A.F. Tieman

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Spillover of Domestic Regulation to Emerging Markets

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Abstract

Correlation between the risks of portfolios of different commercial banks leads to too much risk taking from a social planner’s perspective. The presence of a regulator improves this risk-benefit allocation of the financial system. In this paper I show that first-best regulation also leads to more attention for the fundamentals of borrowing countries.

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1 Introduction

While the importance of spillover effects from one country to another from optimizing behavior of economic agents has been the subject of numerous theoretical and empirical studies, relatively little research has focussed on the effects of spillovers from domestic regulation to foreign countries. Recently, this role has received more attention from policy makers, especially after the Asian crises of 1997-1998. This paper illustrates the existence of spillovers from regulating the correlated risks of the portfolios of different domestic commercial banks which lend money to an emerging market’s government. Taking account of the correlation creates a more sound domestic financial environment and in addition leads the emerging market’s government to take better care of its fundamentals.

Commercial banks which invest in risky assets run the risk of a bad return on the asset. When multiple commercial banks invest in the same asset, such as lending to the same country, the risks of bad returns are correlated. An adverse macro shock hitting the country, leading the country to default on (a part of) its debt, affects all lenders simultaneously, although not necessarily in the same order of magnitude. Moreover, the effects of such a shock do not cancel out over a large number of banks. The adverse shock leads all lending commercial banks to be weak at the same time, which may lead to adverse effects for the domestic economy, such as e.g. a credit crunch. In other words, the behavior of the individual commercial banks posits a negative externality to the domestic financial system as a whole. When determining their optimal portfolios,

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1For instance the positive spillovers in new trade theory, which is nicely discussed in e.g. (Krugman 1996) or Krugman and Venables (1995). For a survey on stylized facts on multinational spillovers and some empirical evidence see e.g. Markusen (1995) and the references therein. Another leading example of (negative) spillovers is the international slowdown of growth right after the Asian crises of 1997.

2The emerging market’s government is modelled as a benchmark case for lending to a third party. Instead one can also think of lending to private businesses (or, even more specifically banks), which are prone to similar (macro) shocks, as is usually done when evaluating the risks of an individual bank’s portfolio.

3For a model of default resolution see e.g. Hart and Moore (1997).

4See e.g. Bolton and Freixas (1998) and the references therein or Hancock and Wilcox (1998).
commercial banks do not take this externality in the form of the correlation of risks their respective portfolios into account, see e.g. Freixas and Rochet (1997). The decentralised system in which all banks optimize independently does therefore not yield the socially optimal outcome.

Most commercial banks fall under the authority of a domestic regulator, which represents the interest in the stability of the domestic financial system. The regulator is modelled as a social planner. As such, the regulator is concerned with these externalities. It will internalize the correlation of risks, and thus arrive at an optimal portfolio choice different from the commercial bank’s choice, even when it attaches the same weights to returns versus risks as the individual commercial banks do (i.e. when it has the same utility function as the commercial banks). The regulator has the power to force the commercial bank to change its portfolio choice through enforcing capital adequacy requirements (CARs) for commercial banks which lend to a specific country, see for instance Dewatripont and Tirole (1994).

A borrowing foreign government has incentives to look after its fundamentals, such as the government debt, capital regulation, the countries competitiveness or the soundness of its financial system. Better fundamentals represent more sound economic policy and lead to less volatile outcomes and thus to cheaper supply of capital. Creating better fundamentals comes at a (political) cost. When e.g. competitiveness is improved by advocating low wage increases, the cost comes in the form of lower government popularity. When the government debt is reduced, the cost lies in achieving lower output growth because of the lower government expenditures on social security or other public infrastructure, which may also lead to a decreased popularity of the government. These costs are modelled as a disutility from the effort exerted to improve the fundamentals. The country faces a trade-off between putting effort in improving its fundamentals and more expensive lending.

Regulating correlated risks by binding CARs increases the costs of lending and thus reduces the amount of funds the commercial banks are willing to lend out to the foreign government at any given interest rate. Borrowing thus becomes more expensive for the
government and its utility decreases. However, higher interest rates also yield higher marginal revenues of reducing the risk premium by exerting effort, i.e. a strengthening of the foreign government’s incentive to exert effort.

In this paper I study the two effects sketched above by looking at the incentive structure for the borrower in the absence of regulation and studying optimal CARs. I show that when the regulator enforces the socially optimal risk-benefit allocation within the financial system, *the strengthening of the incentive structure leads borrowing countries to pay more attention to their fundamentals.*

I focus attention on the simplest possible model which exhibits the features described above. The problem of the borrowing government, together with the optimal portfolio choices of the commercial banks and the regulator are described in section 2. I highlight the fact that the regulator imposes the monopoly investment solution on the sector and discuss the consequences of changes in the competition structure of the domestic banking sector. Section 3 studies optimal regulation and analyzes what the effect of optimal regulation on the foreign government’s action is. In this section, I also pay attention to a regulator that takes the utility of the borrowing government into account. In section 4 some concluding remarks are made. Also, the (consequences of the) assumption that the regulator is able to observe the correlation between the different portfolios perfectly is discussed. Explicit derivations of the expressions in the paper can be found in the appendix.

## 2 The Model

Consider a regulator which regulates two commercial banks, labelled $j = 1, 2$. Each commercial bank is endowed with one unit of funds to be used for investments. This amount is on the liability side of the bank’s balance sheet and consists of deposits and bank equity. Both commercial banks are assumed to have identical liabilities. Moreover, since in this model the focus is entirely on the asset side of the commercial bank’s balance sheet, the liability side is considered fixed, which means that CARs boil down to a
restriction on the fraction of assets invested in the risky asset. Given this restriction, a commercial bank decides how to allocate its capital over the different investment options, namely a riskfree asset $f$, which yields a return of $i_f$ one period later for sure, and a risky asset which yields a stochastic return $S^j$ one period later. The returns on the risky assets are assumed to be normally distributed with mean $\mu_S > 0$ and variance $\sigma_S^2 > 0$, $\forall j$.

The risky asset is interpreted as an investment in an emerging market and more specifically as lending to an emerging market government (henceforth labelled ‘the government’). The return $S^j$ consists of two components: a macroeconomic component, which yields the same realization for all banks which invest in the risky asset, and a bank-specific component which is i.i.d. over the different banks and independent of the macroeconomic component. The return of the risky asset $S^j$ for bank $j$ is thus positively correlated across banks through the macro variable. I denote the correlation between the returns $S^1$ and $S^2$ by $\rho(S^1, S^2) > 0$. The value of $\rho$ is perfectly observable to the regulatory authority. Below, I discuss the sensitivity of the model outcomes to this assumption.

The emerging market government seeks to maximize the increase in the country’s wealth as proxied by its growth of GDP. In this model, I abstract from the consumer side of the economy and assume that the government operates under a (fixed) balanced budget. Consequently, I can proxy GDP growth by net return on government investment, labelled $R_I$. Naturally, the government is constraint by a budget constraint, which states that government investment should be lower than net debt accumulation $\Delta D$. Debt comes at an interest cost $i_f + i(e)$, where $i(e) > 0$ is the risk premium the emerging market government pays in addition to the risk free rate $i_f$. I assume that the government can influence the risk premium indirectly by reducing the variance of the returns on it loans $\sigma_S^2$ through exerting costly effort $e \geq 0$, i.e. $\sigma_S^2 = \sigma_S^2(e)$ and $\frac{d\sigma_S^2}{de} < 0$. The costs of effort are given by the function $C(e)$, $e \geq 0$. Effort proxies costly gov-

\footnote{When the risk premium $i(e)$ is calculated from equating supply of and demand for capital, I will show that this premium is declining in government effort, i.e. $\frac{di(e)}{de} < 0$.}
ernment policy to improve its fundamentals. Examples are improving banksupervision or improving the countries investment climate by for instance making it more accessible for foreign capital, see e.g. Van der Ploeg (1994). The function $C(.)$ is taken to be twice continuously differentiable, with $C''(.) > 0$. Further restrictions on $C(.)$ follow.

The government faces a continuum of infinitesimal investment opportunities with declining expected (marginal) return. The expected (marginal) return of investing an additional unit of funds given an amount $I$ of invested funds, is denoted by $M_I(I)$. I assume this return to be linearly declining with $I$, i.e. $M_I(I) = \gamma - \delta I$, $i_f < \gamma < i(0) + i_f$, $\delta > 0$.

Thus, the governments problem is

$$\max_{I,e} U_G(I, e) = R_I - C(e)$$

s.t. $I \leq \Delta D$

Since the restriction $I \leq \Delta D$ will be binding, all investments are financed by increased borrowing. The first order conditions (FOCs) follow from equating marginal benefits and costs of both investment and effort. The FOC for the investment decision is $M_I(I) = i_f + i(e)$ \textsuperscript{6}, which yields $I = I^*(e) = \frac{1}{\delta}[\gamma - i_f - i(e)]$. The total net return on the optimal investment $I^*$ is equal to the integral

$$R^*_I(e) = \int_0^{I^*} \{\gamma - \delta x - i_f - i(e)\} dx = \frac{1}{\delta} [\gamma - i_f - i(e)]^2.$$

Here the binding nature of the restriction $I^* \leq \Delta D$ is taken into account by incorporating $i_f + i(e)$ as the costs of investment. The aforementioned risky investment projects $S^j$ now are the marginal investment projects in the country yielding exactly $i_f + i(e)$ in expectation. Thus, I have $\mu_S = i_f + i(e)$ \textsuperscript{7}.

\textsuperscript{6}The second order condition for this problem yields $-\delta < 0$ and thus the condition for a maximum is satisfied.

\textsuperscript{7}Note that $i_f + i(e)$ is the total expected return per unage, meaning that $100(i_f + i(e) - 1)$ is the expected percentage interest on the risky asset.
By setting the investment level at $I^*$ and incorporating the binding restriction $I^* = \Delta D$, I reduce the optimization problem to a problem in effort only

$$\max_e U_G(e) = R_i^*(e) - C(e)$$

(1)

The optimal effort level follows from $\frac{dR_i^*(e)}{de} = C(e)$, yielding

$$\frac{2}{\delta}[i(e) - (\gamma - i_f)] = C'(e)$$

(2)

For the equation to have a solution, I now assume $C'(0) < \frac{2}{\delta}[i(0) - (\gamma - i_f)]$ and $C''(e) > \frac{2}{\delta}i'(e)$, $\forall e \geq 0$, i.e. marginal costs of small effort levels are small and rise faster than the benefits of effort. The second order condition for a maximum is $\frac{2}{\delta}i'(e) - C''(e) < 0$, which is satisfied under the conditions above. Note that at this point equation (2) cannot be solved explicitly, since the functional form of $i(e)$ has not been derived yet. In section 3 $i(e)$ is derived from equating capital supply and demand.

From the government’s optimization problem it follows that government demand for funds is a function of effort, $d(e) = \Delta D = I^*(e) = \frac{1}{\delta} [\gamma - i_f - i(e)]$. Relabelling $\alpha = \frac{1}{\delta} \gamma$ and $\beta = \frac{1}{\delta}$ yields a standard demand function $d(e) = \alpha - \beta [i_f + i(e)]$.

Commercial bank $j$ decides what fraction $x^j$ of its monetary assets to invest in the risky asset. It does so by maximizing a mean-variance utility function

$$\max \mathbb{E} P^j - a^j \cdot var \left( P^j \right) - R^D_f,$$

with $a^j$ the degree of risk aversion of the bank, which I set equal to 1 $\forall j$ for simplicity and where $P^j = x^j S^j + (1 - x^j) f$ is the portfolio of bank $j$. The amount the bank pays out to deposit holders is denoted by $R^D_f$. Since the amount of deposits is considered fixed, $R^D_f$ does not influence the bank’s investment decision. Thus the bank chooses portfolio

$$x^*(e) = \arg \max_x \left\{ x (i_f + i(e)) + (1 - x) i_f - x^2 var (S) \right\} = \frac{i(e)}{2\sigma^2(e)},$$

illustrating that the fraction invested in the risky asset depends on the received risk premium

$^8$The second order condition is $-2\sigma^2(e) < 0$, indicating that $x^*$ is indeed a maximum.
The commercial bank does not take account of the external effect its investment decision has on the domestic financial system as a whole, such as the possibility of a domestic credit crunch which might emerge when both banks experience adverse effects on the returns of their risky assets from the same foreign macro shock. In particular, a bank does not care about the correlation of its portfolio’s returns with those of the other bank. This type of externality poses a need for regulation.

The regulator is assumed to act as a social planner. In the absence of consumers in this model, the regulator thus maximizes total producer profit. Therefore the regulator has a utility function with the same characteristics as both commercial banks, i.e. it maximizes the mean-variance utility of the sum of the portfolios of the individual banks

$$\max_x EP - a \cdot \text{var}(P),$$

with $P = \sum_j P^j$ and $a = 1$. Thus, the regulator takes explicit account of the externalities the commercial banks levy on the financial system and as such on each other. The regulator’s maximization problem can be rewritten as

$$\max \mathbb{E} \left( \sum_j P^j \right) - \text{var} \left( \sum_j P^j \right) = \max \sum_j \mathbb{E} P^j - \sum_j \text{var} (P^j) - 2 \sum_{j \neq k} \text{cov} (P^j, P^k),$$

which yields (see appendix)\(^9\)

$$x^{**}(e) = \frac{i(e)}{2(1 + \rho) \sigma_S^2(e)}.$$

The internalization of the correlation between the portfolios of the banks is immediately clear from the factor $1 + \rho$ in the denominator. The higher the correlation, the lower the optimal portfolio choice from the perspective of the regulator. In the extreme case of perfect correlation, i.e. $\rho = 1$, the regulator’s optimal portfolio calls for only half as much investments in the risky asset as the individual bank’s optimal portfolio, i.e. $x^{**}(e) = \frac{1}{2} x^*(e)$.

Note that the regulator chooses the same portfolio as a monopoly bank would. Thus a monopolistic banking sector would not need regulation in this model. The need for

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\(^9\)The second order condition for a maximum is satisfied with $-4(1 + \rho) \sigma_S^2(e) < 0$. 

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regulation stems purely from the fact that competing banks do not internalize the externality their portfolio choice levies on the banking sector as a whole. Although the current model does not permit me to analyze the effects of increased competition explicitly, some general conclusions can be drawn. Since it is the externality from the individual bank to the sector as a whole that matters, portfolio choices in a sector consisting of many small banks will be further away from the regulators (social) optimum than when the sector is oligopolistic in setup. Thus, in this model, the more the banking sector consists of small firms, i.e. the closer the sector is to perfect competition, the more is the need for regulation.

3 Optimal Regulation and Its Consequences

The regulator has the power to impose binding CARs on the commercial banks. Since the liability side of the commercial bank’s balance sheet (which consists of deposits and equity) is assumed fixed, imposing more stringent binding CARs leads to less investments in the risky asset and more investments in the riskfree asset. It thus entails a shift on the asset side of the balance sheet in the form of setting a maximum $\pi$ for $x^j$. The commercial banks now face a constrained optimization problem, which yields an optimal portfolio choice $x^{**} = \pi$ whenever the CARs are binding. I denote the optimal portfolio choice of the commercial banks as a fraction $(1 - \zeta_{\rho})$ of their unconstrained optimal portfolio choice $x^*$, i.e.

$$x'^*(e) = (1 - \zeta_{\rho}) x^*(e) = \frac{(1 - \zeta_{\rho}) i(e)}{2 \sigma_S^2(e)}$$

and solve for the fraction $(1 - \zeta_{\rho})$ which yields optimal regulation. This fraction follows from equating $x'^*(e)$ to $x^{**}(e)$ which yields

$$\zeta_{\rho} = 1 - \frac{1}{1 + \rho}.$$

\footnote{Note that setting the CARs $\pi$ to $x^{**}$ indeed makes them binding, which guarantees that the commercial banks optimization problem will yield $x'^* = x^{**}$.}
The optimal portfolio choices of the commercial banks with and without regulation yield a supply of capital labelled \( s(e) \) and \( s'(e) \) respectively, where

\[
s(e) = 2x^*(e) = \frac{i(e)}{\sigma_S^2(e)}
\]

and

\[
s'(e) = 2x''(e) = 2x^{**}(e) = \frac{i(e)}{(1 + \rho) \sigma_S^2(e)}.
\]

Equating supply \( s(e) \) of and demand \( d(e) \) for capital results in the equilibrium risk premium. For the unregulated case this is

\[
i^*(e) = \frac{\alpha \sigma_S^2(e) - \beta \sigma_S^2(e) i_f}{1 + \beta \sigma_S^2(e)}, \tag{3}
\]

while in the regulated case one gets

\[
i^{**}(e) = \frac{\alpha (1 + \rho) \sigma_S^2(e) - (1 + \rho) \beta \sigma_S^2(e) i_f}{1 + (1 + \rho) \beta \sigma_S^2(e)}. \tag{4}
\]

Note that in the equations (3) and (4), the dependence of \( i^* \) and \( i^{**} \) on \( e \) is through \( \sigma_S^2(e) \) only. Straightforward differentiation shows that indeed \( i^* \) and \( i^{**} \) are declining in \( e \), i.e. \( \frac{di^*(e)}{de} \frac{d\sigma_S^2(e)}{de} < 0 \), since \( \frac{di^{**}(e)}{de} > 0 \) and, by assumption, \( \frac{d\sigma_S^2(e)}{de} < 0 \) and similarly for \( i^{**} \).

**Proposition 3.1** For all positive effort levels, the equilibrium risk premium will be higher when optimal regulation is exerted than when this is not the case, i.e. \( i^{**}(e) > i^*(e) \) \( \forall e \geq 0 \).

**Proof.**

It suffices to show that \( \frac{di^{**}}{d(1+\rho)} > 0 \) when all parameters are positive, since that means that increasing \( \rho \) from 0 to \( \rho > 0 \) increases the equilibrium interest rate.

\[
\frac{di^{**}}{d(1 + \rho)} = \frac{\alpha \sigma^2(e) - \beta \sigma^2(e) i_f}{[1 + (1 + \rho) \beta \sigma^2(e)]^2}
\]

which is positive since \( i^{**} > 0 \). Q.E.D.

Thus, regulation of a competitive banking sector results in a higher interest rate premium for the emerging market government. With this observation in mind, it is
straightforward to show that this leads the government to exert more effort. The argument is that at any effort level, the marginal benefit of effort will rise when interest rates are higher, while the marginal costs of effort remain the same. Consequently, the optimal effort level will rise. Label the optimal effort levels without and with regulation in place by $e^*$ and $e^{**}$ respectively. Once a functional form for $\sigma^2_S(e)$ is specified, these effort levels can be derived explicitly from the maximization problem (1) on $U_G(e)$, using equation (2).

**Proposition 3.2** Consider a twice continuously differentiable cost function of effort $C(e)$ with $C'(e) > 0$, $C'(0) < \frac{2}{\delta} [i(0) - (\gamma - i_f)]$ and $C''(e) > \frac{2}{\delta} i'(e)$. Then, the emerging market government will exert more effort when the domestic banking sector is optimally regulated, i.e. $e^{**} > e^*$.

**Proof.**

From the FOC (2) of problem (1), it is immediately clear that marginal benefit of effort $\frac{2}{\delta} [i(e) - (\gamma - i_f)]$ are increasing in $i(e)$. Marginal costs $C'(e)$ are not directly affected by changes in the interest rate. Thus, since $i^{**}(e) > i^*(e)$ (from Proposition 3.1), and since the conditions on the cost function for both a feasible solution and a maximum are met, marginal benefits from exerting effort are higher under regulation. Therefore, $e^{**} > e^*$, i.e. the emerging market government exerts more effort when the domestic banking sector is regulated. Q.E.D.

Although the government exerts more effort, its total utility will be lower when regulation is in place. To see this, note that at $e^{**}$, still $i^{**}(e^{**}) > i^*(e^*)$, stating that investment is more costly when regulation is in place. Thus, the level of investment, and with that the total expected return on investment, will be lower. At the same time, the increasing nature of the cost function yields $C(e^{**}) > C(e^*)$. Lower revenues and higher costs together result in lower utility for the government. In the model, the regulator does not take this utility into account, but instead cares only for the domestic economy. When the regulator also puts some weight on the utility of the emerging markets government, things change slightly. The regulator will then increase the emerging market
governments utility by putting less severe restrictions on bank lending and thus facilitating lending at a cheaper rate. This way, the regulator sacrifices part of the domestic utility from fully incorporating the domestic externalities by tight regulation to higher foreign utility from cheaper borrowing.

4 Concluding Remarks

Ideally, emerging markets’ governments take proper care of their fundamentals. In practice these governments often lack incentives to do so, e.g. by a lack of independent (democratic) control. This paper has shown that optimal regulation on the side of the lenders of capital leads to positive spillover effects to the borrowing country’s government. Its incentives to pay attention to fundamentals is strengthened. This way, regulatory bodies in developed countries with stable, well-regulated financial markets can contribute to better fundamentals in emerging markets. From the macro literature it is well known that better fundamentals enlarge the possibilities for economic growth. Therefore, I have shown a way in which positive spillovers from regulation might enhance growth in emerging markets.

Throughout the paper, it is assumed that the regulator perfectly observes the correlation between the commercial banks’ portfolios. Real world regulators have some clue about these correlations, but do not observe the actual values. The results of the current setup, that is the regulator constraints the banks in their portfolio choice and as a result the government exerts more effort, also follow in such an asymmetric information setting where the commercial banks have more information about the correlation of their portfolios than the regulator does, as long as the regulator observes an informative signal about the correlations. However, if the information content of the signal is low, it might make sense to pursue different regulatory policies. As stated before, in this model the regulator imposes the portfolio choice of a monopolistic banking sector on the competing banks. When the regulator is unable to get an informative signal about the correlation between the different portfolios, and the externalities levied on the finan-
cial system are severe, it might be beneficial from a welfare point of view to encourage collusion within the sector. This clearly alleviates the asymmetric information problem. At the same time consumer welfare (which is not modeled in the present setup) is in general negatively affected by the presence of monopolistic firms. The regulator thus faces a trade-off between these two problems. The outcome might be a mild variant of a policy supporting collusion, by ensuring that banking competition does not get too severe, e.g. by posing tough entry requirements. In general regulators around the world face such a trade-off between increasing the stability of the banking sector by facilitating market power of big banks and consumer welfare through increased competition (see e.g. Bolt and Tieman (2001) and the references therein).

Note that many real world regulators care about the externality posed by the investment strategy of different domestic commercial banks. To mitigate such externalities, many regulators pose additional requirements when exposure of domestic commercial banks to certain countries or regions becomes relatively large. This makes it unattractive for a commercial bank to actually take large positions in specific countries. In the context of this model, this regulatory strategy tries to prevent correlations between different risks from becoming large rather than posing capital adequacy requirements directly.

The obtained results can be related to the policy discussion on adaptation of a new CAR framework, which is currently going on at the Basle Committee on Banking Supervision (see for instance the reports Basle Committee On Banking Supervision (1999) and Basle Committee On Banking Supervision (2000)). Current CAR regulation under the Basle accord is not specifically focussed on regulating correlated risks, but instead prescribes commercial banks to hold a minimum amount of equity against risky assets in order to create a buffer and prevent excessive risk taking. In the model this is equivalent to setting a maximum fraction of assets to be invested in the risky asset. As in reality the financial sector consists of more and less solvent banks, the former type of bank is not affected by the requirements as severely as the latter type, even when their portfolios yield large externalities on the stability of the financial system. Therefore,
the current CAR framework leaves room for improvement.

Of course, by preventing excessive risk taking by the commercial banks, current BIS regulation does lead to a higher interest rate compared to the unregulated case and therefore also leads the borrowing country to take better care of its fundamentals. Yet, taking explicit account of the correlation of risks could improve the CAR framework. This point is on the agenda of the Basle committee, but attention focusses on correlation between different investments made by a single commercial bank. The new CAR framework will put emphasis on the internal risk management systems of the commercial banks, which accounts for these internal correlations. Correlation of risks between different banks is not prominently on the agenda of the Basle committee. Taking up this point in the CAR framework would further improve the stability of the financial system.

A Technicalities.

Commercial banks solve

\[ x^* (e) = \arg \max_x \left\{ x (i_f + i (e)) + (1 - x) i_f - x^2 \text{var} (S) \right\}, \]

\[ \frac{d}{dx} \left( x (i_f + i (e)) + (1 - x) i_f - x^2 \sigma_S^2 (e) \right) = 0 \]

\[ (i_f + i (e)) - i_f - 2x \sigma_S^2 (e) = 0 \]

\[ x^* (e) = \frac{i (e)}{2 \sigma_S^2 (e)} \]

The second order condition of this problem yields \( -2 \sigma_S^2 (e) < 0 \) satisfying the condition for a maximum.

The regulator solves

\[ \max \mathbb{E} \left( \sum_j P^j \right) - \text{var} \left( \sum_j P^j \right) = \]

\[ \max \sum_j \mathbb{E} P^j - \sum_j \text{var} (P^j) - 2 \sum_{j \neq k} \text{cov} (P^j, P^k), \]
which yields

\[
\max 2 \left[ x (i_f + i(e)) + (1 - x) i_f \right] - 2x^2 \sigma_S^2(e) - 2x^2 \rho \sigma_S^2(e)
\]

\[
\frac{d}{dx} \left( 2x (i_f + i(e)) + 2(1 - x) i_f - 2x^2 (1 + \rho) \sigma_S^2(e) \right) = 0
\]

\[
2(\sigma_S^2(e)) x = -2x^2 (1 + \rho) \sigma_S^2(e)
\]

\[
x^{**}(e) = \frac{i(e)}{2(1 + \rho) \sigma_S^2(e)}
\]

The second order condition of this problem yields \(-4(1 + \rho) \sigma_S^2(e) < 0\) satisfying the condition for a maximum.

Imposing CARs transforms the commercial banks problem into

\[
\max \{ x (i_f + i(e)) + (1 - x) i_f - x^2 \text{var}(S) \}
\]

s.t. \( x \leq \bar{x} \)

Optimal regulation means setting \( \bar{x} = x^{**} \), which yields an optimal constrained portfolio choice of \( x^{**}(e) \) for the commercial banks. Denoting \( x^{**}(e) \) as a fraction \((1 - \zeta\rho)\) of the unconstrained optimum \( x^*(e) \) yields \( x^{**}(e) = \frac{(1 - \zeta\rho)i(e)}{2\sigma_S^2} \). Subsequently equating this \( x^{**}(e) \) to \( x^{**}(e) \) yields the optimal \( \zeta\rho \)

\[
\frac{1 - \zeta\rho}{2\sigma_S^2} i(e) = \frac{i(e)}{2(1 + \rho) \sigma_S^2}
\]

\[
\zeta\rho = 1 - \frac{1}{1 + \rho} = \frac{\rho}{1 + \rho}
\]

Thus, \( \zeta\rho > 0 \) implies \( \rho > 0 \). Basically, this is a condition which says that correlated risks do not need regulation whenever \( \rho < 0 \) (in fact, it would need subsidy if anything).

Supply of capital in the unregulated case is going to be

\[
s(e) = 2x^*(e) = \frac{i(e)}{\sigma_S^2(e)}
\]
Equating supply and demand leads to a risk premium of

\[ d(e) = s(e) \]

\[ \alpha - \beta f - \beta i(e) = \frac{i(e)}{\sigma^2_S(e)} \]

\[ \alpha \sigma^2_S(e) - \beta f \sigma^2_S(e) - \beta i(e) \sigma^2_S(e) = i(e) \]

\[ \alpha \sigma^2_S(e) - \beta \sigma^2_S(e) i_f = i(e) (1 + \beta \sigma^2_S(e)) \]

\[ i^*(e) = \frac{\alpha \sigma^2_S(e) - \beta \sigma^2_S(e) i_f}{1 + \beta \sigma^2_S(e)} \]

Regulation leads to

\[ s(e) = 2x^*(e) = 2x^{**}(e) = \frac{i(e)}{(1 + \rho) \sigma^2_S(e)} \]

and thus from \( d(e) = s(e) \) to a risk premium

\[ \alpha - \beta f - \beta i(e) = \frac{i(e)}{(1 + \rho) \sigma^2_S(e)} \]

\[ \alpha (1 + \rho) \sigma^2_S(e) - \beta f (1 + \rho) \sigma^2_S(e) - \beta i(e) (1 + \rho) \sigma^2_S(e) = i(e) \]

\[ \alpha (1 + \rho) \sigma^2_S(e) - (1 + \rho) \beta \sigma^2_S(e) i_f = i(e) (1 + (1 + \rho) \beta \sigma^2_S(e)) \]

\[ i^{**}(e) = \frac{\alpha (1 + \rho) \sigma^2_S(e) - (1 + \rho) \beta \sigma^2_S(e) i_f}{1 + (1 + \rho) \beta \sigma^2_S(e)} \]

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