b(1-z)$, $\tilde{x}_2 = Rz + \rho R_b(1-z)$, from which the demand for bank bonds at repayment rate R_b may be found as $1-z$. The rate R_b^* which the bank proposes to its debtors may then be found as the value of R_b^* for which

$$\rho m_{R_b^*}^G + \left(1-\rho\right) m_{R_b^*}^B = 1 - z, \tag{16}$$

where $m_{R_b^*}^G$ and $m_{R_b^*}^B$ are optimal input levels at repayment rate R_b^* given that technique G, respectively B, is chosen; these input levels satisfy

$$\gamma_G'\left(m_{R_b^*}^G\right) = \frac{R_b^*}{\pi_1 + \pi_2}, \gamma_B'\left(m_{R_b^*}^B\right) = \frac{R_b^*}{\pi_1}. \tag{17}$$

A profit maximizing bank will choose the decision variables R_b and ρ in such a way that the expected profit $[(\pi_1 + \pi_2\rho)(R_b^* - R_b)](1 - z) - \rho c$ is maximal.

The question of whether a bond market for country 1 debt can coexist with a monopolistic bank in country 2 is not entirely trivial. As in previous sections, we need some specific structure on the production functions in order to be sure that there is an equilibrium of the type we are interested in. In our present case the assumptions must be such that without a financial intermediary, there is an equilibrium with zero production in country 2, and such that the gains from spreading production as a result of the activity of the financial intermediary exceed the cost of monitoring the choice of technique. This is specified in the following proposition.

Proposition 4. *Assume that*

(a) $\frac{\gamma_B'(0)}{\gamma_G'(1)} < \left(1 + \frac{\pi_2}{\pi_1}\right)$,
(b) $\gamma_G'\left(\frac{1}{2}\right) \leq c\left(1 + \frac{\pi_2}{\pi_1}\right)$, *and*
(c) $\gamma_G'\left(\frac{1}{4}\right) - \gamma_G'\left(\frac{3}{4}\right) \leq \frac{4c}{\pi_1 + \pi_2}$.

Then there is no market for country 2 bonds, but there is an equilibrium with bond market for country 1 and a profit maximizing bank in country 2. This equilibrium is characterized by incomplete monitoring, $0 < \rho < 1$.

In the setup considered here, where the financing of firms in country 1 is carried out via the bond market, whereas the firms in country 2 use a financial intermediary, since the bond market will not accept country 2 bonds, it comes as no surprise that the credit allocation established by the intermediary brings a Pareto improvement relative to the alternative which is no credits at all in country 2. On the other hand, the monopolistic behaviour of

the bank gives rise to the usual distortions due to higher interest margin than what is dictated by monitoring cost alone; this distortion results in smaller than optimal production in country 2, larger than optimal production in country 1. It should be emphasized that this is a loss which goes beyond the cost of monitoring debtors and it is strictly related to monopolistic pricing behaviour.

There is however, another problem which has not been considered here, namely that of asymmetric information with respect to the monitoring activity carried out by the bank. It has been assumed throughout that savers know the (true) inspection rate ρ when making their portfolio decisions. If however ρ is not generally observable, we have a new situation. The bank may be tempted to reduce its value, thereby saving monitoring cost, and in lack of other counterbalancing features, which would have to be introduced into the model, the only possible inspection level would then be 0 in which case the bank would get no deposits. We shall not expand on this problem of equilibrium choice of inspection level by banks, which on the one hand opens up for a discussion of the role of banks in the recent financial downturns of some countries, but on the other hand would take us away from the central message of the model, namely that high interest levels (and high country risk) may be caused by the system of financing investment rather than by the fundamental economic structures of the countries.

5 Extensions of the Model

The model which has been discussed in the previous sections has been designed for the study of problems of capital flows under the conditions of liberalized trade and capital movements. It may

be argued that the two-country aspects of the model are not very elaborated, since countries are only identified by the productive firms, which are considered as non-transferable national identities, and from the distinction between debt contracted by firms in one country and firms in another country which is derived from the national character of the firms.

Apart from this, the two-country framework does not put limitations on the economic activites of the agents; thus, the consumer-savers were behaved identically whether they were situated in one country or another. On the other hand, most of the traditional features of two-country models of international trade may be introduced into the model without modifying the basic structure and the conclusions of the model. Thus, we may add another type of consumer, namely consumers endowed with labor power, which is used as input in the firms' intertemporal production, giving rise to a wage paid out of the finished product. These consumers are specific for the country and cannot migrate. To introduce this feature, we need only to reinterprete the production functions $f_j(m)$ as

$$f_j(m) = F_j(m, L), \quad j \in \{B, G\}, \tag{18}$$

where $F_j(m, L)$ is a constant return to scale production function in the two productive factors commodity and labour, and L is the total labour endowment, assumed to be identical in the two countries. Now everything goes as before, with wages taking the place of the profits of consumer-entrepreneurs.

Another feature which might be added to the model has to do with the belief structure; in the preceding results, we have shown that asymmetric equilibria may arise but we have not given any explanation of *why* they should arise. It should be remembered that the symmetric equilibrium, where each country invests 1/2 and where bonds, even if country-specific, have the same price

in the market, is also possible. Without further structure in the model, we have only established that asymmetries may arise, not that they must arise.

A possible explanation of the phenomenon that the money market expects higher risk in country 2 than in country 1 – an expectation which in our model leads to high interest rates driving the firms into risky investments which then confirm the expectation of high risk – can be obtained if we introduce differences in the initial wealth of countries, which will lead to differences in the situations of the two firms as to the likelihood of moral hazard effects, since firms of wealthy countries borrow less and invest more of their own wealth. Therefore, we introduce *own investment* by firms. Assume that country 1 firms are able to finance some of their production by own means, not resorting to the loan market, whereas country 2 firms either do not have this possibility or at least are less well endowed with such capital. This means that the countries are no longer absolutely identical, country 1 being richer than country 2, but otherwise they have access to the same technology, have identical labour endowment etc. In this situation we must distinguish between country 1 and country 2 production functions, with

$$\gamma_j^i(m) = F_j\left(m_0^i + m, L\right) - m_{j'}^i \quad i = 1, 2, \quad j \in \{B, G\}, \quad (19)$$

where m_0^i denotes the initial capital available in firms of country i. Thus, the production function $\gamma_j^i(m)$ gives the net output resulting from adding m to the already existing input m_0^i, which of course has to be reestablished afterwards (if possible). We assume that if a project fails, then all capital, own as well as borrowed, is lost, meaning that expected profits of country 1 firms at bond repayment rate R becomes

$$\Pi_G^i\left(m, R, m_0^i\right) = (\pi_1 + \pi_2)\left(\gamma_G^i(m) - Rm\right) - \pi_3 m_0^i, \quad (20)$$

if technique G is used, and

$$\Pi_B^i\left(m, R, m_0^i\right) = \pi_1\left(\gamma_B^i\left(m\right) - Rm\right) - \left(\pi_2 + \pi_3\right) m_0^i \qquad (21)$$

in case of technique B.

We show that in this situation, the change of technique from G to B takes place at a higher repayment rate, the higher the initial level of capital endowment.

Proposition 5. *Assume that* $m_0^1 > m_0^2$. *If* $\hat{R}^i$ *is the repayment rate at which firms in country* i *are indifferent between the two techniques,* $i = 1, 2$, *then* $\hat{R}^1 > \hat{R}^2$.

The fact that the richer (in terms of firms' initial investments) country is more likely to choose G than the poorer country – or, otherwise put, rich countries are less likely to be affected by moral hazard – gives a rationalization of the asymmetric beliefs which in are their turn sustained by asymmetric equilibria. Thus, it comes as no surprise that rich countries have low interest rates and choose the less risky techniques, whereas the poorer countries are forced into a choice of risky investments, giving substance to the beliefs among investors. However, the explanation has the possible disadvantage of reducing the asymmetry to a phenomenon which is partially explained by differences of endowments, or comparative advantage in receiving credits. Still the model retains the main message that slow development in some countries may be caused by the system of credit allocation rather than by specific circumstances of economic or political nature. The standard explanation of the economic difficulties of the less developed countries of e.g. Latin America is turned around, since the bad average performance of the countries is an effect rather than a cause of their low rating in financial markets.

6 Discussion

In the previous sections, we have developed a simple model of international credit and investment, with uncertainty playing a crucial role; the choice of technique in the investment projects is crucially dependent on the rate of interest, forcing countries exposed to a high rate of interest to choose risky investments, thereby reinforcing the opinions of the savers as to the creditworthiness of these countries. This may lead to a breakdown of the bond market for investment in such countries, a situation which opens up for the operation of banks which may offer credits to investors given that they monitor (partially or fully) the behaviour of the debtors. Thus, the banks fulfil a role in international finance which cannot be performed by a competitive bond market.

Clearly, the model focuses on a particular aspect of banking, and its general recommendation of enhancing the functioning of financial intermediaries should of course be seen in this light; banking is in the present study synonymous with monitoring of credits, and even so, the viability of the arrangement depends on whether the monitoring performed by the banks is in accordance with the expectation of the public. Seen in this light the results are compatible with possible negative effects of the banking sector in aggrevating rather than alleviating crises (such as may have been the case in Argentina, cf. e.g. della Paolera and Taylor (2003)).

It has been a main point of the model that the countries were identical at the outset, so that eventual asymmetries in final allocation must be caused by the institutions rather than by the underlying characteristics of the economies. In particular, instead of the asymmetric equilibria there might have been a symmetric one, where both countries produced identical amounts

of goods and consumers enjoyed identical levels of utility (recall that in our model, uncertainty is not country-specific, so it hits each country in the same way). However, the market may result in the asymmetric situation, where too much is produced in one country, too little in the other, and with the welfare reducing greater risk sustained by the market (or, alternatively, by the financial intermediary).

Thus, the model may be considered as one way of explaining why standard trade theory, according to which investment would flow towards the country exhibiting the highest marginal productivity, does not predict the actual state of affairs very well. Marginal productivity may well be considerably higher in poor countries than in rich ones (where interest rates by now are historically low), but the market mechanism cannot allocate savings to their best purpose when uncertainty and information asymmetries are present. Thus, the model shows that we have to take market failure into consideration also when considering international capital markets, which are as much subject to market failure as any other market.

The model does not point directly to what can be done to remedy the situation. On one hand, a bank which fully monitors the investers in country 2 may indeed provide a second best solution to the welfare maximization problem, but then the question arises whether such a bank can be given the right incentive structure to support such a solution. The model in its present version is probably too oversimplified to give answers to such questions, which therefore remain topics for future research.

References

Clark, E. & Jockung, O. (1998). Risk aversion, wealth and international capital flows. *Review of International Economics*, 6:507–515.

Collier, P., Hoeffler, A., & Patillo, C. (2001). Flight capital as a portfolio choice. *The World Bank Economic Review*, 15:55–80.

della Paolera, G. & Taylor, A. M. (2003). Gaucho banking redux. *Economía*, 3(2):1–42.

Diamond, D. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies*, 51:393–414.

Diamond, D. (1991). Monitoring and reputation: The choice between bank loans and directly placed debt. *Journal of Political Economy*, 99:863–882.

Diamond, D. & Dybvig, P. (1983). Bank runs, deposit insurance and liquidity. *Journal of Political Economy*, 91:401–19.

Ferrer, A. (2003). La enfermedad argentina. In Lascagna, M. R., editor, *La Economía Argentina Hoy*. Editoral El Ateneo, Buenos Aires.

Freixas, X. & Rochet, J. C. (1998). *Microeconomics of Banking*. The MIT Press, Cambridge, Massachusetts.

Galiani, S., Heymann, D., & Tommasi, M. (2003). Great expectations and hard times: The Argentine convertibility plan. *Economía*, 3(2):109–160.

Keiding, H. & Knudsen, M. J. (2003). Disadvantageous financial integration, An overlapping generations model of international trade with capital markets. Manuscript, Institute of Economics, University of Copenhagen.

Leland, H. E. & Pyle, D. H. (1977). Informational asymmetries, financial structure and financial intermediation. *Journal of Finance*, 32:371–87.

Mussa, M. (2002). Argentina and the Fund: From triumph to tragedy. *Policy Analyses in International Economics*, 67. Institute of International Economics.

Newbery, D. M. G. & Stiglitz, J. E. (1984). Pareto inferior trade. *Review of Economic Studies*, 51:1–12.

Sturzenegger, F. (1997). Understanding the welfare implications of currency substitution. *Journal of Economic Dynamic and Control*, 21:391–416.

Tornell, A. & Velasco, A. (1992). The tragedy of the commons and economic growth: Why does capital flow from poor to rich countries? *Journal of Political Economy*, 100:1208–1231.

7 Appendix: Proof of Propositions

In this section, we give the proofs of the propositions and theorems stated in the text.

Proof of Proposition 2: We need to prove that there is a value of z different from 0 and 1 so that the equation (13), restated below as

$$\frac{\gamma'_B(1-z)}{\gamma'_G(z)} = \left[1 + \frac{\pi_2}{\pi_1}\frac{u'(\gamma'_G(z)\,z)}{u'(\gamma'_G(z)\,z + \gamma'_B(1-z)(1-z))}\right], \quad (22)$$

is satisfied. Using (i) we have that for $z = 0$, the left-hand side of this expression is $\leq K^{-1} \leq \left(1 + \frac{\pi_2}{\pi_1}\right)^{-1}$, which is smaller than 1, whereas the right-hand side may be assessed using (ii), from which it follows that it takes a value ≥ 1. For $z = 1$ we use again (i) to obtain that the left-hand side is greater than $\left(1 + \frac{\pi_2}{\pi_1}\right)$, whereas the right-hand side of (11) equals $\left(1 + \frac{\pi_2}{\pi_1}\right)$.

By continuity there is z_0 strictly between 0 and 1 such that equality obtains in (11), showing existence of equilibrium where both types of bonds are demanded. □

Proof of Proposition 3: Suppose that R and R^* together with m_R and m_{R^*} satisfy (6) – (7) above.

We show first that firms in country 1 satisfy (4), so that G is the preferred technique. Suppose first that input is fixed at m_R^*, which is the input maximizing the right-hand side in (4); then technique G is as good as B at the repayment rate R if

$$(\pi_1 + \pi_2)(\gamma_G(m_R^*) - Rm_R^*) - \pi_1(\gamma_B(m_R^*) - Rm_R^*) \quad (23)$$

or $R \leq \hat{R}^*$ where

$$\hat{R}^* = \frac{\pi_1 + \pi_2}{\pi_2} \frac{\gamma_G(m_{R^*})}{m_{R^*}} - \frac{\pi_1}{\pi_2} \frac{\gamma_B(m_{R^*})}{m_{R^*}}. \tag{24}$$

Since $\gamma_B(m_{R^*}) \leq \lambda_B \gamma_G(m_{R^*})$, we have that

$$\hat{R}^* \geq \frac{\pi_1(1-\lambda_B) + \pi_2}{\pi_2} \frac{\gamma_G(m_{R^*})}{m_{R^*}} \geq \gamma_G'(m_R), \tag{25}$$

where we have used (i). On the other hand, by (6) we have that $R = \gamma_G'(m_R)$, and we may conclude that $R \leq \hat{R}^*$, so that technique G is as good as B at the input level m_{R^*}; since m_R is the input level at which G is as good as possible we conclude that (4) is satisfied.

We show in a similar way that also firms in country 2 satisfy the incentive compatibility condition. Define

$$\hat{R} = \frac{\pi_1 + \pi_2}{\pi_2} \frac{\gamma_G(m_R)}{m_R} - \frac{\pi_1}{\pi_2} \frac{\gamma_B(m_R)}{m_R}. \tag{26}$$

Then technique B is as good as G at input m_R if $R^* \geq \hat{R}$. Since $\gamma_G(m_R) \leq \mu_B \gamma_B(m_R)$, we get from (ii) that

$$\hat{R} \leq \frac{\gamma_B(m_R)}{m_R} \leq \gamma_B'(m_{R^*}) = R^*, \tag{27}$$

and we conclude that B is as good as G when input is m_R. It follows now easily that (5) is satisfied, so that B is chosen in country 2.

Proof of Theorem 1: The existence of an equilibrium follows from Propositions 1 – 3: From Proposition 2 we have that there are divisions of total savings into investments in the two techniques and corresponding levels of repayment for which the consumers want to hold both types of bonds, and from Proposition 3 we

get that these repayment rates are such that firms in country 1 choose technique G and firms in country 2 choose technique B. Since the bond market and the market for inputs (which coincide in the model) are in balance, we have an equilibrium with the desired properties.

To show the second part of the theorem, we notice that the allocation where the endowment of each country is inserted in the production of the same country using technique G results in higher expected utility for each consumer (saver or entrepreneur) than the equilibrium with different bond types. □

Proof of Proposition 4: If bonds of country 2 enter the portfolio of the consumer-saver, then by (11) we must have

$$\frac{\gamma'_B(0)}{\gamma'_G(1)} \geq 1 + \frac{\pi_2}{\pi_1} \tag{28}$$

(there is a nonzero input level for firms of country 2 which is compatible with the repayment rate at which country 2 bonds can be accepted by the savers). However, this contradicts the assumption (a) of the proposition, and we conclude that country 2 bonds will not be accepted.

Turning to the monopolistic bank in country 2, it has the option of choosing $\rho = 1$ (perfect monitoring), so that all country 2 firms choose G. The bank will offer the savers a repayment $R_b = R$ and charge the debtors a repayment R_b^* such that $(\pi_1+\pi_2)(R_b^* - R)m_{R_b^*} - c \geq 0$. Such a repayment R_b^* exists, since the bank may choose to have deposits of size $m_{R^*} = \frac{1}{4}$, which will be accepted at the rate $R_b^* = \gamma_G\left(\frac{1}{4}\right)$, and since $z = \frac{3}{4}$, the expected profit of the bank is

$$(\pi_1 + \pi_2)\left[\gamma'_G\left(\frac{1}{4}\right) - \gamma'_G\left(\frac{3}{4}\right)\right]\frac{1}{4} - c \tag{29}$$

which is ≥ 0 by assumption (b).

We have shown that there is a decision (ρ, R_b^*) at which the bank earns nonnegative profits, and consequently (as the decision variables belong to compact intervals and the profit function is continuous) there is a profit maximizing decision as well. We show that the monitoring level $\rho = 1$ is not optimal ($\rho = 0$ is excluded since in that case the consumer-savers will not place their savings with the bank). Indeed, from (15) we have that

$$R_b = R\frac{\pi_1 u'(\tilde{x}_1) + \pi_2 u'(\tilde{x}_2)}{\pi_1 u'(\tilde{x}_1) + \rho\pi_2 u'(\tilde{x}_2)}, \tag{30}$$

and differentiating at $\rho = 1$ we get that

$$\frac{\partial R_b}{\partial \rho} = -\frac{R\pi_2}{\pi_1 + \pi_2}. \tag{31}$$

Thus, reducing ρ from the value 1 means that the bank will have to pay more to the savers to retain the previous market share; however, it will also save monitoring cost of the size c. Since $R \leq \gamma_G'\left(\frac{1}{2}\right)$ it follows that profits are increased if

$$\gamma_G'\left(\frac{1}{2}\right)\frac{\pi_2}{\pi_1 + \pi_2} \leq c. \tag{32}$$

Since this inequality holds due to assumption (b), we have that $\rho = 1$ is not an optimal choice of the bank. □

Proof of Proposition 5: Changing m_0^i slightly at $\hat{R}^i$ we get

$$\begin{aligned}
\frac{\partial \Pi_G^i}{\partial m_0^i} &= (\pi_1 + \pi_2)\left(\gamma_G^i\right)' - \pi_3 = (\pi_1 + \pi_2)\hat{R}^i - \pi_3, \\
\frac{\partial \Pi_B^i}{\partial m_0^i} &= \pi_1\left(\gamma_G^i\right)' - (\pi_1 + \pi_3) = \pi_1\hat{R}^i - (\pi_2 + \pi_3),
\end{aligned} \tag{33}$$

which shows that Π_G^i increases more than Π_B^i when m_0^i gets larger, from which the conclusion follows. □