Bank Taxes, Bailouts and Financial Crises

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Following the Great Financial Crisis, more than a dozen countries adopted innovative bank taxes as part of their response. This paper characterizes, calibrates and discusses Pigovian taxes on bank borrowing to address externalities associated with either the collapse of systemic financial institutions or, to prevent that, public guarantees to bail out their creditors. It also characterizes optimal bailout policy, differentiating between circumstances in which the government can and cannot commit. Building on the analysis for a representative bank, it considers the implications for corrective taxation of various aspects of bank heterogeneity, connectedness, and asymmetries of information.

Keywords: bank taxation, Pigovian taxation, financial crisis

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1. Introduction

The Great Financial Crisis that began in 2007 has left a long trail, both practical and intellectual. One central policy response has been the Basel III program of reform of the regulation and supervision of the financial sector. Less noted, but no less innovative, has been a fundamental reconsideration of the tax treatment of the financial sector. At one level – and perhaps ultimately most importantly – this has meant recognizing that pre-existing tax distortions

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may be costlier than had generally been supposed, notably[1] the bias towards debt finance inherent in most corporate tax systems (providing deductions for interest but not the return to equity). All that, however, was well-known to the public finance community before the crisis. The more novel issue raised was whether new types of tax instruments, applied specifically to discourage socially excessive leverage and risk-taking by financial institutions, might have a constructive role to play in limiting the likelihood of and social damage from financial failures.[2] A charge of this type was proposed in a report to G20 by the IMF (2010).[3] But action ran far ahead of analysis. In 2011, for instance, the U.K. introduced a levy on (essentially) banks' uninsured debt obligations, "... to encourage banks to move away from risky funding models that threaten the stability of the financial sector and wider economy" (HM Revenue & Customs, 2010). Within a few years, France, Germany, Sweden and others – a total of fourteen member states, as well as three non-EU members – had introduced some special charge on financial institutions.

These bank taxes/levies[4] are a wholly novel development in tax policy.[5] They differ in significant ways in rationale and design. One strand of thought has stressed their potential role in financing, ex ante, the bank resolution and other costs likely to be experienced in future crises.[6] This is conceptually distinct from, though often conflated with, another role for such taxes, as stressed, for instance, by the U.K.: the idea of such taxes as playing a purposive role in addressing externalities emanating from financial stress and failure.[7] Indeed the idea of Pigovian taxes on the financial sector has become increasingly

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1 But not only. Another long-standing concern is the exemption of most financial services under the value added tax: see for example IMF (2101a), Keen et al. (2016). Shackelford et al. (2010) also discuss aspects of financial sector taxation in light of the crisis.

2 The links between this debt bias issue and the corrective taxes that are the focus of this paper are taken up in the concluding section.

3 Background papers, along with the report itself, are in Claessens et al. (2010).

4 For brevity, we speak of 'banks' and 'bank taxes' throughout, though in both principle and practice the issues extend beyond narrowly-defined banks, and the term 'levies' is also often used when emphasis is placed on the rationale for a charge as a user fee to cover ex ante the costs of cleaning up post-crisis.

5 Taxation in the shape of deposit insurance has long been familiar in the sector, but this has generally been seen as targeted at potentially ill-informed retail depositors rather than as addressing the systemic risks at issue in the crisis. Another tax innovation coming out of the crisis was the deployment of bonus taxes, aimed at addressing both distributional concerns and incentives for excessive risk-taking: see for instance (on theory and evidence respectively) Besley and Ghatak (2013) and Von Ehrlich and Radulescu (2017). Short-lived, and in some cases explicitly temporary, these are not considered here.

6 This is the rationale, notably, for the contributions to the Single Resolution Fund (SRF) of the EU, to be made by members of the banking union, established in 2016. These are of essentially the form proposed in IMF (2010).

7 Distinct charges to these distinct ends could even co-exist. Austria, for example, reportedly indicated an intention to impose both the bank charge introduced in 2011 and mandatory contributions to the SRF.

common currency, one recent example being the appearance of such a tax on shadow banks in recent reform proposals of the Federal Reserve Bank of Minneapolis (2016). These innovations in practical policy have taken place, however, without (beyond a few important exceptions noted later) much precision as to how such taxes should be structured or calibrated.

The aim of this paper, which originated in the heady days of the crisis, is to sketch how bank taxes might be designed to address what the crisis reminded us can be strongly adverse external effects from the collapse, and potential collapse, of systemic financial institutions,[8] along with associated issues relating to bailout policy.

In their detail, the mechanics of these effects, operating both across financial institutions and between the financial and nonfinancial sectors, are complex and varied. The former includes, for instance, the effects of firesale externalities as distressed asset sales by one institution lead to price reductions that jeopardize the solvency of others: this is a pecuniary externality that has real effects as a consequence of incompleteness of markets and regulatory and other constraints. They include too information spillovers (as bad news about one institutions is taken as cause for concern regarding others). The latter include the likelihood that sharper credit constraints will limit opportunities open to nonfinancial businesses.[9] Their ultimate consequences, however, have been clear. During the Great Financial Crisis, many governments, lacking tools to resolve systemically important institutions in an orderly fashion, faced the dilemma of either letting such collapse occur, allowing these externalities full play and accepting the economic disruption that would imply, or, instead, committing sufficient public funds for bailouts to avert this damage, but in so doing trigger another kind of externality, and potential inequities, by creating an expectation of future bailouts: the 'too big to fail; syndrome.' Or, of course, doing some of both.

The social costs associated with either course of action have proved very high. Laeven and Valencia (2016) estimate the median cumulative output loss in the four years following banking crises in advanced economies to be around 33 percent of GDP; Basel Committee on Banking Supervision (BCBS, 2010) find a median cumulative output loss of 63 percent of initial GDP, and a mean of over 100 percent. In narrower fiscal terms, governments' exposures at the height of the Great Financial Crisis were huge: through guarantees and the like, the advanced G-20 economies committed to making an average of

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8 There is of course also evidence of positive externalities from well-functioning financial systems (Levine, 2005), but these are not at issue here.

9 Systemic externalities originating in the financial sector are reviewed in Bank of England (2009) and Wagner (2010).

25 percent of GDP available for support operations.[10] And in normal times, of course, the expectation of bailout manifests itself in reduced borrowing costs that can amplify any inherent tendency toward excessive leverage of financial institutions.

This dilemma is at the core of this paper. The central aim is to characterize and explore, in a series of settings, the optimal design of corrective taxes on bank borrowing (to discourage inappropriately low capital ratios) in the presence of this inherent dilemma: between, on one hand, incurring the collapse externality associated with failure of systemic institutions or, on the other, incurring a 'bailout' externality by providing resources to bail out creditors should such institutions become distressed. In relation to the latter, a key and very practical question is whether or not the government can credibly commit to its bailout policy; both possibilities, and their implications for corrective taxation, are examined.

Several post-crisis papers have taken up aspects of the use of Pigovian taxes in the financial sector.[11] Closest to the analysis here is Acharya et al. (2016), which, as discussed further below, arrives by a different route at an optimal tax formula that differs from but has strong similarities to that in Proposition 1 below; from there, however, they turn to their principal concert of characterizing and measuring the contribution of individual financial institutions to systemic risk, while the analysis here explores further the issues of tax design and optimal bailout policy. The recent literature has also taken up the fundamental issue as to the relative merits of taxation and regulation in this context. These are discussed, for example, in IMF (2010), Keen (2011a, b) and Coulter et al. (2014). These issues,[12] however, would require a fuller treatment that is

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10 As of mid-2014 (no more recent data of this kind seem to be available), public support actually extended to the financial sector since the Great Financial Crisis in a selection of advanced countries averaged 7.4 percent of GDP (with a high of 41 percent in Ireland), of which a little over one-third had been recovered (IMF (2014), table 1.4).

11 Less formal arguments to the same effect are in Shin (2010) and in the proposal of Perotti and Suarez (2009) for a corrective tax on maturity mismatch that would be, in effect, largely a tax on short-term debt. Several papers have argued for corrective taxation of unsecured borrowing on other grounds. In Huang and Ratnovski (2009), for instance, it serves to reduce banks' funding reliance on creditors with such high seniority that they may impose inefficient liquidation in response to noisy signals on the institution's prospects; in Jeanne and Korinek (2010) it serves to discourage borrowing that increases asset prices and so, in the presence of collateral constraints, amplifies volatility by allowing others to borrow more too; see also Bianchi and Mendoza (2010) and Korinek (2009). As noted by Korinek (2009), the characterization of optimal policy in terms of Pigovian taxation in these papers is as an analytical convenience, with corresponding regulation seen as just as good a way to implement it.

12 A further option for dealing with externalities is through ex post liability (Shavell, 2011) – this is not especially attractive in the context of financial crises, however, since institutions contributing to them may by then no longer exist.

possible here, and so are not taken up in what follows – although, as will be seem, some of the results below are relevant to it.

One area in which knowledge has advanced significantly since the financial crisis is the empirical importance of the tax issues addressed here. At that point, it was not even clear whether – given the capital requirements that they face – taxation had any significant impact on the financing decisions of banks. Now it is clear that it does: banks generally hold a capital buffer above those requirements, leaving clear scope for tax effects, as shown by De Mooij and Keen (2016) and Hemmelgarn and Teichmann (2014). And indeed there is evidence that the recent bank taxes have themselves had an appreciable effect: see Devereux et al. (2013).[13] It is worth noting too that while capital requirements are now higher, and of higher quality, under Basel III, controversy continues as to whether they are adequate.[14]

The plan of the paper is as follows. The next section sets out a model of a representative bank whose decisions determine its own risk of failure, and formalize and explores the collapse and bailout externalities. Section 3 then characterizes and calibrates the optimal corrective tax in that context. Recalling the policy interest in using bank charges to provide ex ante financing for ex post resolution, it also asks whether the revenue raised by such a charge can be expected to be adequate to meet expected bailout costs. Section 4 then characterizes optimal bailout policy and its implications for corrective taxation, drawing an important distinction between the cases in which the government can and cannot commit to its bailout policy. Section 5 extends the analysis to settings with multiple and heterogeneous banks, dealing first with the case in which banks are unconnected, before turning to that in which they are connected through inter-bank deposits and finally considering the implications of asymmetries of information between banks and government, Section 6 concludes.

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2. Banking and Systemic Externalities

This section develops a basic model of a single bank,[15] with endogenous failure risk, that allows an initial characterization and exploration of the policy dilemma raised above: the choice between allowing a failed institution to collapse, or, to avoid the damage this would cause, bailing out its creditors.

13 Buch et al. (2017), however, find little evidence of a sizable impact from the German levy.
14 The highest capital requirement under Basel III, for systemically important banks, is 15.5 percent (relative to risk-weighted assets); there is also a leverage ratio (relative to unweighted assets) of 3 percent. In contrast, the influential book by Admati and Hellwig (2013), for instance, argues for a leverage ratio in the order of 25–30 percent, and Federal Reserve Bank of Minneapolis (2016) recommends one of 15 percent.
15 Or many identical ones.

2.1. The Bank

The 'bank' has equity capital in an amount K, taken throughout as given,[16] and chooses how much to borrow, B and lend, L ('loans'), with

$$L = K + B. \tag{1}$$

It offers creditors a rate of return of ρ (inclusive of return of principal), the determination of which is considered below. The return on loans (also inclusive of principal), $r \geq 0$, is stochastic; its distribution, described by density ϕ and (twice continuously differentiable) distribution function Φ, is taken as given, with $\phi(r) > 0$ for all $r > 0$. Denoting the risk-free return by ζ, it is also assumed throughout that

$$\int_{-\infty}^{\infty} (r - \zeta)\phi(r)dr = E[r - \zeta] > 0. \tag{2}$$

Loans are thus expected to yield more than the safe return: this ensures that they are socially desirable and that banks are willing to borrow in order to make them.

The assumed exogeneity of the distribution of returns means that the bank has no choice as to the riskiness of its assets.[17] This does not mean, however, that it has no risk-taking decision to make. To the contrary, this assumption serves to focus attention on the most fundamental of any bank's risk decisions: that of how large a risk to accept that the return on its assets will prove so low, relative to its capital base and promises to creditors, that the bank fails and its equity is wiped out.

Such failure arises if and only if the bank is unable to meet its obligations to creditors in full, even by fully exhausting equity K. This happens[18] if and only if

$$rL < \rho B. \tag{3}$$

Defining the capital ratio $k \equiv K/L$ (and using (1)) this defines a critical return on loans of

$$R \equiv \rho(1 - k) \tag{4}$$

below which failure occurs. All else equal, failure is thus less likely the lower is the interest rate at which the bank borrows and the higher is its capital ratio

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16 Keen (2011a) considers briefly the implications of adding an upward-sloping supply of bank capital.

17 An alternative model of bank behavior (for a different purpose) that does incorporate a decision as to the riskiness of the bank's assets is set out in de Mooij and Keen (2016); see also Devereux et al. (2013).

18 To see that equity is in this case wiped out, recall that the interest terms include repayment of principal: the rL term thus includes in effect full use of equity to pay creditors.

(or the lower its leverage $b \equiv B/L = 1-k$). The probability of failure is zero if and only if $k = 1$ or, equivalently, $b = 0$.

In the event of bankruptcy, bank owners are assumed to incur costs – beyond the loss of their equity – of δK. These might be literal bankruptcy costs, a loss of ego rents (as in Dewatripont and Tirole, 1993) or loss of franchise value of the bank (Hellman et al., 2000).

The government levies a per unit tax on the bank's borrowing at rate τ, implying a tax charge of $\tau B = \tau(L-K)$. This, we assume for simplicity, is payable and paid in full whether or not the bank fails.[19] The choice of τ is a central concern in what follows.

Bank owners (and, later, creditors and the government) are risk-neutral. Normalizing relative to the (fixed) amount of equity capital K, their problem is thus to choose the capital ratio k to maximize the payoff to the bank's owners, which is given by

$$\pi \equiv -\Phi(R)\delta + \int_R^\infty \left\{ r\left(\frac{1}{k}\right) - \rho\left(1-\frac{1}{k}\right)\right\}\phi(r)\,dr - \tau\left(\frac{1}{k}-1\right), \tag{5}$$

where $\Phi(R)$ is the probability of failure and the truncation in the integral reflects the operation of limited liability (the full consequences of which evidently depend on the return ρ required by the bank's creditors, to which we turn in a moment). We refer to π as the bank's (after-tax) profits, though it also reflects the bankruptcy costs δ that may in part be non-pecuniary. To focus solely on Pigovian taxation as a policy instrument, there are no capital requirements and no tax-induced debt bias of the kind that, as noted in the Introduction, is inherent in most corporate tax systems.[20]

It remains to characterize the determination of ρ, the rate at which the bank borrows. One approach would be to assume creditors to be myopic, taking no account of the possibility that the bank may be unable to repay them: this is the archetypal view of small depositors and provides one rationale for deposit insurance. More at issue in the crisis, however, was the behavior of large and uninsured wholesale depositors, more naturally assumed to be sufficiently sophisticated (and well-informed) to take the possibility of failure into account in their lending decisions. That is the assumption made here.[21]

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19 This assumption – implicit already in the failure condition (3) – avoids complications relating to the priority accorded to such obligations that are not of the essence to the issues at stake.

20 De Mooij and Keen (2016) analyze debt bias in the presence of capital requirements.

21 As John et al. (1991) and Sinn (2003, 2010) stress, limited liability reacquires importance when information is asymmetric between the bank and its creditors. Though the assumption the lenders are fully informed requires quite a leap of faith, asymmetric information of this type is not considered here, so as to focus on the inefficiencies associated with collapse and bailout.

In forming their expectations, creditors are therefore assumed to take account of any prospect of their being bailed out by the government if the bank itself cannot meet its obligations to them. This possibility is characterized by a parameter $\mu \in [0,1]$ that can be interpreted as either the probability that all creditors will be fully protected (in the sense of receiving the return ρ) by the government or – the language used below – the extent to which each will be protected (with $1-\mu$ being, conversely, the extent of the haircut each will take). Creditors are assumed throughout to take μ as given, and it assumed for now – this will be relaxed later – that the government's commitment to this bailout policy is fully credible.

Given their alternative of simply investing at the risk-free rate ζ, and assuming a competitive loan market, creditors will thus require a return ρ such that

$$\zeta = \rho\{1-\Phi(R)\} + \mu\rho\Phi(R) + \left(\frac{1-\mu}{1-k}\right)\int_{-\infty}^{R} r\phi(r)dr, \tag{6}$$

where the first term on the right reflects full payment of ρ on its borrowing of B if the bank does not fail, the second the extent of the bailout of creditors if it does, and the third[22] that creditors not bailed out in the event of failure receive only the residual value of the bank's assets. Notwithstanding the limited liability of the bank's owners, creditors thus receive an expected return equal to the risk-free rate, through some combination of an elevated return when the bank does not fail and in injection of public funds when it does.

Recalling that $R = \rho(1-k)$, equation (6) defines the rate of return on borrowing as a function $\rho(k,\mu)$, routine comparative statics showing that[23] ρ_k and ρ_μ are both strictly negative (except, for the former, when $\mu = 1$, in which case the bank can borrow at the safe rate).[24] This is as expected: the less likely is failure, and the higher is the probability of bailout, the lower is the rate at which the creditors will be willing to lend to the bank. From this, the critical return at which the bank fails is given by

$$R(k,\mu) = \rho(k,\mu)(1-k) \tag{7}$$

22 The lower limit of the integral is taken to be $-\infty$ in expressions like this, even though r is assumed non-negative in all realizations, as a reminder that integration is over a range that includes failure of the bank. Use is also made in this third term of the implication of (1) that $L/B = 1/(1-k)$).

23 Derivatives are indicated by subscripts for functions of several variables.

24 Explicitly:

$$\rho_k = -\left(\frac{(1-\mu)S}{(1-k)^2[1-\Phi(1-\mu)]}\right)$$
$$\rho_\mu = -\left(\frac{kS}{(1-k)[1-\Phi(1-\mu)]}\right). \tag{N.1}$$

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with both R_k and R_μ strictly negative.

Solving (6) for $\rho\{1-\Phi(R)\}$ and substituting into (5), the bank's objective function, regarded as a function of its capital ratio and the two policy parameters, can be written as

$$\pi(k,\tau,\mu) = -\Phi[R(k,\mu)]\delta + \int_{-\infty}^{\infty}\left\{r\left(\frac{1}{k}\right) - \zeta\left(1-\frac{1}{k}\right)\right\}\phi(r)dr + \mu S(k,\mu) - \tau\left(\frac{1}{k}-1\right), \tag{8}$$

where

$$S(k,\mu) \equiv \rho(k,\mu)\Phi[R(k,\mu)]\left(\frac{1}{k}-1\right) - \left(\frac{1}{k}\right)\int_{-\infty}^{R(k,\mu)} r\phi(r)dr, \tag{9}$$

$$= \left(\frac{1}{k}\right)\int_{-\infty}^{R(k,\mu)} (R(k,\mu)-r)r\phi(r)dr, \tag{10}$$

the final step following from $R = \rho(1-k)$.

The expected payoff to bank owners thus comprises three components. The first is the expected private cost of failure. This arises whether or not the government bails out creditors: equity is assumed to be wiped out whenever the bank is unable to meet its obligations, any bailout applying only to creditors. The second component is the value that the bank would have if there were simply unlimited liability and no possibility of bailout (recalling that creditors are then compensated for the risk of failure by a sufficiently high return ρ).[25] The third component is the expected value of the bailout, μS, and of interest to owners not because they themselves will be rescued but because it reduces the rate at which they can borrow while the bank is in operation. This term is central in what follows, and merits closer attention.

2.2. The Bailout Externality

This third component of the bank's maximand in (8), $\mu S(k,\mu)$, is the value to the bank – conversely, the revenue cost to the government – of expected public support (topping up the residual value of assets) to pay off creditors (expressed per unit of equity. K). This term thus captures the implicit subsidy

25 To see this, note that the return to bank owners given limited liability is

$$\int_{R}^{\infty}\left\{r\left(\frac{1}{k}\right) - \rho\left(\frac{1}{1-k}\right)\right\}\phi(r)dr.$$

Setting $\mu = 0$ in (6), when there is no possibility of bailout the return to creditors is

$$\rho = \frac{\zeta}{1-\Phi(R)} - \left(\frac{1}{(1-k)(1-\Phi(R))}\right)\int_{-\infty}^{R} r\phi(r)dr.$$

Combining these two gives the second term in (8).

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from the prospect of bailout: the 'too big to fail' subsidy. It is in itself a transfer, but inefficiencies will arise from the actions of bank owners to exploit it (as well as from any distortionary taxes levied to pay for it). We refer to these inefficiencies as the *bailout externality*.[26]

The properties of the bailout subsidy $\mu S(k,\mu)$ will be important in what follows and of interest in themselves. It is immediate from (10) that, for all $k<1$, S is strictly positive, while differentiating in (10) gives[27]

$$kS_k = -S + R_k\Phi(R) < 0 \tag{11}$$

so that (since that $R_k < 0$) the bailout subsidy is strictly decreasing in the capital ratio: banks that choose a safer capital ratio stand to benefit less from the prospect of being bailed out. One might expect it also to be convex in k; differentiating again, this will indeed be the case under the plausible condition that $R_{kk} \geq 0$ (though this will not be assumed in what follows). it can be shown too that – also as one would expect – the bailout subsidy is strictly increasing in the probability of bailout out,[28] μ.

To provide some sense of the possible magnitude of the bailout subsidy, denote by $\rho' \equiv \rho(k,0)$ the return that the bank would pay if there were no prospect of bailout. Setting $\mu = 0$ in (6), this is given by

$$\zeta = \rho'\{1-\Phi'\} + \left(\frac{1}{1-k}\right)\int_{-\infty}^{R'} r\phi(r)dr, \tag{12}$$

where R' and Φ' denote the corresponding critical return and risk of failure. Comparing this with (6), evaluated at the same capital ratio but for any bailout probability μ, gives

$$S(k,\mu) = \{\rho'(1-\Phi'\} - \rho\{1-\Phi\})b + \left(\frac{1}{k}\right)\int_{R}^{R'} r\phi(r)dr. \tag{13}$$

The subsidy is thus closely related to $\rho' - \rho$, which is the reduction in the bank's borrowing rate consequent on the possibility of bail out. Estimates have put this in the range of 10–50 basis points, and commonly around 20.[29] Equa-

26 Kocherlakota (2010) refers to this as a 'risk externality'.

27 It is assumed that $k \in (0,1)$ at all private and social optima considered.

28 Differentiating (10) with respect to μ gives

$$S_\mu = \left(\frac{1}{k}\right)R_\mu\Phi$$
$$= -\left(\frac{S\Phi}{1-\Phi(1-\mu)}\right)$$

the second equality following on noting that $R_\mu = \rho_\mu(1-k)$ and on using equation (N.1) of footnote 24 above. Hence

$$S + \mu S_\mu = \frac{(1-\Phi)S}{1-\Phi(1-\mu)} > 0.$$

29 See Baker and McArthur (2009), Haldane (2009) and, for a review and extension of the evidence, IMF (2010).

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tion (13) also shows, however, that is not an exact measure of the value of the bailout subsidy, ignoring as it does the two considerations that the benefit of the lower borrowing rate applies only when the bank does not fail, and that residual assets are lower in the event of default when there is some degree of bailout (since default than occurs at a lower return on assets), which reduces the cost to the government of making creditors whole and so reduces the value of the bailout subsidy).

2.3. The Bank's Choice of Capital Ratio

Differentiating in (8), the necessary condition on the bank's choice of capital ratio is

$$\pi_k(k,\tau,\mu) \equiv -\phi(R)\delta R_k - \left(\frac{1}{k}\right)^2 E[r-\zeta] + \mu S_k(k) + \tau\left(\frac{1}{k}\right)^2 = 0. \quad (14)$$

The bank thus trades off the beneficial effects of a higher capital ratio in reducing the chances of failure and cutting its tax bill against the adverse effects through contracting a profitable loan portfolio and reducing the value of the implicit bailout subsidy.

Satisfaction of the second order condition, however, is not assured by the assumptions made so far.[30] That the bank's maximand may not be globally concave is analytically inconvenient. The potential that it implies for small changes in the environment to lead to large shifts between stable equilibria has potential implications for the wider issue of choosing between tax and regulatory approaches that are discussed in Keen (2011b). For present purposes, however, we set these difficulties aside and take the second order condition to be satisfied, in which case (14) is easily seen to define the privately optimal capital ratio as a decreasing function $k(\tau)$ of the rate of bank taxation. Substituting this into (8) then gives maximized profits $\pi[k(\tau),\tau]$.

30 This requires negativity of

$$\pi_{kk} = -\Psi\delta + 2\left(\frac{1}{k}\right)^3 E[r-\zeta] + \mu S_{kk} - \tau 2\left(\frac{1}{k}\right)^3$$

where $\Psi \equiv \phi'(R_k)^2 + \phi R_{kk}$. It is reasonable to suppose the density of returns to be increasing in the low tail associated with failure, and the intuitively plausible assumption that $R_{kk} \geq 0$ then ensures that $\Omega > 0$. The second order condition can be satisfied, however, only if the effects through this and the tax-related term are strong enough to outweigh two others. The first of these reflects the mechanical feature that increasing the capital ratio requires a smaller reduction in profitable loans the higher is the initial ratio. The second reflects the likely convexity of the bailout subsidy discussed above.

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3. Optimal Corrective Taxation with a Representative Bank

One of the two externalities highlighted in the introduction – the bailout externality – is directly present in the bank's optimization problem, it is time now to introduce the other.

3.1. The Collapse Externality

Failure of the bank is assumed to generate wider social costs, additional to the cost δK borne by owners and the fiscal cost S. These arise, however, only to the extent that its creditors are not bailed out, reflecting the common rationale for bailout as a circuit breaker, forestalling the operation of external effects from a bank's failure that trigger wider failures and damage to the real economy.[31] The protection of creditors of AIG, Bear Sterns and RBS, for example, reflected fear of the wider fallout from their collapse; the collapse of Lehman, on the other hand, was an instance of the damage that unmitigated failure of a systemically important institution can cause. As noted in the Introduction, the mechanisms by which the distress and failure of financial institutions give rise to these wider social costs of collapse are many and diverse, Here, however, we simply take the social harm from unmitigated bank failure to be of the form $(1-\mu)\Delta K$, with the magnitude of the *collapse externality* $\Delta \geq 0$ taken as exogenous. While a complete treatment would model these costs explicitly, this would add another level of complexity; the simpler approach here of taking the social cost of the externality as parametric – also taken by Acharya et al (2016) – has the merit of clarity and sharpness.[32]

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3.2. The Optimal Tax on Bank Borrowing

The government, we assume, attaches full weight to the costs incurred by owners in the event of failure. It also faces costs of $\lambda \geq 0$ in raising the revenue needed to finance any bailouts, reflecting not only deadweight losses in the wider tax system but also perhaps a lesser social value of transfers to bank creditors than of transfers from general taxpayers. Again normalizing relative

31 In practice, the decision to bail out an institution may of course reflect considerations other than the avoidance of wider social damage, such as regulatory capture, the impact of lobbying or the view of large financial institutions as 'national resources': see for instance Shull (2010).

32 Proportionality in K is readily relaxed: the possibility, perhaps more plausible, that social costs are proportional to the volume of loans or of deposits, for instance, can be encompassed in the more general supposition that collapse costs (per unit of equity) are of the form $\Lambda(k)$, with $\Delta'(k) < 0$.

to equity, the government thus evaluates policy by the objective function

$$w(k,\tau,\mu) \equiv \pi(k,\tau,\mu) - \Phi(R(k,\mu))(1-\mu)\Delta - (1+\lambda)\mu S(k,\mu) + \tau\left(\frac{1}{k}-1\right), \quad (15)$$

so adjusting the private after-tax profits of the bank by taking account of the revenue it receives from the bank tax and the impact of the two externalities at work: the collapse externality, and the fiscal cost associated with the bailout externality.[33]

Differentiating in (15) with respect to τ, taking account of the impact k_τ on the bank's choice of capital ratio (and the envelope property $\pi_k = 0$) gives

$$\frac{dw}{d\tau} = -\left((1-\mu)\Delta\phi(R)R_k + (1+\lambda)\mu S_k + \tau\left(\frac{1}{k}\right)^2\right)k_\tau. \quad (16)$$

Hence, since $k_\tau < 0$:

Proposition 1 The optimal tax on bank borrowing is characterized by

$$\tau = (1-\mu)\tau_C + \mu\tau_B \geq 0, \quad (17)$$

where

$$\tau_C \equiv -\Delta\phi(R)R_k k^2 > 0 \quad (18)$$

$$\tau_B \equiv -(1+\lambda)S_k k^2 > 0. \quad (19)$$

The optimal tax is thus a very straightforward weighted average of two corrective terms, each addressed to one of the possible consequences of failure identified above, the weights reflecting the likelihood of bail out. Each reflects an element of social gain from an increase in the capital ratio (with the multiplication by k^2 translating this into a tax on leverage).[34]

The first component in Proposition 1, τ_C, is addressed to the collapse externality, with each small increase in the capital ratio induced by the tax reducing the probability of collapse by $-\phi(R)R_k$. Strict negativity of R_k ensures that this component is strictly positive.

The second component, τ_B, counteracts the bank's incentive to increase the bailout subsidy by setting a lower capital ratio than it otherwise would, an aspect of corrective policy stressed, for example, in the informal treatments of Weder di Mauro (2010) and Kocherlakota (2010). From (11), this term too is

33 There is, it should be noted, an element of schizophrenia here, if λ is to be interpreted as to some degree reflecting the deadweight loss of the wider tax system. For then revenue from the bank tax, τb, should also be weighted by λ in (15). Allowing for this would simply introduce a revenue-raising motive for the bank tax, which seems a second-order concern for present purposes relative to the fiscal challenges often posed by bank bail outs.

34 Recall that $b = 1/(1-k)$.

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strictly positive. Its magnitude depends, however, on the extent of deadweight loss (or distributional angst) associate with financing the bailout: the greater this is, the higher, as one would expect, is the optimal tax on bank borrowing.

In their Proposition 1, Acharya et al. (2016) arrive, within a different setting, at a similar optimal tax formula that also comprises two additive components. One, corresponding roughly to τ_B, relates to the cost of government guarantees and is seen as related to idiosyncratic risk. The second, closer to the collapse component τ_C, relates the externalities associated with systemic failure arising from capital shortfall across the entire financial sector to the expected shortfall of the institution conditional on such system-wide shortfall: the institution's 'systemic expected shortfall (SES). The central focus in Acharya et al. (2016) is then on the empirical exploration of the determinants of SES. Here, however, we pursue further the public finance perspective, exploring the tax design and other implications (including for bailout policy) of, and to that end extend, the simpler but more direct characterization established above.

One clear public finance concern is with the revenue raised by the optimal corrective tax. A common rationale offered for the bank levies introduced in the wake of the financial crisis,[35] as noted at the outset, was to meet the fiscal costs of dealing with bank failures. While this is a conceptually quite different rationale from the Pigovian objective of changing behavior that is the main concern here, it is thus of interest that (the proof being in appendix 7.1):

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Proposition 2 The revenue raised by the component τ_B of the optimal tax on bank borrowing is at least as great as the fiscal cost of bailout, μS.

Put differently, the optimal corrective tax to address the bailout externality is higher than that needed for an insurance-type charge to meet the expected fiscal cost of bailout. Intuitively, this follows from the likely convexity of S in k noted above (though that is not required for the result): the marginal damage from reducing the capital ratio exceeds the average damage.

It is natural too to wonder how large the optimal corrective described in Proposition 1 might be. Some rough calculations[36] can give a sense of possible orders of magnitude of each of its two components.

Consider first the optimal tax on borrowing to address the collapse externality. Estimates of the probability of crisis $\Phi[R(k,\mu)]$ (reviewed in Annex 2 of BCBS (2010)) suggest it to be strongly convex in the capital ratio. Thus $-\phi(R(k,\mu))R_k(k,\mu) \geq \Phi(R(k,\mu))/(1-k)$, and so a lower bound on the

35 And now reflected in the structure of the EU's SRF.
36 What follows are not, it should be stressed, simulations.

corrective tax related to the collapse externality is given by[37]

$$\tau_C \geq \left(\frac{\overline{\Delta}\Phi(R(k,\mu))k^2}{\overline{K}(1-k)} \right) \tag{20}$$

where $\overline{K} \equiv K/GDP$ and $\overline{\Delta} \equiv \Delta/GDP$ denote respectively bank capital and collapse costs in percent of GDP. For the U.K., which has a large banking sector, bank capital is around 10 percent of GDP; and reasonable figures for cumulative output loss from systemic collapse might be, recalling the discussion above, between 63 and 100 percent of GDP. For the five largest banks in the United Kingdom, BCBS (2010) reports estimated (annual) probabilities of failure $\Phi(k)$ at various capital ratios (calculated using a Bank of England model). These are shown in the first two rows of Table 1. Using these values, the third and fourth rows of Table 1 report the implied upper bound on τ_C at different capital ratios and for the two alternative collapse costs $\overline{\Delta}$.

Two features stand out. The first is that the (lower bound on the) optimal tax is in some cases quite large, certainly much larger than those generally adopted or envisaged: about 50 basis points in the more extreme of the circumstances shown. In the U.K. for instance, the bank levy was initially levied at 7.5 basis points, and peaked in 2015 at 21 basis points. There is, it should be noted, an important difficulty of interpretation here, in that the model is of a single institution while the collapse cost estimates refer to the wider financial system. For an institution that is indeed systemically important, of course, the distinction is moot. Nevertheless, one might expect losses from isolated failures – to the extent that those can be imagined – to be less than those from the system as a whole. This naturally reduces the optimal tax, though it plausibly remains significant: if damage is only 25 percent of GDP, for instance, it falls to 12 basis points at a capital ratio of 6 percent. The second and still more striking aspect of the results in Table 1 is the very strong variation of the optimal tax with the capital ratio (reflecting that of the probability of crisis): even with potential output costs of 100 percent of GDP, the optimal tax is negligible at a capital ratio of 12 percent. The implication is that the optimal borrowing tax is likely to be highly nonlinear, increasing rapidly as capital ratios fall so low as to markedly increase the likelihood of crisis.

Consider now the corrective taxation in respect of the bailout externality. Taking the extreme case in which $\mu = 1$, an upper bound on the optimal tax on borrowing is shown in appendix 7.2 to be given by[38]

$$\tau_B \leq (1+\lambda)\zeta\Phi(k)k^2. \tag{21}$$

37 Here regarding Φ as a function $\Phi(R(k))$ of k.
38 The error reflects the residual value of the bank's assets in the event of its failure.

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The final two rows of Table 1 tabulate values of this approximation assuming a risk-free interest rate ζ of 3 percent and at two values of the marginal excess cost of raising public revenue λ: the lower of these, at 0.25, reflects common estimates to be found in the literature, while the higher, at unity, would be appropriate if bailouts could be financed by lump sum taxation but – not wholly at odds with the views expressed by many – zero social value was attached to the benefit that bank owners derived from being bailed out.

The implied corrective tax aimed at the bailout externality clearly looks much smaller than that directed at collapse. But it is not trivial, being around the order of magnitude of the initial bank levy in the U.K. It seems hard on these very simple calculations, however, to justify the final value of the U.K. levy without appeal to concerns with bank collapse.

Table 1
Approximating the Optimal Corrective Tax Components

	Capital ratio, k			
	6	8	10	12
Probability of crisis (annual), $\Phi(k)$	12.8	2.6	0.9	0
Collapse externality, $\tau_C\,(\mu=0)$:				
$\Delta = 63$	31	11	5	0
$\Delta = 100$	49	19	9	0
Bailout externality, $\tau_C\,(\mu=1)$:				
$\lambda = 0.25$	6	4	2	0
$\lambda = 1$	9	7	3	0

Note: Tax rates are in basis points, rest in percent. The ratio of bank capital to GDP, $\overline{K}$, is taken to be 10 percent, and the risk-free return, ζ, to be 1.03 (recalling that returns in the analysis are inclusive of return of principal). The reported tax rates are (approximations to) the rates that would be optimal if, given the assumed parameter values, they induced banks to choose the capital ratio indicated.

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4. Optimal Bailout Policy

The question also arises as to the government's optimal bailout policy: the choice, that is, of the extent to which it credibly commits to bail out creditors in the event of bank failure. The banks' owners, of course, always prefer bail out to be as complete as possible, since it enables them to borrow at a lower rate, which reduces the chances of their being wiped out and increases their profits when they are not. This can be seen on differentiating in (8) and using the envelope property $\pi_k = 0$ to find

$$\frac{d\pi}{d\mu} = -\delta\phi R_\mu + (\mu + S_\mu) \geq 0 \tag{22}$$

with non-negativity following from the earlier observations that R is strictly decreasing and μS is strictly increasing in μ. Differentiating in (15), using (14) and again that $\pi_k = 0$, the impact on social welfare of an increased likelihood of bailout is then given by

$$\frac{dw}{d\mu} = -[\delta + (1-\Phi)\Delta]\phi R_\mu + \Delta\Phi - \lambda(S + \mu S_\mu). \tag{23}$$

This is a straightforward trade-off between, on one hand, the benefits that a more extensive bailout brings in reducing expected collapse and bankruptcy costs (by allowing the bank to borrow more cheaply) and, on the other, the expected fiscal cost of bailout. This runs starkly counter to the connotation of bailouts as something uniformly undesirable. Apart from the distortionary (or distributional) costs of financing them, bailouts are simply a transfer that enables a socially desirable expansion of the bank's loan portfolio by providing a guarantee to its creditors and so reducing its borrowing costs. If there are no fiscal costs associated with bailing out ($\lambda = 0$) – unlikely, but an important benchmark – then (23) implies that complete bailout is a first-best instrument for addressing the inefficiencies associated with the possibility of failure – with, of course, an appropriately high tax rate. And even when there is some social cost to financing bailouts, so that $\lambda > 0$, it will generally not be optimal for the government to commit to never bail out.

Summarizing so far:

Proposition 3a If the government can commit, then full bailout ($\mu = 1$) is optimal if $\lambda = 0$. And while it is necessary for less than full bailout to be optimal that $\lambda > 0$, this is not sufficient.

It is perhaps more plausible to suppose, however, that the government cannot credibly commit to its bail out policy, but must decide whether or not to bail out creditors conditional on the realization of r. When this is below the critical level R, its options are to either allow unmitigated failure, resulting in social costs of ΔK, or to bail out, incurring costs of $\lambda(\rho B - rL)$ in raising tax revenue to top up the residual value of assets so as to leave creditors whole. So bailout is ex post optimal if only if

$$r \geq \tilde{R}(k) \equiv \tilde{\rho}(1-k) - \left(\frac{k\Delta}{\lambda}\right). \tag{24}$$

where $\tilde{\rho}$ denotes the rate at which the bank can borrow in these circumstances. The government will thus bailout only if the failure is not too spectacular: when $r < \tilde{R}$, the bank is 'too big to bail'.[39]

39 The practical importance of this possibility is stressed by Demirgüç-Kunt and Huizinga (2013).

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Taking account of the implications for the bank's borrowing rate, which is now determined not by (6) but by

$$\zeta B = \rho(k)\{1-\Phi(\tilde{R})\} + \left(\frac{1}{1-k}\right)\int_{-\infty}^{\tilde{R}} r\phi(r)dr, \tag{25}$$

and proceeding as in deriving (8) above it is straightforward to show that both the payoff to the bank and the objective of the government differ in the no-commitment case only in that μS is replaced by

$$\tilde{S}(k) \equiv \frac{1}{k}\int_{\tilde{R}}^{R} (R-r)\phi(r)dr, \tag{26}$$

where $R(k) = \tilde{\rho}(1-k) > \tilde{R}$. This simply recognizes that the bank is now bailed out only in the more circumscribed circumstances in which the return on its loans is below R but above $\tilde{R}$.

Proceeding as for Proposition 1, the optimal bailout-related corrective tax is in the no-commitment case then given by $-(1+\lambda)\tilde{S}_k k^2$, where from (26)

$$k\tilde{S}_k = -\tilde{S} + R_k\{\Phi(R) - \Phi(\tilde{R})\} - \tilde{R}_k(R-\tilde{R})\phi(\tilde{R}). \tag{27}$$

This is evidently more complex than the analogous expression for the commitment case, equation (11). To see the key difference, recall that in the commitment case an increase in the capital ratio reduces the value of the bailout subsidy by making it less likely that the bank will fail and hence less likely that any bailout will come into play. In the no commitment case, in contrast a higher capital ratio makes it cheaper for the government to bail out creditors, and hence more likely that it will choose to do so – which acts in the direction of the bank's choosing a *higher* capital ratio than otherwise.

This new consideration has a striking implication: the optimal bailout related component τ_B may be strictly negative. That is, the incentive for the bank to lower its borrowing costs by making itself more salvageable could be so strong that the optimal corrective policy is to tax not borrowing, but equity capital. A sufficient condition for this is that $\Phi(R)$ be concave between $\tilde{R}$ and R: not what one would normally suppose, but enough – given too that clearly $\tilde{S}_k < 0$ for sufficiently low $\tilde{R}$ (which effectively takes us back to the commitment case) – to establish that the optional corrective tax in the no commitment case can take either sign. More precisely:

Proposition 3b When the government cannot commit, the optimal bailout-related corrective tax is $-(1+\lambda)\tilde{S}_k k^2$. Its sign is ambiguous, a sufficient condition for it to be strictly negative being that $\Phi(R)$ is concave between $\tilde{R}$ and R.

Proof. See appendix 7.3.

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5. Heterogeneous Banks

The assumption of a representative bank is a reasonable first pass at thinking about either banks that are so systemically important that what happens to them is effectively all that matters or so small that that their impact on others can be ignored. But this is clearly a restrictive view, and this section sets about relaxing it.

5.1. Unconnected Banks

Suppose now that there are two banks, A and B, distinguished by superscripts. They are unconnected in the sense that they do not transact with one another; the returns that they earn on their loans, however, may be correlated. Both are as described in Section II, identical except perhaps in the marginal distributions and realizations of the returns earned on their loans and perhaps in the social damage that their collapse would cause. The joint distribution of the returns on the loans they make is denoted by $\Phi(r^A, r^B)$. Each bank is treated in the same way by the government, so each faces the same optimization problem, which is as above. They may choose different capital ratios because they differ in the distribution of the return on the loans that they make (or, perhaps, in bankruptcy costs).

From the social perspective, however, a range of possibilities now arise as to whether neither bank, both banks, or only one bank fails – which may have quite different external effects. This could arise in terms of both the collapse and the bailout externality. For the latter, it could be that a rising marginal cost of public funds makes it more than twice as expensive to bail out two banks as it is to bail out one. Here, however, we focus on non-linearity in relation to the costs of bank failure. This can be captured by distinguishing between the collapse costs Δ^A and Δ^B associated with failure of only one or other bank and a collapse cost of Δ^{AB} when both fail. The assumption that

$$\Delta^{AB} > \Delta^A + \Delta^B \tag{28}$$

then captures the idea that some additional social cost arises when both banks fail beyond those associated with the isolated failure of each.

Recalling (15), and assuming for simplicity that the extent of bailout μ is the same for isolated and simultaneous failures, the government's maximand is now

$$w = \sum_{i=A,B} \omega^i(k^i) + (1-\mu)\Omega(k^A, k^B) \tag{29}$$

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where, denoting marginal distribution and densities of r^i by Φ^i and ϕ^i,

$$\omega^i(k^i) \equiv \Phi^i(R(k^i,\mu))\delta^i + \int_{-\infty}^{\infty}\left\{r\left(\frac{1}{k_i}\right) - \zeta\left(\frac{1}{k^i}-1\right)\right\}\phi^i dr \\ -\lambda\mu S(k_i,\mu) + \tau\left(\frac{1}{k^i}-1\right) \tag{30}$$

and

$$\Omega(k^A,k^2) \equiv \Delta^A \int_0^{R(k^A)}\int_{R(k^B)}^{\infty}\phi(r^A,r^B)dr^A dr^B \\ + \Delta^B \int_0^{R(k^B)}\int_{R(k^A)}^{\infty}\phi(r^A,r^B)dr^B dr^A \\ + \Delta^{AB}\int_0^{R(k^A)}\int_0^{R(k^B)}\phi(r^A,r^B)dr^B dr^A \tag{31}$$

the three terms of which correspond to failure only of A (which arises when r^A falls short of the critical R^A but r^B exceeds R^B), of B only, and of both banks.

The only change to the government's problem thus arises through the more complex structure of expected collapse costs. To see the implications, note that differentiating in (31) shows the effect on expected collapse costs of a small increase in k_A – which will drive the level of the corrective tax – to be

$$\frac{\partial\Omega}{\partial k^A} = \left\{\Delta^A\int_{R(k^B)}^{\infty}\phi(R(k^A),r^B)dr^B - \Delta^B\int_0^{R(k^B)}\phi(R(k^A),r^B)dr^B \right. \\ \left. +\Delta^{AB}\int_0^{R(k^B)}\phi(R(k^A),r^B)dr^B\right\}R_k^A. \tag{32}$$

The interpretation here is that an increase in A's capital ratio makes it less likely that only A will fail (the first term on the right), and (hence) also less likely that both banks will fail (the third term), but makes it more likely that only B will fail (the second). Rearranging this and denoting by $\Phi^{r^B|r^A}$ the conditional distribution of r^B, it is then straightforward to show, proceeding as in deriving Proposition 1, that:

Proposition 4 With two unconnected banks, the optimal corrective tax on borrowing by bank A is given by $\tau = (1-\mu)\tau_C + \mu\tau_B \geq 0$ where

$$\tau_C \equiv \{\Delta^A + (\Delta^{AB} - \Delta^A - \Delta^B)\Phi^{r^B|r^A}(R^B|R^A)\}\phi^A(R^A)R_k^A(k^A)^2 > 0 \tag{33}$$

while τ_B remains as in (19). That for bank B is symmetric.

Comparing with (18) of Proposition 1, so long as there is some systemic loss from a failure of both banks in the sense of (28) (and there is some probability that B will fail when A is at the cusp of failure) the optimal corrective

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tax on each bank is thus unambiguously greater than it would be if each were the only bank in existence.

This is so, importantly, whatever the joint distribution of banks' returns: the additional tax component is positive, in particular, whether the correlation in the banks' returns is positive or negative. The nature of the correlation does, however, affect the magnitude of this additional component of the corrective tax. With independent returns, it becomes simply $(\Delta^{AB} - \Delta^{A} - \Delta^{B})\Phi^{B}(R^{B})$. A positive covariance between the banks' returns would be expected to increase this component, leading to a greater corrective tax, since bank *B* is then more likely to fail when *A* is on the cusp of failure. If returns are jointly normal distributed, for instance, it can be shown that $\Phi^{r^B|r^A}(R^B|R^A)$ is increasing in their covariance so long as $R^i < E[r^i]$, for $i = A$ and B. In the limit, when the returns of the two banks are perfectly correlated (so that there is no chance of only one failing) the analysis reduces to that of a single bank as above, with each bank optimally taxed at a rate reflecting the social cost Δ^{AB} of their both collapsing.

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5.2. Connected Banks

One key source of systemic importance as the concept emerged from the crisis is that of interconnectedness: the idea that the distress or failure of one institution directly increases the likelihood of distress or failure for others. And one important source of such contagion, analyzed for instance by Allen and Gale (2000), is inter-bank lending.

Imagine then that there are again two banks modeled as in Section II, but now with bank *B* borrowing from bank *A*, but not conversely. Then *B* acquires systemic importance in the sense that its failure, an inability to repay its creditors will make failure of bank *A* more likely. This evidently makes the analysis far more complex, but one likely conclusion seems clear: relative to the characterization of the optimal tax on unconnected banks in Proposition 4, with connected banks the corrective tax on borrowing by the systemic bank *B* in relation to the collapse externality will include an additional term capturing the increase in the likelihood of *A*'s failure conditional on *B*'s failure.

What quickly becomes clear, however, is that there is in this case an additional and potentially important tax instrument to consider, beyond that on bank borrowing in general: one on inter-bank borrowing. Addressing the richer possibilities that thus arise with connected banks is an important but difficult task that is not attempted here.

5.3. Asymmetric Information

The assumption so far has been that the bank and government have the same information on how the banks' capital ratio affects its payoff and the probability of its failure. In practice, banks are likely to have superior information as to their own circumstances that affect these relationships – such as the riskiness of their asset positions, the quality of their managers, and their willingness to accept risk.

To see the possible implications of this for optimal tax policies – and their link with regulatory ones too, it will turn out – suppose now, adopting a stylized version of the model above, that the bank's maximand is of the form $\pi(k,a)$, strictly concave in k, and where a – referred to as 'efficiency' though this is not the only interpretation – is some exogenous characteristic known by the bank but not observed by the policy maker. Greater efficiency leads to higher profits, so $\pi_a > 0$, and this effect is assumed to be stronger at lower levels of the capital ratio (perhaps because of the greater difficulty of monitoring the larger volume of loans this implies): thus, as a single-crossing condition, $\pi_{ka} < 0$. The privately optimal capital ratio for a bank of type a, $\overline{k}(a)$, is thus defined by

$$\pi_k(\overline{k},a) = 0 \tag{34}$$

and is decreasing in a. Social welfare, in contrast, is given by $\pi(k,a) - \theta(k,a)$, where – again following the broad structure of the model above, while shedding its details – the term θ can be thought of as an amalgam of collapse and bailout externalities; it is assumed that $\theta_k < 0$, $\theta_{kk} > 0$ and $\theta_{ka} \geq 0$. The first best capital ratio for type a, implicitly defined by

$$\pi_k(k^*,a) = \theta_k(k^*,a) < 0, \tag{35}$$

is then readily shown to be decreasing in a. Clearly too $k^*(a) > \overline{k}(a)$, so that, as in the simple model of Section II, the privately optimal capital ratio is, for any type, lower than is socially desirable.

Supposing there to be just two possible efficiency types, with $a_1 > a_2$, it follows that the more efficient bank has the lower first best capital ratio: in obvious notation, $k_1^* < k_2^*$. The question is how this allocation can be implemented. Figure 1 illustrates, showing the payoff each type as a function of k.

Importantly, regulation alone – in the form of a minimum capital requirements – cannot implement the first best, because of the self-selection constraints that need to be respected. If regulation takes the form of a minimum capital requirement, this would have to be set at k_1^* in order to place the high efficiency bank at the appropriate capital ratio. But then the low efficiency bank is unrestricted in the neighborhood of its first best k_2^*, where its profits

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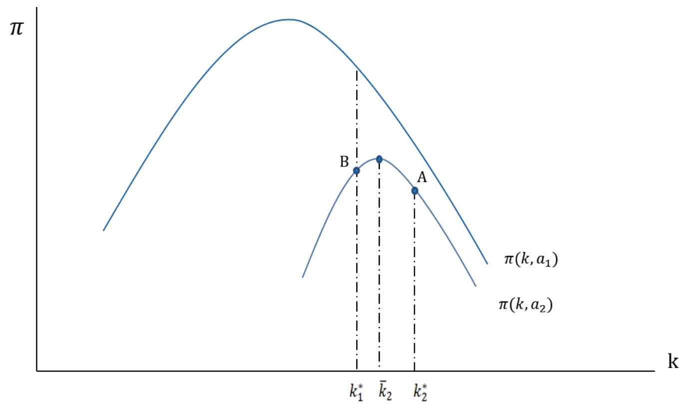
Figure 1
Bank Payoffs with Differing Efficiencies



are strictly decreasing in k, and so will not choose that first-best: as drawn in figure 1, it will instead choose its own private optimum $\overline{k}_2$.

An alternative strategy is to offer banks a choice between capital ratios k_1^* and k_2^*. The difficulty then arises that the less efficient bank may prefer the low capital ratio intended for the more efficient type to that intended for itself:[40] this is the case in figure 1, the payoff to the low efficiency type 2 being higher at point B than at A.

The figure also suggests, however, that the first can be implemented by levying a tax T on any bank choosing the lower capital ratio, intended for the higher efficiency bank, that is high enough to deter the low efficiency from mimicking the high efficiency bank – but not so large as to induce the high efficiency bank to switch to the higher capital ratio that is socially appropriate for the low efficiency bank. This means finding an amount T such that the self-selection constraints

$$\pi(k_2^*, a_2) \geq \pi(k_1^*, a_2) - T \quad (36)$$

$$\pi(k_1^*, a_1) - T \geq \pi(k_2^*, a_1) \quad (37)$$

are both satisfied.[41] That such a T can be found is established in appendix 7.4, giving

40 Note that in the absence of any tax the self-selection constraint will never bite for the high ability bank, since convexity of π in k means that that $\pi(k, a_1)$ is decreasing in k above $\overline{k}_1$, and $k_2^* > k_1^* > \overline{k}_1$.

41 It is assumed that $\pi(k_2^*, a_2) \geq 0$, so that the participation constraint for the low efficiency type is met at its socially optimal capital ratio. It is then straightforward to show that the participation constraint for the more efficient type will also be met if the self-selection constraint (15) is met.

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Proposition 5 The first-best can be implemented by offering banks the choice between (k_1^*, T) and $(k_2^*, 0)$, where

$$T \equiv \max\{\pi(k_1^*, a_2) - \pi((k_2^*, a_2), 0\} \geq 0. \tag{38}$$

Implementation can thus be achieved by offering banks a menu that allows them to choose a capital ratio lower than some norm only on payment of an appropriate tax.[42] This result points too towards an integration of regulatory and tax policies, being equivalent to setting a minimum capital requirement as the norm, with the option of choosing a lower level conditional on payment of tax. (Or, equivalently, to setting a minimum capital ratio but providing an appropriate tax reduction or subsidy to banks choosing a higher ratio). The nonlinear tax schemes to which Proposition 5 thus points are potentially complex – but not obviously any more so than the differentiated capital requirements under Basel III.

6. Concluding

Before the Great Financial Crisis, the presumption of tax policy makers was that banks should be taxed in essentially the same way as all other businesses. The externalities associated with bank failures were something for regulators and supervisory authorities to worry about and take care of. While recalibration of regulatory and supervisory oversight has been a primary policy response to the financial sector externalities so painful during the crisis, the emergence of bank taxes is a marked departure from that prior view of an essentially passive role for taxation. Beyond drawing a general analogy with Pigovian taxes, however, relatively little formal attention was paid to the design of such taxes from an explicitly corrective perspective. The aim in this paper has been to go some way to providing such an analysis.

For the benchmark case of a single representative bank, the analysis here establishes the optimal corrective tax on bank borrowing as a weighted average of two components, with the weights reflecting the probability that collapse will be averted by bailing out creditors. One component addresses the collapse externality (and so is weighted by the probability of collapse). In the case of a representative bank, this takes a simple and predictable form: bank borrowing is taxed at rate equal to the product of the impact of higher leverage on the probability of failure and the social damage that failure would cause. The other component of the optimal corrective tax is addressed to the social costs of guaranteeing bank creditors in order to avoid collapse. This depends not only on the marginal cost of public funds – which shapes the social cost of taxpayer support – but, in more complex ways, or the extent to which the

42 Boyer and Kempf (2017) arrive at a similar result.

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government can credibly commit to such bailout. When the government can commit, the extent of that commitment can itself be seen as a choice variable – and it has been seen here that when the marginal cost of public funds is low, it may indeed be optimal to wholly insure bank creditors. Importantly, given the fee-type rationale sometimes given for bank taxation. the bailout component – mitigating the incentive for the bank to take on excessive risk in the expectation of public support in the event of failure – is optimally set above the insurance-like level that would recoup the expected fiscal cost of future bailouts. When the government cannot commit to its bailout policy, and may lack the resources to bail out creditors in the event of failure, this component of the optimal corrective charge may well be lower, since the bank itself then has an incentive to limit its borrowing so as to make it relatively cheap for the government to bail out its creditors.

Additional considerations arise with heterogenous banks. When banks are not directly connected but differ in the distributions of their returns, then – whatever the correlation between these returns – the optimal corrective tax is higher than in the case of a representative bank so long as there are additional social costs from simultaneous failures. Connectedness through one-way interbank loans, the analysis here also suggests, points to a still higher corrective tax on the depositing bank – an outcome, importantly, that no single-rate bank tax (or uniform capital requirement) can achieve. A similar conclusion emerges from the analysis of asymmetric information, with the optimal policy implemented by offering banks a menu that involves a higher tax charge on those that, being more efficient, wish to operate with a lower capital ratio.

The focus of this paper is in important respects narrow. Technically, there is much that is left open by the analysis here. Inter-connectedness, in particular, raises complex issues of both definition and measurement – as explored, for instance, in Acharya et al. (2016) and Adrian and Brunnermeier (2016) – as well as, potentially, a richer set of tax instruments than the simple charge on bank borrowing considered here. Nor, more fundamentally, has the paper taken up the relative merits of taxation and regulation. Much of the analysis could be interpreted, indeed, in terms of defining optimal capital requirements. What then does emerge, however, is the inadequacy of applying the same capital requirements to heterogeneous banks – and indeed Basel III steps ways from that, with the introduction of supplementary requirements for systemically important institutions. Intellectually at least – and therefore perhaps, at some point, in practical terms too – the question of whether that differentiation is best achieved by tax or regulatory measures (which has hardly been raised, for instance, in the context of inter-connectedness), remains open.

The discussion has been narrow too in terms of practical policy priorities. Given current tax policies, the question of whether Pigovian taxes on bank barrowing are appropriate is very much second order. The first order issue is

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the systemic bias towards debt finance inherent in most corporate tax systems. The Pigovian question is whether borrowing should be penalized. But existing debt bias means that it is now inherently, and very extensively, tax-favored. Bank taxes could in principle be a way to offset that bias in the financial sector. But that would require such taxes to be levied at a much higher rate than observed in practice: at a borrowing rate of 5 percent, for example, undoing the effects of deductibility at a corporate tax rate of 20 percent would require a tax on borrowing of 100 basis points. Recent work suggests that the social costs of this debt bias may well be high: De Mooij et al. (2014), for example, put the gain in expected output from eliminating the debt bias associated a corporate tax rate of 28 percent at up to 12 percent of GDP. It is, at the very least, perverse that regulatory measures designed to discourage excessive bank borrowing are combined with tax systems that do the exact opposite. Dealing with this remains the central challenge in fixing the tax treatment of the financial sector.

7. Appendix

7.1. Proof of Proposition 2

The revenue raised by the component τ_B of the optimal tax on borrowing is $-(1+\lambda)S_k k^2 B$, while the cost of bailout is SK. Since $\lambda \geq 0$ and $B/K = (1-k)/k$, it therefore suffices to show that $-k(1-k)S_k > S$. For this, note from (11) that

$$-k(1-k)S_k = (1-k)S - (1-k)R_k\Phi \tag{39}$$

$$= (1-k)S + R\Phi - (1-k)^2\rho_k\Phi \tag{40}$$

$$= S + \int_{-\infty}^{R} r\phi dr - (1-k)^2\rho_k\Phi > S, \tag{41}$$

where the second equality uses the implication of (4) that $R_k = \rho_k(1-k) - \rho$, and the third follows from (10).

7.2. Derivation of Equation (21)

With $\mu = 1$, (6) implies that $\rho = \zeta$, and so from (9)

$$S = \zeta\Phi[\zeta(1-k)]\left(\frac{1-k}{k}\right) - \left(\frac{1}{k}\right)\int_{-\infty}^{\zeta(1-k)} r\phi(r)dr. \tag{42}$$

Differentiating this with respect to k and canceling terms gives

$$S_k = -\zeta\Phi(R) + \left(\frac{1}{k}\right)^2 \int_{-\infty}^{\zeta(1-k)} r\phi(r)dr \tag{43}$$

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from which, the integral term being non-negative and recalling the definition of τ_C in (19), the inequality in (21) follows.

7.3. Proof of Proposition 3b

Note first that, subtracting and adding $\tilde{R}_k\{\Phi(R)-\Phi(\tilde{R})\}$, (27) can be written as

$$k\tilde{S}_k = -\tilde{S} + (R_k - \tilde{R}_k)\{\Phi(R)-\Phi(\tilde{R})\} + \tilde{R}_k\{\Phi(R) - \Phi(\tilde{R}) - (R-\tilde{R})\phi(\tilde{R})\}. \quad (44)$$

From (26),

$$k\tilde{S} = \int_{\tilde{R}}^{R}(R-\tilde{R})\phi(r) + \int_{\tilde{R}}^{R}(\tilde{R}-r)\phi(r)dr \quad (45)$$

$$= (R-\tilde{R})\{\Phi(R)-\Phi(\tilde{R})\} + \int_{\tilde{R}}^{R}(\tilde{R}-r)\phi(r)dr \quad (46)$$

and hence, since $R-\tilde{R} = k(R_k - \tilde{R}_k)$,

$$-S = -(R_k-\tilde{R}_k)\{\Phi(R)-\Phi(\tilde{R})\} + \left(\frac{1}{k}\right)\int_{\tilde{R}}^{R}(r-\tilde{R})\phi(r)dr. \quad (47)$$

Substituting this into (44) gives

$$k\tilde{S}_k = \tilde{R}_k\{\Phi(R)-\Phi(\tilde{R})-(R-\tilde{R})\phi(\tilde{R})\} + \left(\frac{1}{k}\right)\int_{\tilde{R}}^{R}(r-\tilde{R})\phi(r)dr. \quad (48)$$

Since the final term of the right of (48) is strictly positive for $R > \tilde{R}$ and concavity of Φ over this range implies that $\Phi(R)-\Phi(\tilde{R}) < (R-\tilde{R})\phi(\tilde{R})$, it suffices to show that $\rho_k < 0$ and hence that $\tilde{R}_k < 0$.

For this, dividing by B and differentiating in (25) gives, on canceling terms and rearranging

$$\rho_k = -\left(\frac{1}{(1-\Phi(\tilde{R})(1-k)^2}\right)\int_{-\infty}^{\tilde{R}} r\phi(r)dr < 0 \quad (49)$$

as required.

7.4. Proof of Proposition 5

There are two possibilities.

The first is that $T = \pi(k_1^*, a_2) - \pi(k_2^*, a_2) > 0$. In this case, in the absence of any tax, the self-selection constraint on the low efficiency type would bind:

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so (36) must hold with equality. To see that (37) holds, note that since $k_1^* < k_2^*$ and $\pi_{ka} < 0$,

$$\int_{k_1^*}^{k_2^*} \{\pi_k(k,a_2) - \pi_k(k,a_1)\} dk > 0. \tag{50}$$

Hence

$$\pi(k_2^*, a_2) - \pi(k_1^*, a_2) > \pi(k_2^*, a_1) - \pi(k_1^*, a_1) \tag{51}$$

or

$$-T > \pi(k_2^*, a_1) - \pi(k_1^*, a_1) \tag{52}$$

which gives (37).

The second possibility is that $\pi(k_1^*,a_2) - \pi(k_2^*,a_2) < 0$, and hence $T = 0$. In this case it is immediate that (36) holds. And (37) holds because $k_2^* > k_1^* > \overline{k}_1$ (so that k_2^* is further along the downward-sloping part of $\pi(k,a_1)$ than is k_1^*).

References

Acharya, V., Pedersen, L., Philippon, T., and Richardson, M. (2016), Measuring Systemic Risk, Review of Financial Studies 30, 2–47.

Admati, A., and Hellwig, M. (2013), The Bankers' New Clothes: What's Wrong with Banking and What to Do about It, Princeton University Press, Princeton.

Adrian, T., and Brunnermeier, M. (2016), CoVaR, American Economic Review 106, 1705–1741.

Allen, F., and Gale, D. (2000), Financial Contagion, Journal of Political Economy 106, 1–33.

Bank of England (2009), The Role of Macroprudential Policy, Discussion Paper.

Baker, D., and McArthur, T. (2009), The Value of the "Too Big to Fail" Big Bank Subsidy, Center for Economic and Policy Research, Washington, D.C.

Besley, T., and Ghatak, M. (2013), Bailouts and the Optimal Taxation of Bonus Pay, American Economic Review 103, 163–167.

Bianchi, J., and Mendoza, E. (2010), Overborrowing, Financial Crises and 'Macro-Prudential' Taxes, NBER Working Paper 16091.

Basel Committee on Banking Supervision (2010), An Assessment of the Long-Term Impact of Stronger Capital and Liquidity Requirements, http://www.bis.org/publ/bcbs173.htm (Access Date: 2017-12-09).

Boyer, P. C., and Kempf, H. (2017), Regulatory Arbitrage and the Efficiency of Bank Regulation, Journal of Financial Intermediation, 1–17.

Buch, C. M., Hilberg, B., and Tonzer, L. (2016), Taxing Banks: An Evaluation of the German Bank Levy, Journal of Banking and Finance 72, 52–66.

Claessens, S., Keen, M., and Pazarbasioglu, C. (2010), Financial Sector Taxation: The IMF's Report to the G-20 and Background Material, https://www.imf.org/external/np/seminars/eng/2010/paris/pdf/090110.pdf (Access Date: 2017-12-09).

Coulter, B., Mayer, C., and Vickers, J. (2014), Taxation and Regulation of Banks to Manage Systemic Risk, in: De Mooij, R., and Nicodeme, G. (Eds), Taxation and Regulation of the Financial Sector, MIT Press, Boston, 67–88.

Delivered by Ingenta
? 129.187.254.47 Mon, 20 Aug 2018 11:55:38
Copyright Mohr Siebeck

De Mooij, R., and Keen, M. (2016), Debt, Taxes and Banks, Journal of Money, Credit and Banking 48, 5–33.

De Mooij, R., Keen, M., and Orihara, M. (2014), Taxation, Bank Leverage and Financial Crises, in: De Mooij, R., and Nicodeme, G. (Eds), Taxation and Regulation of the Financial Sector, MIT Press, Boston, 235–260.

Demirgüç-Kunt, A., and Huizinga, H. (2013), Are Banks Too Big to Fail or Too Big to Save? International Evidence from Equity Prices and CDS Spreads, Journal of Banking and Finance 37, 875–894.

Devereux, M. P., Johannesen, N., and Vella, J. (2013), Can Taxes Tame Banks? Evidence from European Bank Levies, Centre for Business Taxation Working Paper no. 1325, Oxford University.

Dewatripont, M., and Tirole, J. (1993), The Prudential Regulation of Banks, MIT Press, Cambridge, MA.

Federal Reserve Bank Of Minneapolis (2016), The Minneapolis Plan to End Too Big To Fail, https://www.minneapolisfed.org/~/media/files/publications/studies/endingtbtf/the-minneapolis-plan/the-minneapolis-plan-to-end-too-big-to-fail-2016.pdf?la=en (Access Date: 2017-12-09).

Haldane, A. (2009), Banking on the State, 12th Annual Federal Reserve of Chicago International Banking Conference, www.bankofengland.co.uk/publications/speeches/2009/speech409.pdf (Access Date: 2017-12-09).

Hellman, T. F., Murdock, K. C., and Stiglitz, J. E. (2000), Liberalization, Moral Hazard in Banking and Prudential Regulation: Are Capital Requirements Enough?, American Economic Review 90, 147–165.

HM Revenue & Customs (2010), Bank Levy, http://www.hmrc.gov.uk/budget-updates/autumn-tax/tiin1065.htm (Access Date: 2017-12-09).

Hemmelgarn, T., and Teichmann, D. (2014), Tax Reforms and the Capital Structure of Banks, International Tax and Public Finance 21, 645–693.

Huang, R., and Ratnovski, L. (2009), The Dark Side of Wholesale Funding, IMF, mimeo.

International Monetary Fund (2010), A Fair and Substantial Contribution by the Financial Sector: Final Report for the G-20, www.imf.org/external/np/g20/pdf/062710b.pdf (Access Date: 2017-12-09).

International Monetary Fund (2014), Back to Work: How Fiscal Policy Can Help, Fiscal Monitor, http://www.imf.org/en/Publications/FM/Issues/2016/12/31/Back-To-Work-How-Fiscal-Policy-Can-Help (Access Date: 2017-12-09).

Jeanne, O., and Korinek, A. (2010), Managing Credit Booms and Busts: A Pigouvian Taxation Approach, Johns Hopkins University, mimeo.

John, K., John, T., and Senbet, L. (1991), Risk-Shifting Incentives of Depository Institutions: A New Perspective on Federal Deposit Insurance Reform, Journal of Banking and Finance 15, 895–915.

Keen, M. (2011a), The Taxation and Regulation of Banks, IMF Working Paper 11/206.

Keen, M. (2011b), Rethinking the Taxation of the Financial Sector, CESifo Economic Studies 57, 1–24.

Keen, M., Krelove, R., and Norregaard, J. (2016), The Financial Activities Tax, Canadian Tax Journal 64, 398–400.

Kocherlakota, N. (2010), Taxing Risk and the Optimal Regulation of Financial Institutions, Economic Policy Paper, Federal Reserve Bank of Minneapolis.

Delivered by Ingenta
? 129.187.254.47 Mon, 20 Aug 2018 11:55:38
Copyright Mohr Siebeck

Korinek, A. (2009), Systemic Risk-Taking: Amplification Effects, Externalities, and Regulatory Responses, University of Maryland, mimeo.

Laeven, L., and Valencia, F. (2016), Systemic Banking Crises Database, IMF Economic Review 61, 55–83.

Levine, R. (2005), Finance and Growth: Theory and Evidence, University of Minnesota, mimeo.

Perotti, E., and Suarez, J. (2009), Liquidity Insurance for Systemic Crises, CEPR Policy Insight 31.

Shackelford, D. A., Shaviro, D., and Slemrod, J. (2010), Taxation and the Financial Sector, National Tax Journal 63, 781–806.

Shavell, S. (2011), Corrective Taxation Versus Liability, American Economic Review: Papers and Proceedings 10, 273–276.

Shin, H. S. (2010), Non-Core Liabilities Tax As a Prudential Tool, policy memo, http://www.princeton.edu/~hsshin/www/NonCoreLiabilitiesTax.pdf (Access Date: 2017-12-09).

Shull, B. (2010), Too Big to Fail in a Financial Crisis, Hunter College, CUNY, Working Paper No. 601.

Sinn, H.-W. (2003), Risk-Taking, Limited Liability, and the Competition of Bank Regulators, FinanzArchiv / Public Finance Analysis 59, 305–329.

Sinn, H.-W. (2010), Casino Capitalism, Oxford University Press, Oxford.

Von Ehrlich, M., and Radulescu, D. (2017), The Taxation of Bonuses and Its Effect on Executive Compensation and Risk-Taking: Evidence from the UK Experience, Journal of Economics & Management Strategy 26, 712–731.

Wagner, W. (2010), In the Quest of Systemic Externalities: A Review of the Literature, CESifo Economic Studies 56, 96–111.

Weder di Mauro, B. (2010), Taxing Systemic Risk: Proposal for a Systemic Risk Charge and a Systemic Risk Fund, University of Mainz, mimeo.

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