INSURING AGAINST FINANCIAL KATRINAS: SYSTEMIC RISK AS A COMMON POOL PROBLEM

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1. Introduction

When financial markets fail, the damage caused can spill over to the "real" economy with surprising speed. In 1997, the Asian Financial Crisis highlighted the vulnerability of seemingly well-functioning markets to systemic failure. The current subprime mortgage meltdown, the subsequent lockup of the credit markets, and the precipitous drop in worldwide demand, investment, asset values, commodities and employment levels revealed a similar inherent fragility of the financial system.

The systemic risks facing financial markets, then, can impose significant socials costs, and should be addressed at a national level. The current proposal for a systemic risk regulator, for instance, recognizes the fact that even if each firm in the sector is financially sound, there might be an overall risk of system-wide failure that is greater than the sum of the risks of individual failure.

We argue that this systemic risk takes the form of a common pool problem: firms have incentives to add risk to the system above the level that is socially desirable, since the benefits from the additional investments are localized, while the fallout from systemic failure is globalized. This larger problem of systemic risk can be addressed in a number of ways. A regulator could simply prohibit banks from taking on investments above a certain risk profile. Or they can require increased reserve ratios relative to risk, like Basel II requirements.

We show here, however, that an insurance scheme in which firms contribute to a central fund in proportion to the riskiness of their investments can achieve an efficient allocation of resources while avoiding more direct government involvement in overseeing and limiting the types of investments that firms are allowed to make and avoiding the pro-cyclical nature of Basel II requirements.

2. Financial Markets and Systemic Risk

Assume that there are N identical firms in the financial sector. Following the CAPM model, a representative firm faces positive capital costs and will therefore invest in assets above the Security Market Line (SML):

$$E(R_i) \geq R_f + [E(R_M) - R_f]\,\beta_i, \tag{1}$$

where R_i is the return on asset i, R_f is the return on the risk-free asset, R_M is the market return, and

$$\beta_i = \frac{cov(R_i, R_M)}{var(R_M)}$$

is the non-diversifiable risk associated with asset i. The slope coefficient in Equation 1, $[E(R_M) - R_f]$, thus measures the equilibrium price of risk, and the intercept is the return on risk-free assets, such a Treasury bills.

Each firm can pursue investment opportunities uniformly distributed in risk-return space, where the expected return of asset i is $\mu_i \in [0, \bar{\mu}]$, and the risk is $\sigma_i \in [0, \bar{\sigma}]$.[1]

Let Θ denote the set of investments made by each firm in the market. Then the overall profit to firms in the financial sector is the sum of the expected returns of each project:

$$R(\Theta) = N \int_{\theta \in \Theta} \mu(\theta)\, d\theta,$$

and the total risk of market investments is:

$$\sigma(\Theta) = N \int_{\theta \in \Theta} \sigma(\theta)\, d\theta.$$

[1]We use σ for notational familiarity, although it should be remembered that the relevant component of risk for each project is β_i, the variance in returns that cannot be diversified away. We also assume that $\bar{\sigma} \geq \frac{\bar{\mu} - R_f}{[E(R_M) - R_f]}$, so that firms' portfolios are limited not by the lack of riskier projects to finance, but by the upper bound on the returns to risky projects.

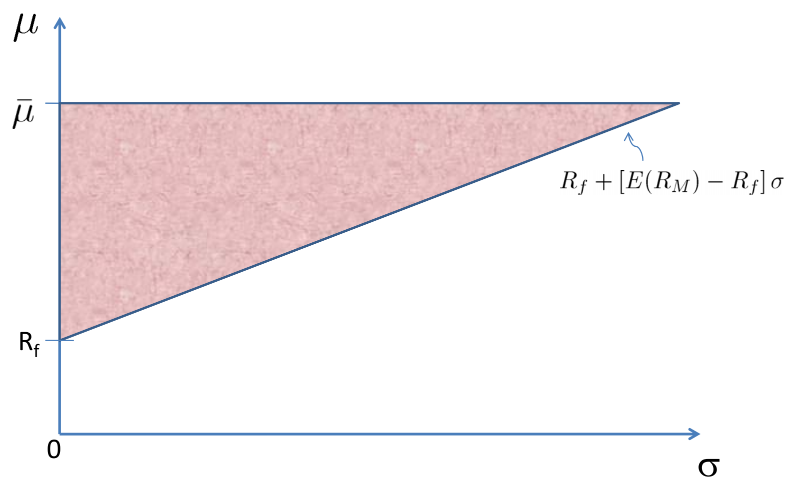

FIGURE 1. Equilibrium investments with no market insurance.

If the amount of up-front investment necessary for investment θ is $I(\theta)$, then the total investment made to generate these returns is:

$$I(\Theta) = \int_{\theta\in\Theta} I(\theta)\, d\theta.$$

Denoting by Θ_0 the set of investments consistent with Equation 1, the set of investments made by each firm is illustrated in Figure 1, with an expected return equal to the area of the triangle generated:

$$\begin{aligned} R(\Theta_0) &= N \cdot \frac{1}{2}(\bar{\mu} - R_f)\frac{\bar{\mu} - R_f}{[E(R_M) - R_f]} \\ &= \frac{N(\bar{\mu} - R_f)^2}{2\,[E(R_M) - R_f]}. \end{aligned}$$

We also assume that, in addition to the asset-specific risk β_i, there is a systemic risk of market failure. We model systemic risk by assuming that with probability ϕ the normal market ceases to operate and all investments made have zero return, forcing the government into bailout mode.[2] This "ϕ-event" could be triggered by a collapse of foreign markets, the bursting of a housing bubble in which many firms had invested, or some such unforseen event.[3] With probability $(1-\phi)$ this event does not occur and normal market returns obtain.

To counteract the negative consequences of a ϕ-event, the government can institute an insurance program that works as follows. A surcharge of $t(\theta)$ is applied to every investment θ made. If a surcharge schedule t induces a firm-level investment portfolio Θ_t, the insurance fund will have reserves equal to:

$$F(t) = N \int_{\theta \in \Theta_t} t(\theta) I(\theta)\, d\theta.$$

In the case of a ϕ-event, the reserves are used for a bailout of the financial system and the government receives utility $B(F)$, with $B' > 0$; otherwise the funds are left to accrue for possible bailouts in future periods.

The economy lasts for two periods: in the first, markets function normally and reserves are built up in the insurance fund; in the second, the market may function normally, or with probability ϕ investment returns are zero. The government is assumed to maximize a utility function increasing in the amount of returns to the financial sector, and in utility under a bailout scenario:

$$\begin{aligned} U_G(t) &= R(\Theta_t) + (1-\phi)R(\Theta_t) + \phi B\left(F\left(t\right)\right) && (2) \\ &= (2-\phi)R(\Theta_t) + \phi B\left(F\left(t\right)\right). && (3) \end{aligned}$$

Here, the utility of the government under a bailout scenario, $B(\cdot)$, is left general so as to scale the government's relative utility for returns in good times and extra funds for a bailout in bad times. We also want the government to prefer

[2] The assumption that all investments have zero return is made for analytical convenience. We could instead assume that each investment fails with some given probability without qualitatively changing the results. What defines systemic risk is that when the adverse event occurs, the financial sector needs outside assistance to return to its normal operating mode. We discuss further ramifications of this assumption in the conclusion.

[3] In assuming that a ϕ-event in period t is unforseen in period $t-1$, we echo Keynes's (1963, p. 76) dictum that "A sound banker, alas, is not one who foresees danger and avoids it, but one who, when he is ruined, is ruined in a conventional way along with his fellows, so that no one can really blame him."

the state of the world with no risk of collapse ($\phi = 0$) to one where collapse is certain ($\phi = 1$), which implies that $R(\Theta_t) > B(F(t))$ for all t.

3. Constant Systemic Risk

Given the above setup, we can now explore the socially optimal insurance scheme. If the risk of systemic failure does not depend on the types of investments made, then the only consideration when setting the insurance rate schedule $t(\theta)$ is to generate enough reserves to efficiently support the financial markets in times of a downturn or sudden market event. This must be weighed against the inefficiencies generated by reducing the amount of total investment in the economy due to the need to contribute to the insurance fund.

Since the composition of firms' investments has no impact on the risk of systemic failure, the structure of the optimal surcharge schedule $t(\theta)$ is easy to determine. The Security Market Line in Equation 1 summarizes social tradeoffs between risk and reward. So raising a given amount of funds F can be accomplished with the least social cost by simply shifting the SML upwards. This, in turn, implies that the tax charged per investment is a constant: $t(\theta) = t$ for all θ.

When faced with a constant surcharge t per dollar invested, firms will only invest in those projects which generate a return at least t higher than previously, since they must pay the surcharge in addition to the investment capital. This changes equilibrium investments to those shown in Figure 2, removing a set of investments from the previous portfolio, as indicated.

The government here will set t to solve the following problem:

$$
\begin{aligned}
\max_t \quad & R(\Theta_t) + (1-\phi)R(\Theta_t) + \phi B\left(F\left(t\right)\right) \\
= \quad & \frac{(2-\phi)(\bar{\mu} - R_f - t)^2}{2\left[E(R_M) - R_f\right]} + \phi B\left(F\left(t\right)\right) \\
B' \quad = \quad & \frac{(2-\phi)}{\phi} \cdot \frac{\bar{\mu} - R_f - t}{\left[E(R_M) - R_f\right]}.
\end{aligned}
$$

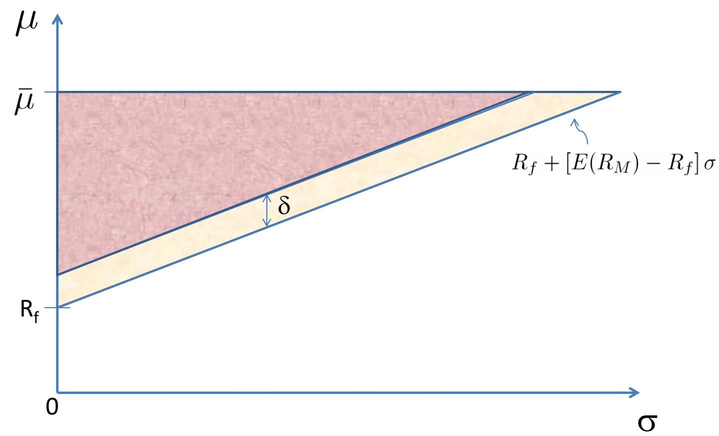

FIGURE 2. Equilibrium investments with constant insurance rates.

Although the insurance scheme illustrated in Figure 2 raises the optimal amount of funds to support the financial sector in times of crisis, it is not clear from this analysis why these funds should come from the sector itself. After all, the surcharge decreases the amount of socially useful investments made, which is a cost offsetting the benefits of the insurance scheme. Optimally, funds for a bailout should be raised in the least distortional manner from the overall economy, so a complete solution would mix funds from general revenue with funds from the financial sector, with the latter raised only until the point where the marginal social cost of the surcharge is equal to the cost of raising funds from other sectors of the economy.

4. Portfolio-Dependent Systemic Risk

Accordingly, we now change the assumptions of the model to include the possibility that the greater the risks taken by the individual firms, the greater the probability of the ϕ-event occurring. In particular, we will assume that the greater the total risk of outstanding investments, the greater the chance of system-wide failure: for firm-level portfolios Θ, $\phi = \phi(\sigma(\Theta))$, with $\phi' > 0$ and $\phi(0) = 0$.

Note that if the number of firms in the market is large, then no one firm will have incentives to internalize the increased probability of increased systemic risks when investing; their behavior would look like it did in the previous section. Thus the insurance scheme can have two objectives: both building up reserves for a rainy day and discouraging investments that would benefit a given firm if viewed in isolation, but whose social costs outweigh social benefits.

For which investments will this condition hold? Consider the case where the market is generating total returns R, with associated risk σ, and a firm is considering embarking on a new investment with return ΔR and risk $\Delta\sigma$. Substituting into the government's utility function, letting $\Delta\phi = \phi(\sigma + \Delta\sigma) - \phi(\sigma)$, and ignoring second-order effects, the new investment is worthwhile if:

$$\begin{aligned}
(2 - (\phi + \Delta\phi))(R + \Delta R) + (\phi + \Delta\phi)B &\geq (2 - \phi)R + \phi B \\
(2 - \phi)\Delta R - \Delta\phi R + \Delta\phi B &\geq 0 \\
\Delta R &\geq \Delta\phi \cdot \frac{R - B}{2 - \phi}. \qquad (4)
\end{aligned}$$

This last term is guaranteed to be positive, since as mentioned above $R > B$. It also rises with ϕ, the pre-existing level of risk in the system.

In equilibrium, the portfolio of each firm will be stable at some Θ^*, leading to total risk $\sigma(\Theta^* \equiv \sigma^*$, along with total returns B^* and bailout utility B^*. Then Equation 4 says that the return on an investment with risk σ must be greater than $\Delta\phi(\sigma) \cdot \frac{R^* - B^*}{2 - \phi^*}$. This is a line in the risk-return space, going through the origin, as illustrated in Figure 3.

As illustrated in the figure, optimal surcharges have the following properties. First, there is a certain level of risk, σ_0, below which no surcharges are necessary. For investments in this range, the demands of the capital markets, and the availability of the risk-free asset, imply that firms will only make investments which are socially desirable even with no regulation. Second, for levels of risk above σ_0, social and firm-level interests begin to diverge, so the optimal surcharge will increase with the riskiness of investments. And third,

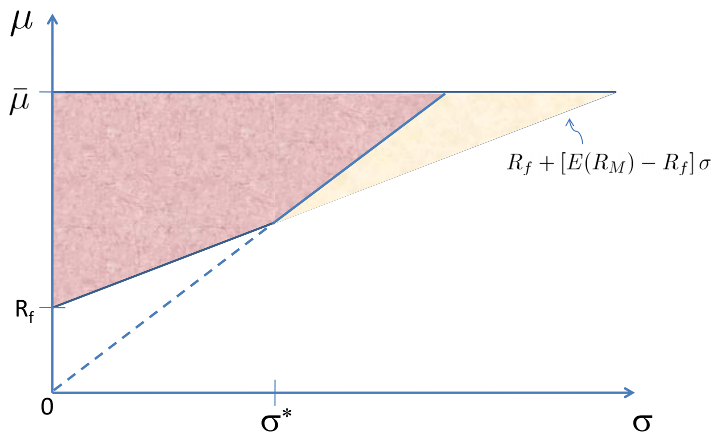

Figure 3. Equilibrium investments with increasing insurance rates.

there are some investments for which the upper bound on returns means that they are too risky to be allowed, even if firms would find it in their individual interests to do so.

5. Conclusion

This paper motivated an insurance-based approach to the regulation of systemic risk in capital markets. It showed that systemic risk is a common pool problem: just as owners of livestock have incentives to add extra animals to their herd until common grazing areas are picked clean, investors in financial markets have incentives to add risk to the overall pool. But a properly designed insurance scheme can realign firms' incentives without relying on direct government involvement in market transactions.

It has often been claimed that financial markets need little regulation, because the actors in those markets are smart enough to see the risks posed by their actions and avoid them.[4] But our analysis shows that the problem with systemic risk is not that firms cannot anticipate it. Rather, even the smartest firms will have little reason to curb their practices, as the benefits that accrue to good investments are internalized, while the risk of failure is shared throughout the system. This is a classic collective action problem, and it can only be solved through the use of a centralized mechanism that forced firms to face the true social costs of their investment decisions.

[4] Former Federal Reverse chairman Alan Greenspan was, apparently, in this group: "Those of us who have looked to the self-interest of lending institutions to protect shareholdersŠ equity, myself included, are in a state of shocked disbelief" he told the House Committee on Oversight and Government Reform. See `http://www.nytimes.com/2008/10/24/business/economy/24panel.html`.