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Author(s): Jacob Paroush
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The Domino Effect and the Supervision of the Banking System

JACOB PAROUSH*

ABSTRACT

The paper models the domino effect and defines a measurement for the necessity of banking supervision. The effect of several factors, such as the desired stability of the banking system, its size, the amount of negative externalities that are considered by banks, and supervisory costs, on the necessity of supervision are studied. For instance, it was found that, under certain circumstances, supervision becomes *less* essential if the number of banks increases. The paper has also emphasized that objective difficulties in the supervision of banks, by simply imposing restrictions on their activities, are intrinsic to the operation of the banks themselves. The paper provides some insight into the current debate as to the necessity or redundancy of supervision and regulation.

THE RATIONALE BEHIND THE supervision and regulation of the banking industry by monetary authorities is twofold. First, monetary authorities, which are responsible for conducting monetary policy, control the money supply by imposing restrictions on the banking system. Second, as representatives of the public, the authorities do their best to avoid the social cost involved in bank failures. A bank that fails to meet its obligations introduces instability into the whole banking system and generates external diseconomy by reducing public confidence in the system as a whole. By using supervisory means, the authorities restrict the "irresponsible conduct" of banks and maintain the safety and soundness of the financial system. These two motives—the execution of monetary policy and stability—are obviously not always compatible and are a source of interminable discussion among politicians, economists, and bankers.

Although the two motives are interrelated, this paper is concerned only with the stability aspect of supervision of the banking industry, specifically the negative externalities that bank failure imposes on the system.

The high number of bank failures in the U.S. during the economic crisis of the 1930s was a most traumatic experience. This historic event conspicuously demonstrated how great could be the social cost of an unstable banking system. Since then, the impact of the negative externalities of bank failure has been vividly described by terms such as "domino effect" or "run on the banks".

Even in countries where deposit insurance exists, such as the U.S., the diseconomies of a bank failure do not vanish. The burden of the social cost might instead be shifted, in part, from bank customers to taxpayers.

* Department of Economics and Business Administration, Bar Ilan University, Israel. Helpful comments by Yoram Landskroner, Itzhak Swary, Yaacov Weis, and anonymous referees are gratefully acknowledged.

Explanations of bank regulation have been considered and discussed in several studies, and the stability aspect has been mentioned or even emphasized in many,[1] but to our knowledge the negative effect of externalities in bank failure has not been modeled.[2]

This paper attempts to model the domino effect and to specify the conflict of interest between a bank and the public, regarding the desirable level of default risk. We explicitly formulate the relationship between the essential supervision of banks and the negative externalities of bank insolvency. The paper studies the effects of uncertainty, the size of the banking industry, and several costs on the indispensability of supervision. In addition, efficient choices of supervisory means are discussed.

Our analysis provides many insights into the ongoing dialogue between supervisors and financial intermediaries and thereby contributes to the current debate as to the necessity or redundancy of supervision and regulation (or deregulation) of the banking industry.[3]

Section I presents a model of conflict between a bank and the public with regard to optimal default risk and derives a measure for the essentiality of supervision. Section II performs a comparative-statics analysis on the essentiality of supervision with respect to factors such as the desired stability of the banking system and its size. Section III discusses the choice of means to supervise banks. Conclusions are in Section IV. Direct and indirect costs of supervision are introduced as major factors in determining the efficient choice of supervisory tools.

I. A Model of Conflict between a Bank and the Public

Consider an economy with a given number, n, of identical banks. For the sake of simplicity and without any loss of generality, assume that a failure of any single bank entails a chain reaction, such that eventually all the other banks in the system will also fail. This is called assumption D.

Assumption D seems, of course, to be an extreme description of the Domino Effect, but, as will be apparent, our model also describes, with a slight modification, cases in which assumption D does not exist.

For every bank, two functions must be defined: the expected profit and the likelihood of bankruptcy, denoted by $E(x)$ and $p(x)$, respectively. Common argument x is a policy variable controlled by the bank such that, in the relevant domain, both E and p are either strictly increasing or strictly decreasing functions

[1] See, for instance, Meltzer [9], Benston [2], Black, Miller, and Posner [5], and, more recently, the comprehensive study by Benston, Eisenbeis, Horvitz, Kane, and Kaufman [3] and many of the references cited there.

[2] However, there are several studies that discuss the domino effect and bankruns, such as Bernaka [4]. An attempt to measure empirically the domino effect can be found in Aharony and Swary [1]. The domino effect has also been mentioned recently in the context of the Continental Illinois National Bank incident. See, for instance, Swary [17] and the Statement of Isaac, William (The Chairman of FDIC) presented to the Subcommittee on Financial Institutions Supervision of the Committee on Banking, Finance and Urban Affairs, House of Representatives, October 4, 1984.

[3] See Meltzer [9], Santomero [14], Santomero and Watson [15], Pyle [12], Kane [7], Merrick and Saunders [10], and many of the discussions in Dale [6].

of x. Note that, because of the fundamental tradeoff between profits and risk, almost every bank activity would possess this property and therefore could serve as argument x. For example, consider activities that also serve as possible instances of government regulation, such as capital adequacy, off-balance sheet business, or the amount of credit extended to a single borrower. In the first case, both E and p are decreasing functions; in the second and third cases, they are increasing functions.

Suppose that the bank's objective is to maximize expected profits, such that the default risk is upperbounded by a predetermined value p^*; i.e.,

$$\max E(x) \quad \text{subject to} \quad p(x) \leqq p^*. \tag{1}$$

Given the monotonicity of E and p, the optimal value, x^*, to this problem obviously solves $p(x) = p^*$. Thus, x^* is a strictly monotonic function of p^*, and, therefore, any restriction of x is also a means to restrict p.

The basic question is what the bank's considerations are in originally posing the specific value p^* as an upperbound for its risk. More specifically, does the bank take into account the domino effect while determining the value of p^*?

Suppose g is the socially desired upperbound for the likelihood that the entire banking system would collapse. This probability is greater than zero because otherwise the system would be paralyzed. In this case, the socially desired upperbound for the risk taken by a single bank is the solution to the equation:

$$1 - (1 - p)^n = g. \tag{2}$$

The left-hand side of (2) is the probability that at least one bank out of the n fails. Because of assumption D, this probability must be equal to g.

The value of g is determined by the degree of stability sought by society. Thus, more stability means smaller value of g and vice versa.

Denote by p' the solution of (2). Obviously, if $p^* > p'$, there is a conflict between the viewpoint of the single bank and that of the public. If $p^* > p'$, the bank does not take into consideration the negative externalities of failure; the gap between the two values calls for public intervention in the bank's activity. This case is comparable to that of a driver who adjusts the speed of his car by considering the risk of being involved in an accident but who does not take into account the risk his driving imposes on other drivers. Such a gap calls for traffic regulations that set speed limits, etc.

Note that the left-hand side of (2) can be decomposed into two parts:

$$1 - (1 - p)^n = p + (1 - p)[1 - (1 - p)^{n-1}].$$

The first term is the objective probability of bankruptcy of any specific bank, and the second term is the likelihood of its default as a result of a default of at least another bank in the system. This second term is the effect of the negative externalities. This part of the probability might be ignored or given less weight by the specific bank so that a gap is generated between p^* and p'. An analytical expression for the amount of externalities taken into account by the bank is given by

$$h = 1 - \frac{(1 - p')^n - (1 - p^*)^n}{(1 - p^*) - (1 - p^*)^n}. \tag{3}$$

The numerical value of h is always between zero and one. It retains the value of one if all the externalities are taken into account, so that $p^* = p'$. It takes the value zero if none of the externalities is taken into consideration, so that $p^* = 1 - (1 - p')^n = g$. For example, suppose that $p^* = 0.02$ and $p' = 0.01$ and that the economy comprises five banks. Then, h = 0.38.

For a given h the single bank derives its target risk p^*, which is a parameter in its objective function (1), as a solution to the equation:

$$p + (1 - p)[1 - (1 - p)^{n-1}]h = g. \tag{4}$$

Besides the bank's own risk p, the bank takes into account the externality effect $(1 - p)[1 - (1 - p)^{n-1}]$ with a certain proportion h. Note that (4) coincides with (2) for $h = 1$. Also note that (3) is obtained by equating (4) to (2) and solving for h.

Equation (4) specifies p^* as an implicit function of three factors: the stability conditions of the economy as reflected by g, the number of banks in the system n, and the amount of externalities considered by the bank, as measured by h. Figure 1 illustrates equations (2) and (4) and the conflict of interest between the bank and the public, as indicated by the difference between $p^*(h)$ and p'.

The difference $e(h) = p^*(h) - p'$ is defined as the essentiality of supervision. It is clear that $e(h)$ is always non-negative and is also a decreasing function of h. If $h = 1$, $e(h) = 0$ and supervision is unnecessary, and, if $h = 0$, supervision is indispensable. The effects of the stability conditions of the economy, as well as the size of the banking system, on the essentiality of supervision, will be explored below.

We conclude this section with three remarks:

1. Note that the model can be extended to include a heterogenous banking system. For instance, suppose that there are two groups of banks, distin-

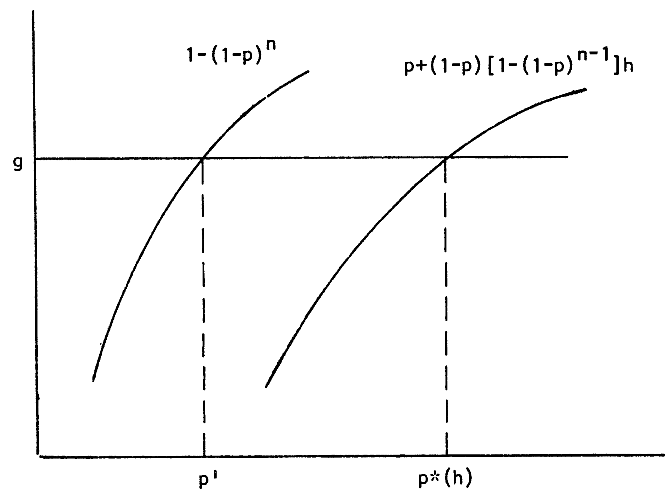

Figure 1. The Bank's Target Risk

guished by size of by specialization, with two different values of h. A single bank now has to consider the externalities of its actions both within and between groups. To avoid complications, this paper considers only the homogenous case, in which all banks are the same.

2. Assumption D can be easily relaxed by giving another interpretation to n. Suppose that m is the number of banks in the system and $n \leqq m$ is the number of banks affected by the domino effect. Insofar as n is a strictly increasing function of m, all the measures defined in this paper, as well as the whole analysis, are still valid.
3. After some manipulations, equation (4) can also be written as

$$h(1-p)^n + (1-h)(1-p) = 1-g.$$

This formulation sheds additional light on the meaning of h. The desired probability of a stable system $1-g$ is a weighted average of the probability that a single bank is stable, $1-p$, and of the probability that all the banks are stable $(1-p)^n$, where $1-h$ and h are the weights. A bank that entirely disregards its negative externalities sets $h = 0$ and $p^* = g$, and a bank that does not ignore the diseconomies of its failure sets $h = 1$ and $p^* = 1 - (1-g)^{1/n}$. The intermediate case, for which $0 < h < 1$, seems to be the common bank.

II. Comparative Statics

The preceding section shows that p^*, which is derived by (4), is the value of the target risk in the bank's objective function (1) and is therefore an important factor in determining the bank's optimal activity x^*. Here, we study the effects of g, n, and h on p^* and thus on the essentiality of the supervision e.

Note that (4) is equivalent to $f(p, h, g, n) = 0$, where f is defined as

$$\begin{aligned} f(p, h, g, n) &= [1-(1-p)^n] - g - (1-p)[1-(1-p)^{n-1}](1-h) \\ &= f(p, 1, g, n) - (1-p)[1-(1-p)^{n-1}](1-h). \end{aligned}$$

An investigation of the function f yields $\partial f/\partial p = 1 - h + hn(1-p)^{n-1}$, $\partial f/\partial n = h(1-p)^n k$, $\partial f/\partial g = -1$, $\partial f/\partial h = (1-p)[1-(1-p)^{n-1}]$, $\partial^2 f/\partial p^2 = -hn(n-1)(1-p)^{n-2}$, $\partial^2 f/\partial n^2 = -h(1-p)^n k^2$, $\partial^2 f/\partial g^2 = 0$, $\partial^2 f/\partial h^2 = 0$, $\partial^2 f/\partial p \partial n = h(1-p)^{n-1}(1-nk)$, $\partial^2 f/\partial p \partial h = n(1-p)^{n-1} - 1$, and $\partial^2 f/\partial n \partial h = -(1-p)^n k$, where $k = \ln[1/(1-p)]$. Some of these relationships will be used below.

Proposition 1: *The bank would limit its own activity if society would require more stability, if the size of banking system increased, or if the bank gave more weight, in its decision-making process, to negative externalities. More precisely,* $\partial p^*/\partial g > 0$, $\partial p^*/\partial n < 0$, *and* $\partial p^*/\partial h < 0$.

Proof: By total differentiation of p^* with respect to a general parameter θ, we obtain

$$dp^*/d\theta = -[\partial f/\partial \theta]/[\partial f/\partial p^*] = -(\partial f/\partial \theta)/s,$$

where $s = 1 - h + hn(1 - p^*)^{n-1}$. Substitute, in turn, g, n, and h for θ to obtain

$$dp^*/dg = 1/s > 0,$$

$$dp^*/dn = -h(1 - p^*)^n k/s < 0,$$

$$dp^*/dh = [(1 - p^*)^n - (1 - p^*)]/s < 0.$$

Q.E.D.

Table I, which presents the solution p^* of (4) for different values of n, h, and g, illustrates numerically these results. It should be recalled that a synthetic measure of the essentiality of supervision has been defined as the difference between the solutions of (4) and (2):

$$e(h, g, n) = p^*(h, g, n) - p^*(1, g, n).$$

Clearly, the essentiality of supervision is a decreasing function of h; i.e., $de/dh = dp^*/dh < 0$.

We may now consider the impact of the stability requirements imposed by society and the size of the banking industry on the essentiality of supervision. Recall that the stability sought by society is reflected in g so that our concern is the sign of de/dg. The common view is that, if society seeks more safety and soundness of the banking system, supervision will become more essential; i.e., $de/dg < 0$. The following proposition claims that this is correct only if both n is "large enough" and h is "small enough".

PROPOSITION 2: *Each of the inequalities* $(\ln n)/(n - 1) < \ln[1/(1 - p')]$ *and* $h < [1 - n(1 - p')^{n-1}]/[1 - n(1 - p^*)^{n-1}]$ *is a necessary condition for* $de/dg < 0$, *and both are sufficient.*

Proof: $de/dg = dp^*/dg - dp'/dg = (1/s) - 1/n(1 - p')^{n-1}$ so that $de/dg < 0$ if and only if $n(1 - p')^{n-1} < s$ or $h[1 - n(1 - p^*)^{n-1}] < 1 - n(1 - p')^{n-1}$.

If $1 - n(1 - p')^{n-1} > 0$, then, since $e = p^* - p' > 0$ also, $1 - n(1 - p^*)^{n-1} > 0$. Thus, $1 - n(1 - p')^{n-1} > 0$ is a necessary condition for $de/dg < 0$. Given that $1 - n(1 - p')^{n-1} > 0$, $h < [1 - n(1 - p')^{n-1}]/[1 - n(1 - p^*)^{n-1}]$ is necessary and sufficient for $de/dg < 0$. Finally, note that if $1 - n(1 - p')^{n-1} > 0$ if and only if n is "large enough" or $(\ln n)/(n - 1) < \ln[1/(1 - p')]$. Q.E.D.

Table I

Values of p^* (h)

h	$g\backslash n$	2	3	4	5	10	20	50
	0.10	0.09167	0.07379	0.06559	0.05923	0.04044	0.02516	0.01196
0.10	0.40	0.37652	0.32641	0.30750	0.29389	0.26198	0.25078	0.25000
	0.10	0.07296	0.05774	0.04788	0.04094	0.02382	0.01301	0.00552
0.40	0.40	0.31386	0.26486	0.23197	0.20789	0.14279	0.08353	0.05035
	0.10	0.06404	0.04725	0.03748	0.03106	0.01676	0.00873	0.00358
0.60	0.40	0.27924	0.21782	0.17958	0.15318	0.08921	0.04901	0.02093
	0.10	0.05700	0.03991	0.03072	0.02497	0.01290	0.00656	0.00265
0.80	0.40	0.25000	0.18282	0.14433	0.11930	0.06402	0.03327	0.01363

The somewhat counterintuitive result of Proposition 2 is unsurprising if one recalls the result of Proposition 1, that the bank itself limits its own action if society requires more stability of the banking system. This is analogous to the imposition of speed limits, which are not as essential in inclement weather, when drivers restrict themselves anyhow. Only in an economy with a very large banking industry (n is large) that, moreover, entirely disregards the negative externalities it may impose on the system (h is small), does an increase in stability requirements also increase the essentiality of supervision.

It is now germane to investigate the effect of the size of the banking system, n, on the essentiality of supervision. It is again impossible to exclude the counterintuitive case that the essentiality of supervision decreases with n. However, if p^* is sufficiently large, either because h is small or because g is large (and also if n is large enough), then supervision will be more essential as the size of the banking system increases. This finding is expressed more precisely in the following proposition.

PROPOSITION 3: *A sufficient condition for* $de/dn > 0$ *is* $p^* > 1 - e^{-1/n}$.

Proof: First note that

$$\begin{aligned} de/dn &= dp^*(h, g, n)/dn - dp^*(1, g, n)/dn \\ &= \phi(1, p', n) - \phi(h, p^*, n), \end{aligned}$$

where $\phi(h, p^*, n) = -dp^*(h, g, n)/dn = h(1 - p^*)^n \ln[1/(1 - p^*)]/s$ and $p^*(1, g, n) = p'$. Thus, if $d\phi(h, p^*, n)/dh > 0$, then also $de/dn > 0$. However, $d\phi(h, p^*, n)/dh = \partial\phi/\partial h + (\partial\phi/\partial p^*)(dp^*/dh)$. After some manipulation one finds that

$$\partial\phi/\partial h = (1 - p^*)^n \ln(1/(1 - p^*))/s^2$$

and

$$\partial\phi/\partial p^* = h(1 - h)(1 - p^*)^{n-1}[1 - n \ln(1/(1 - p^*))]/s^2,$$

so that

$$\begin{aligned} d\phi/dh = \{&(1 - p^*)^n \ln(1/(1 - p^*)) \\ &+ h(1 - h)(1 - p^*)^{n-1}[1 - n \ln(1/(1 - p^*))](dp^*/dh)\}/s^2. \end{aligned} \tag{5}$$

The first term in the numerator is positive, but $dp^*/dh < 0$. Therefore, a sufficient condition to render the second term and the whole expression positive is $1 - n \ln(1/(1 - p^*)) < 0$, or, equivalently, $p^* > 1 - e^{-1/n}$. Q.E.D.

Note that, if p^* and n are sufficiently small, then $1 > n \ln 1/(1 - p^*)$, so that the second term in the numerator of (5) is negative. In such a case, the absolute value of the second term can, in principle, offset the first term; then $d\phi/dh < 0$, so that $de/dn < 0$. To understand such a result, it may be useful to recall the analogy of traffic regulation, where speed limits are less essential when the road becomes crowded and cars are slowed in any case.

On the other hand, if p^* is sufficiently large, perhaps as a result of the bank's ignorance of negative externalities (h is small), then the final outcome might be reversed and bank supervision will be more essential as n increases.

It is evident that the measure e developed above is an analytical expression and cannot be directly observed. However, because of the high correlation between the essentiality of supervision and the proportion, or the frequency, of bank failures in the economy, the last phenomenon can serve as an indicator for the first. However, in this paper we disregard measurement errors or any problems that emerge as a result of dealing with unobservables.

III. Efficient Choice of Supervisory Means

The one-to-one correspondence of the target risk, p^*, and bank activity, x, suggests that a restriction of x is an efficient supervisory means to restrict p^*. It is evident, however, that banks are usually involved in more than a single activity, and, therefore, supervisory authorities frequently face a problem of choice—which of these activities to select as efficient tools to restrict bank risk. Moreover, in the case of many activities, we shall see that a restriction of bank risk by supervisory authorities becomes very complicated and very costly.

For the sake of simplicity, assume that only two activities are available to the bank, x_1 and x_2. With no loss of generality, also assume, as in Section II, that expected profits E and the probability of default p are both strictly increasing functions of the arguments x_1 and x_2. By using subscripts to denote partial derivatives, this assumption is formulated in (6):

$$E_1 > 0, \quad E_2 > 0, \quad p_1 > 0, \quad p_2 > 0. \tag{6}$$

Moreover, also assume that

$$E_{11} < 0, \quad E_{22} < 0, \quad E_{12} \geqq 0, \quad p_{11} > 0, \quad p_{22} > 0, \quad p_{12} \leqq 0. \tag{7}$$

In other words, (6) and (7) assume that profits increase at diminishing rates and the probability of default increases at accelerating rates. Also, the two activities interact in such a way that each activity increases the marginal effect on profits of the other but decreases its marginal effect on risk. The first may be due to economics of scope, while the other may reflect a diversification risk.

As in Section I, we assume that the bank's objective is to maximize its expected profits with respect to the levels of its activities, subject to a risk constraint, i.e.,

$$\max_{x_1, x_2} E(x_1, x_2), \quad \text{subject to} \quad p(x_1, x_2) \leqq p^*. \tag{8}$$

The first-order conditions require that a regular optimal solution (x_1^*, x_2^*) would satisfy the equations:

$$E_1/E_2 = p_1/p_2 \tag{9}$$

and

$$p(x_1, x_2) = p^*. \tag{10}$$

The optimal point is illustrated in Figure 2. The conditions in (6) and (7)

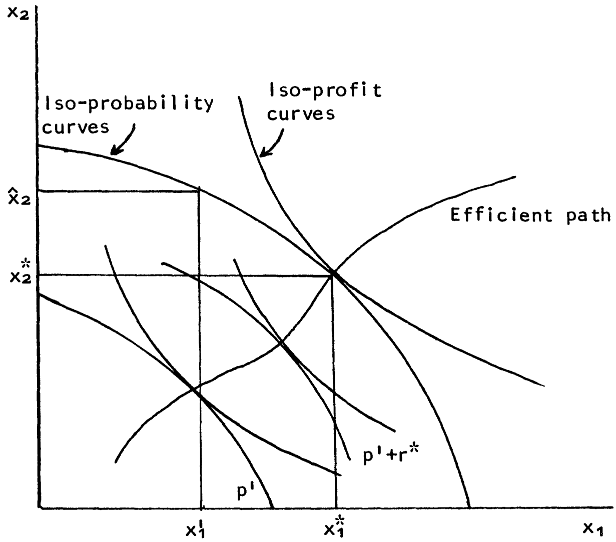

Figure 2. Efficient Choice of Bank Activities

guarantee that the iso-profit curves are concave (toward the origin) and that the iso-probability curves are convex.[4]

The efficient path in Figure 2 is the geometric locus of all the efficient combinations of bank activities that satisfy equation (9). If the essentiality of supervision $e = p^* - p'$ is positive, and the authorities choose the restriction of x_1 as a major tool to restrict p^*, as by imposing constraint $x_1 \leqq x_1'$ where $x_1' < x_1^*$, then the bank will seek a second-best solution by solving the new problems:

$$\max_{x_2} E(x_1', x_2) \quad \text{subject to} \quad p(x_1', x_2) \leqq p^*. \tag{11}$$

This problem yields the solution $(x_1', \hat{x}_2)$, where $p(x_1', \hat{x}_2) = p^*$.

The new point $(x_1', \hat{x}_2)$ is illustrated in Figure 2. Because of the Le Chatelier Principle,[5] the second-best solution satisfies $\hat{x}_2 > x_2^*$. However, in the new situation, the bank is inefficient and its risk remains unchanged. Here, supervision simply harms the banks without any benefit to the economy.

The above analysis describes the difficulties that supervisory authorities face while trying to control default risk in banks involved in several activities. If at

[4] The conditions for quasi-concavity and quasi-convexity are

$$E_1^2E_{22} + E_2^2E_{11} - 2E_{12}E_1E_2 < 0$$

and

$$p_1^2p_{22} + p_2^2p_{11} - 2p_{12}p_1p_2 > 0,$$

respectively. These conditions are obviously guaranteed by (6) and (7).

[5] See Samuelson [13].

least one activity is left unconstrained, it can be used by a risk-seeking decision maker as a channel to retain the bank's initial target risk. Arguments against some supervisory means are mainly substantiated on the same grounds as presented here.[6]

The theory presented herein clarifies how a bank's specialization helps authorities to supervise and, therefore, why some supervision authorities encourage financial institutions to specialize.[7]

In principle, an efficient restriction is a combination (x_1', x_2') constituting a point on the efficient path. The information needed to find such a point is so extensive that it is hard to believe an efficient supervision exists at all. The use of the capital/assets ratio as a restrictive tool transforms the difficulties of finding the proper levels of an efficient basket of restrictions into the difficulty of estimation of the exact risk weights in the aggregate asset of the ratio. Note, however, that, if the function p can be approximated by a linear function in the relevant range and if the function E is homothetic, then the efficient path is a straight line through the origin and an effective restriction that reduces all activities in the same proportion is also an efficient restriction.

Consider the point (x_1, x_2) as an effective restriction, such that $p(x_1, x_2) = p'$, and consider the point (x_1', x_2') as an effective point as well as an efficient restriction; i.e., (x_1', x_2') is the effective point on the efficient path.

Define the function $L(x_1, x_2; p') = E(x_1', x_2') - E(x_1, x_2)$ as the bank's cost function, which emerges as a result of inefficiency. It is obvious that $L(x_1, x_2; p') \geqq 0$. Supervision is not a cost-free activity; to this point, the analysis has disregarded this element. Now define the function $l(x_1, x_2; p')$ as the operating-cost function of the supervisory authorities.

The function $l(x_1, x_2; p')$ includes costs such as expenses on examiners and costs of law enforcement, in addition to the costs of collecting information and devoting efforts to finding and approximating the efficient point (x_1', x_2').

Thus, the total cost of supervision of the banking system is comprised of two parts: the direct cost of supervision l and the indirect cost the whole system pays because of inefficiency resultant from restriction, nL.

As point (x_1, x_2) moves close to (x_1', x_2'), function L decreases and, eventually, function l increases. Thus, a tradeoff occurs between these two types of costs, and, consequently, an optimization problem is generated. The problem controllers face is to minimize the total cost $l + nL$ with respect to the feasible combinations of restrictions, subject to the probability constraint, $p(x_1, x_2) = p'$.

In addition to the expenses of the supervisory authorities l and the costs that the banking system carries nL, there is another cost element, i.e., the expected

[6] The point is well presented in Koehn and Santomero [8] in an analytical way. Recently, the Chairman of the FDIC commented explicitly on a situation where banks bear an exaggerated risk:

> Nor are restrictions on how a bank can be run—what assets it could hold, which services it can offer, where it can branch, and how it should structure its liabilities—an adequate response to the situation. Moreover, bankers who want to take risks have ample means of doing so in today's marketplace. There is almost no end to the ways in which the determined risk-seeking banker can gamble with the FDIC's funds or his customers' deposits. (See Seidman [16], pp. 71–72.)

[7] For instance, the Glass-Steagall Act of 1933 has separated investment and commercial banking services.

social cost of the domino effect, $Fe(p')$, where F is the social loss of the domino effect and $e(p')$ is the essentiality of supervision, i.e., $e(p') = p^* - p'$. The public faces the possibility of trading off the cost of supervision, $l + nL$, with the risk of the unrecognized domino effect. Denote by $B(p')$ the minimum value of the supervision cost. We assume that $B(p')$ is a decreasing function of p', so that B declines as p' approximates p^*. The general problem of authorities that truly represent the public interest is to solve

$$\min_r \, [B(p' + r) + Fe(p' + r)].$$

The optimal value r^* is a perturbation of p' that reflects the additional social risk of the domino effect, Fr^*, to save supervisory costs. Of course, if $r^* \geqq e = p^* - p'$, then, although it sounds paradoxical, supervision is entirely dispensable even if it is essential ($e > 0$).

Taking into account efficiency considerations, the single bank's socially desirable target risk is $p' + r^*$. The socially desirable target risk is a function of h, g, and n, which are arguments in p', and also a function of l, nL, and F, which determine r^*. Now, the essentiality of supervision may be more accurately redefined as $e^* = p^* - (p' + r^*)$; if and only if $e^* > 0$, the situation then calls for the authorities' intervention.

IV. Conclusion

In his well-known description of theories of financial institutions under uncertainty, Pyle [11] classified the several theories into normative and positive types. In principle, such a classification may be used to characterize theories of supervision of financial institutions. However, in the current literature, a positive economic theory of banking supervision can hardly be found. This paper attempts to offer such a theory.

Within a stylized framework, the domino effect has been modeled, and the necessity of banking supervision has been obtained from the model as a natural outcome. A measure for the essentiality of supervision has been defined and its determinants presented. The effect of several factors on the essentiality of supervision has been closely studied. We have investigated factors such as the degree of stability sought by society, the size of the banking system, the amount of negative externalities that are considered by banks, the direct as well as indirect costs of supervision, and the social cost of the domino effect.

Conditions are specified under which some counterintuitive results have been derived. For instance, under certain circumstances, supervision becomes *less* essential if the banking system is required to be more stable or if the number of banks increases.[8] We have also indicated possible directions for further research. It would, for example, be desirable to relax the assumption of homogeneity of the

[8] Note that although deposit insurance reduces the domino effect, it increases the bankers' incentives to take greater risks so that supervision of the banking system is still indispensable. Under deposit insurance, the essentiality of the supervision can still be measured and defined in the very same way, but now it is effected by additional factors such as the premium rate and the bank's incentive to free-ride.

banking system. Also, some of the hypotheses resulting from the theory must be empirically tested. The number of banks in the system is taken in the analysis as a given constant, but the model should be extended to include n as an endogenous variable.

This paper has also emphasized that objective difficulties in the supervision of banks, by simply imposing restrictions on their activities, are intrinsic to the operation of the banks themselves; these difficulties occur particularly if the bank is involved in many activities.[9] As a result of such difficulties, the direct and indirect costs of efficient supervision are extremely high. Supervisory authorities should carefully weigh these costs against expected social costs or the social risk of the unrecognized domino effect.

[9] It is worth noting that the restrictions of the bank's activities discussed in this paper may also include branching restrictions as well as restrictions on the pricing of financial services.

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