Regulator Reputation and Optimal Banking Competition Policy

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Abstract

We consider an economy in which banks increase social welfare by monitoring but where the verifiable part of banking income is stochastic. Banks abstract non-verifiable returns and this can render banking contracts unattractive to investors. The survival of the banking sector is ensured by a regulator who determines the rent, or charter value, which accrues to the holder of a banking license and who sets deposit insurance levels. High charter values encourage bankers to reduce the opacity of their activities and deposit insurance mitigates the effects upon depositors of perquisit consumption. We show that there is a tradeoff between increased charter value and reduced deposit insurance. Moreover, optimal competition levels are a decreasing function of regulator reputation.

The respective retail banking sectors in the United Kingdom and the United States are distinguished by differing levels of competition and of deposit insurance. Deposit insurance in the United Kingdom amounts to £16,000 per depositor while the corresponding figure in the United States is $100,000. The retail banking sector in the United States is characterised by a high number of banks and high competition levels: in the United Kingdom there are fewer banks and lower competition levels, as witnessed by returns on equity for the retail banking sector as high as 30%. The apparent difference in competition levels is the source of a policy debate in the United Kingdom and led to the establishment of a broad review of banking sector services, under the chairmanship of Don Cruickshank. The Cruickshank Committee Report (Cruickshank, 2000) suggests that the regulator should have a primary competition objective, in addition to its existing regulatory activities.

This paper is of relevance in the light of this policy debate. It offers an explanation in terms of differences in regulator screening abilities for inter-jurisdictional differences in competition levels and deposit insurance provision. In our model, capital-constrained banks function as delegated monitors. Banks can achieve superior returns on investments but the proportion of their returns which is verifiable is stochastic. Bankers abstract non-verifiable returns and use them to consume perquisits. Although this does not affect the net social benefits of bank managed investment a sufficiently high level of perquisit consumption may render bank contracts unattractive to depositors who will instead perform non-intermediated investment: this constitutes a social cost.

Some regulation is therefore necessary to protect the interests of depositors and hence to ensure the survival of the banking system – this could take the form of deposit insurance or an increase in bank rent levels, for example via the suppression of competition. The former offers a definite guarantee of safety to depositors while the latter reduces moral hazard problems in the banking sector by raising the value to the banker of his license and hence increasing his incentive to prevent perquisit consumption. We examine the optimal mix of these policies: the paper makes two contributions.

Firstly, we demonstrate that the optimal policy will involve a trade-off between the social costs of the two mechanisms which are available to the regulator. It follows that an increase in U.K. banking sector competition towards the levels of the U.S. should be accompanied by an increase in deposit insurance levels.

Secondly, we show how the optimal mix of regulator policies will depend upon the ability of the regulator to identify unsound banks. In our model bankers are rentiers who take no principal risk. They merely extract an income from the possession of a banking license and may also profit from the abstraction of project returns. Regulators can induce a greater degree of prudence in bankers by threatening to withdraw their licenses. This threat will only be credible if the regulator is able adequately to distinguish between good and bad banker behaviour. Those regulators who enjoy a high reputation for bank supervision will suppress banking competition the furthest and will select a parsimonious level of deposit insurance: the social cost of such a policy for regulators with poor reputations will be excessive and they will opt to reduce the rent on banking licenses and to offer high levels of deposit insurance. Assuming that deposit insurance levels are non-sticky, this suggests that the current regulatory mix in the U.K. is evidence of a highly competent regulator.

In our model, the aggregate price for deposit insurance which enters the regulator's objective function is fair. It is a consequence of informational asymmetries in the economy that fairly priced deposit insurance is not possible at the level of the individual bank. In consequence, moral hazard problems cannot be resolved by charging bankers fair prices for insurance of their deposits. This point is developed further in the conclusion.

The first treatment of banks as delegated monitors was due to Diamond (1984) for whom monitoring was verification of project returns. Diamond also demonstrated that the debt contract is optimal when non-pecuniary penalties are admissible and agents are risk neutral. Our model of monitoring is based upon a role for banks in project selection and management rather than upon the resolution of informational asymmetries which surround project returns: the relationship approach has been previously discussed by Mayer (1988), Sharpe (1990) and Hellwig (1991). Petersen & Rajan (1994) provide evidence of relationship benefits for small borrowers.

In our model the verifiable portion of bank-intermediated project returns is stochastic. Bankers will retain the non-verifiable portion of project returns: this corresponds to the cases where income is spent perquisites such as empire building, excessive bonus payments and so on. Although these activities certainly happen in the banking sector, depositors are typically unable to prove in court that they represent unnecessary expenses: in some emerging economies they have rendered the successful operation of a banking sector virtually impossible. Bankers can exert effort to increase the transparency of their operations by for example investing in superior risk management systems or better auditing procedures but in the absence of regulation they will not choose to do so. We show how the contracting problem which exists between bankers and depositors can be resolved by a regulator who screens banks to reduce the likelihood that they abstract funds.

Our model extends an existing literature on competition and bank regulation. The value associated with a bank license, or *charter value*, has been previously observed (Marcus, 1990) and its erosion in response to increasing levels of competition in the United States has been demonstrated by Keeley (1990). Matutes and Vives (1996, 2000) have examined the effect of bank competition upon portfolio diversification and upon levels of assumed risk, without discussion of charter value or of regulator reputation. The importance of rentier income to a sound banking system has been discussed by Boot & Greenbaum (1993) in a model where low levels of competition encourage prudential monitoring and by Gorton (1995) and Bhattacharya, Boot & Thakor (1998) who suggest that charter value can curb excessive bank risk-taking. Besanko & Thakor (1993) and Petersen &

Rajan (1995) note that heightened competition may diminish the benefits derived from relationship banking. Boot & Thakor (2000) demonstrate that the effects of competition can depend upon its source: interbank competition increases the number of relationship loans but diminishes their value to borrowers while capital market competition has the reverse implication. Welfare effects in their model are ambiguous.

Caminal and Matutes (1997*a*) consider a dual moral hazard problem. Firstly, borrowers faced with a high cost of funds may indulge in asset substitution. Secondly, banks may employ credit rationing rather than perform monitoring. Increasing charter value encourages monitoring but it also raises the cost of funds and hence exacerbates the first problem. When bank moral hazard is greatest, CM demonstrate that competition should be suppressed: note that if this occurs when the regulator is weakest, these results contradict ours. Caminal & Matutes (1997*b*) demonstrate that when competition *is* suppressed, bank portfolios are more concentrated so that they have a greater exposure to macroeconomic shocks.

In our model loan risk is reduced through diversification and charter value acts as an ex ante incentive to good bank management so that the relevance of charter value is determined by the screening competence of the regulator. The importance of regulator reputation has not been discussed in earlier treatments of this topic. In particular, previous discussions of deposit insurance have concentrated upon the associated moral hazard problem without acknowledging the relationship between charter value, deposit insurance and regulator reputation.

The remainder of this paper is organised as follows. Section 1 describes a model of banks as delegated monitors when the verifiable portion of project returns is stochastic and the effort which banks make to reduce opacity is non-verifiable. Section 2 introduces a regulator who is able to set rent levels and deposit insurance policies and section 3 derives his optimal policy. Section 4 contains some concluding remarks which contrast regulation via capital hurdles with imposition of a "fit and proper" requirement for banks and also discusses the difficulties of establishing a fairly priced deposit insurance régime in the presence of asymmetric information. The proofs are contained in the appendix.

1 A Model for Banking with Asymmetric Information

Consider a single period economy. Investors in the economy have an initial endowment of \$1. They are risk neutral and derive utility C from the consumption of C at the end of the period.

Two investment vehicles are available to investors: a bond which will return $\$r > \$1$, and a bank deposit. A bank is an institution which accepts unsecured deposits from investors and then invests them on their behalf in projects. In our model banks have no capital reserves: our substantive results are unaffected if their reserves are fractional. It is a consequence of our capitalisation assumption that bankers do not assume principal risk.

The role of bankers in our model is as delegated monitors. We assume that the banker has information gathering, monitoring and contracting skills which are denied to individual investors. In the absence of monitoring, entrepreneurs will select high risk socially sub-optimal projects. We do not model this process explicitly but we assume that as a consequence of their superior monitoring skills, the return on bank-intermediated projects is $R > r$.

Bankers can earn a return upon their activity in two ways. Firstly, they can earn rent from the possession of a banking license: we refer to this rent as *charter value*. Rent is earned by the legal abstraction of some of the deposits which they receive. This could be achieved through collusive practices when there is little competition in the banking sector; alternatively it could be a consequence of regulatory strictures which disallow the payment of high returns on deposit contracts, as for example in France. We denote by m the total rent which a banker derives from running a bank.

The second source of income which bankers earn is from the abstraction of project returns. We assume that although the total return on bank intermediated projects is R this need not always be verifiable. The verifiable return which bankers earn is either R or $(1-f)\,R$; if it is the latter then we say that the bank is *opaque*. Bankers retain the non-verifiable part Rf of total returns in opaque banks. We call the probability that a bank will be opaque its *opacity*. There are two types of bank: *sound* banks have opacity p and *unsound* banks have opacity $q > p$.

The delegated monitoring activities of banks were modelled by Diamond (1984). In Diamond's paper the return on entrepreneur projects was not observable and banks achieved economies of scale by operating a costly auditing technology on behalf of their depositors. Banks were provided with an incentive truthfully to report the results of their audits by non-pecuniary penalties which were levied in proportion to shortfalls in declared earnings. In our model no enforceable contract can be written upon total project returns and non-pecuniary penalties are therefore legally unenforceable. Moreover, we cannot rely as Diamond does upon the Law of Large Numbers to reduce the deadweight costs of fund abstraction: banks of any size will be subject to this effect.

It is possible for a banker to manage his bank well and thus to reduce its opacity. This will involve such activities as operational and market risk management, improved auditing and investment in computerised reporting systems. The banker can cause his bank to be sound with probability σ at a cost to himself of $e(\sigma)$: we call the probability σ the banker's *effort level*. Bankers are risk neutral: the banker derives utility $v(m,\sigma)$ from charter value m and effort level σ, where

$$v(m,\sigma) = m + Rf\,(q\,(1-\sigma) + p\sigma) - e(\sigma)\,;$$

$e(.)$ is increasing and convex.

The managerial effort of bankers is not directly enforceable and its consequence is simply to adjust the probability with which returns are non-verifiable. It cannot therefore form the basis of an enforceable contract between depositors and bankers. Moreover, banker effort is not affected by the *ex post* division of verifiable returns since fund abstraction is always in their interests so that incentive contracts of the Grossman & Hart (1983) type will be ineffective. The optimal contract will therefore give all of the verifiable returns to the depositors. In the absence of regulatory intervention bankers will have no incentive to exert effort and the bank will be unsound.

Assume that investment in unsound banks is less attractive to investors that investment in the bond market which is in turn less attractive than investment in sound banks:

$$R - qRf < r < R - pRf. \tag{A1}$$

Assumption A1 states that in the absence of any type of regulation there will not be a banking system. Investors will then invest via the bond market and total production will be below the maximum possible level.

Define $b \in (0, 1)$ as follows:

$$b = \frac{R - r}{Rf};$$

b is the highest level of bank opacity which investors will tolerate.

2 Bank Regulation

Bank project management results in superior investment returns and the maintenance of a viable banking system will therefore be welfare-increasing. We therefore introduce a social welfare maximiser whom we call the *regulator* whose role is to ensure the existence of a banking sector. This is accomplished by protecting investor interests to ensure that bank deposits are more attractive to them than bond investments.

No bank can operate without a license issued by the regulator. The regulator can employ one of two strategies: he can offer deposit insurance to protect investors against the losses which arise when bank returns are non-verifiable and he can select the rent m which accrues to the holder of a banking license. We assume that m is bounded above:

$$0 \leq m \leq M \tag{A2}$$

Distribution of deposit insurance takes the form of an ex-post bailout. The regulator announces at the start of the banking contract that he will underwrite bank returns with probability β: we refer to β as the regulator's *insurance policy.*

The regulator's control of m could be effected in several ways: for example, *ceteris paribus* the rent m will be a decreasing function of the number of banks and rent levels can be determined through an explicit competition policy. Alternatively, m could be varied through the use of capital reserve requirements, through the imposition of deposit rate ceilings or via taxation policy.

[Figure 1]

The regulators, the bankers and the investors play the game illustrated in figure 1. At time 0 the regulator announces a bailout policy $\beta \in [0, 1]$ and a rent $m \in [0, M]$ which bankers in the time t economy will extract from their licenses. We assume that there are many potential bankers, each of whom has only one opportunity to apply for a license. One at a time, bankers select their effort level σ and incur a utility cost $e(\sigma)$ in the reduction of opacity. The regulator audits the bank: if it is judged to be sound it is given a banking license. This process is repeated until N licences have been awarded.

In allocating licenses, the regulator will operate an imperfect auditing technology. The auditing technology comprises all of the mechanisms by which a bank's performance may be judged: it includes such items as the disclosure requirements to which the bankers are subject and the regulatory environment in which they operate. The regulator will use the technology to make a judgement about the soundness of the bank: s is the event that the regulator decides that the bank is sound (occupies state S) and u is the event that the regulator decides that the bank is unsound (occupies state U). Licenses will only be awarded to banks which are judged to be sound.

Two types of auditing technology exist: good and bad. Good technology generates the wrong signal with probability $\gamma < \frac{1}{2}$ and bad technology generates the wrong signal with probability $\frac{1}{2}$.

Investors know the policy (m, β); they make their investment decisions after license allocation.

No one, including the regulator, knows which technology is in use: an *ex ante* probability α is assigned that the extant technology is good. We refer to α as the *reputation* of the regulator. It is convenient to define the following quantity:

$$w(\alpha) = \alpha\gamma + \frac{1}{2}(1-\alpha).$$

$w \in \left[\gamma, \frac{1}{2}\right]$ is the unconditional probability that the regulator is wrong: we refer to this term as the *fallibility* of the auditing technology. In other words,

$$P[u|S] = P[s|U] = w.$$

Banking licenses are awarded before investors make their portfolio allocation decisions. The expected utility which a banker derives from effort σ is therefore

$$[m + Rf(p\sigma + q(1-\sigma))](\sigma(1-w) + (1-\sigma)w) - e(\sigma).$$

The banker selects σ to maximise this, subject to the requirement that $\sigma \in [0,1]$. We will shortly parameterise $e(.)$ to ensure that $\sigma \leq 1$ and it follows that the optimum effort level σ satisfies equation 1 with $\sigma \geq 0$ or that $\sigma = 0$:

$$e'(\sigma) = (1-2w)[m + Rf(p\sigma + q(1-\sigma))] - Rf(q-p)(\sigma + w - 2w\sigma) \qquad (1)$$

To determine the optimal investment policy we assume that $e(\sigma)$ has the following quadratic form:

$$e(\sigma) = \frac{1}{2}(E - 2Rf(q-p))\sigma^2. \qquad \text{(A3)}$$

Equation 1 then yields the following expression for $\sigma(m,w)$:

$$\sigma(m,w) = \max\left(\frac{(1-2w)\,m + Rf\,(q\,(1-3w)+pw)}{E-4Rfw\,(q-p)},0\right). \tag{2}$$

Proposition 1 demonstrates that the comparative statics of $\sigma(w,m)$ are affected by regulation in a sensible fashion. To derive it we impose some assumptions upon our parameters.

Firstly, we require the difference between sound and unsound banks to be bounded above:

$$Rf\,(q-p) < \frac{1}{2}. \tag{A4}$$

Secondly, we require E to be bounded below:

$$E \geq \max\left(1,(1-2\gamma)\,M + Rf\,(q\,(1+\gamma)-3p\gamma)\right). \tag{A5}$$

Note that assumptions A4 and A5 together ensure that $e(\sigma)$ and the denominator of equation 2 are both positive. Finally, we require γ to be bounded below:

$$\gamma > \frac{q}{3q-p}. \tag{A6}$$

Proposition 1 *The effort level $\sigma(m,w)$ satisfies:*

1. $\sigma(M,\gamma) \leq 1$; $\sigma(m,0.5) = 0$; $\sigma(0,w) = 0$.
2. $\frac{\partial\sigma}{\partial w} < 0$; $\frac{\partial\sigma}{\partial m} > 0$; $\frac{\partial^2\sigma}{\partial m\partial w} < 0$; $\frac{\partial^2\sigma}{\partial w^2} < 0$; $\frac{\partial^2\sigma}{\partial m^2} = 0$.

Bankers in our model compete in a tournament for banking licenses. Proposition 1 demonstrates that they will increase their effort when the probability of being recognised for doing so increases and when the reward for success increases.

Consider a bank which has been awarded a license. Conditional upon an effort level σ by bankers, the investors will assess respective probabilities p_S and p_U that it is sound (of type S) and unsound (of type U) as follows:

$$\begin{aligned} p_S &= P[S|s] = \frac{P[s|S]\,P[S]}{P[s|S]\,P[S]+P[s|U]\,P[U]} = \frac{(1-w)\,\sigma}{(1-w)\,\sigma + w\,(1-\sigma)}; \\ p_U &= P[U|s] = \frac{w\,(1-\sigma)}{(1-w)\,\sigma + w\,(1-\sigma)}. \end{aligned}$$

When the regulator has a fallibility level w the opacity of a randomly selected bank is given by

$$\begin{aligned}\phi(m,w) &\equiv p_S p + p_U q \\ &= \frac{\sigma p - w\sigma(p+q) + wq}{w+\sigma-2w\sigma}.\end{aligned} \tag{3}$$

Proposition 2 *Bank opacity is increasing in the fallibility of the auditing technology and is decreasing in the rent m which accrues to holders of banking licenses:*

$$\frac{\partial \phi}{\partial w} > 0; \ \frac{\partial \phi}{\partial m} < 0.$$

At each time t in the game the regulator attempts to maximise the utility which accrues to the participants in the time t economy. If the policy (m, β) generates a total output $h(m, \beta, w) \in \{r, R\}$ per investor when the regulator's fallibility is w then it will yield a social utility of

$$h(m, \beta, w) - g(\eta m + Rf\phi(m, w)).$$

$h(.)$ represents the total production in the economy: the regulator is assumed to be unconcerned about questions of distribution. $Rf\phi(m, w)$ is the cost per investor of bailouts and η is a constant which reflects the relative importance of rents and bailouts in the social cost function. $g(.)$ is an increasing convex function. Observe that the total social cost of insurance is fairly priced in the regulator's objective function: we discuss the implications of this in the conclusion. In section 3 we determine optimal regulatory policy.

3 Policy Selection

In this section we derive the regulator's optimal policy (m^*, β^*). It is first necessary to derive the form of the function $h(m, \beta, \alpha)$. Given policy (m, β) and fallibility w, output per investor will be R precisely when the expected return

$$(1 - \phi(m, w)(1-\beta))R + \phi(m, w)(1-\beta)R(1-f) = R - Rf\phi(m, w)(1-\beta)$$

from a bank deposit exceeds the return r from a bond market investment: equivalently, when $\phi(m,w)(1-\beta) \leq b$. $h(m,\beta,w)$ is therefore given by

$$h(m,\beta,w) \equiv \begin{cases} R, & \text{if } \phi(m,w)(1-\beta) < b \\ r, & \text{if } \phi(m,w)(1-\beta) \geq b \end{cases}.$$

Let $\bar{m}(w)$ and $\bar{\beta}(w)$ solve the following problem:

$$\min_{m,\beta} \{Rf\phi(m,w)\beta + \eta m\} \text{ subject to } \phi(m,w)(1-\beta) \leq b. \tag{4}$$

Write $C(w)$ for $Rf\phi(\bar{m},w)\bar{\beta} + \eta\bar{m}$: $g(C(w))$ is the minimum social cost which ensures a return R. The regulator will incur cost $g(C(w))$ provided that the net social return from doing so exceeds r. In other words, the policy (m^*,β^*) will be adopted, where

$$(m^*,\beta^*) = \begin{cases} (\bar{m},\bar{\beta}), & \text{if } R - g(C(w)) \geq r; \\ (0,0), & \text{otherwise.} \end{cases}$$

The Lagrangian for problem 4 is

$$L(m,\beta;w) = Rf\phi(m,w) + \eta m + \lambda(b - \phi(m,w)(1-\beta)).$$

The first order conditions are

$$b \geq \phi(m,w)(1-\beta), \ \lambda \leq 0; \tag{5}$$

$$Rf\phi(m,w) + \lambda\phi(m,w) \geq 0, \ \beta \geq 0; \tag{6}$$

$$Rf\phi_m(m,w)\beta + \eta - \lambda(1-\beta)\phi_m(m,w) \geq 0, \ m \geq 0, \tag{7}$$

where each pair of conditions holds with complementary slackness. Call a solution *interior* if $\beta > 0$ and $m > 0$.

Lemma 3 *At interior solutions to problem 4 the inequality constraints bind:*

$$\lambda = -Rf \text{ and } \phi_m = -\frac{\eta}{Rf}.$$

Proof. If $\beta > 0$ then equation 6 implies that $\lambda = -Rf$. It follows immediately from the complementary slackness condition in equation 5 that $b = \phi(m, w)(1 - \beta)$. If $m > 0$ then equation 7 with $\lambda = -Rf$ implies $\phi_m = -\frac{\eta}{Rf}$. ∎

Proposition 4 *The cost of ensuring a return of R at interior points is decreasing in regulator reputation:*

$$\frac{dC}{d\alpha} < 0.$$

We next examine the relationship between regulator fallibility, bank rents and deposit insurance. Firstly, we regard the deposit insurance policy β as exogenous – for example, it may be set for political rather than economic reasons. $\bar{m}$ is then a function of β and α. In this case for a given reputation α there is a trade-off between rent levels and deposit insurance.

Proposition 5 *When β is a choice variable of the minimisation problem 4 optimal rent levels are decreasing in the level of deposit insurance offered:*

$$\frac{\partial \bar{m}}{\partial \beta} < 0.$$

As we noted in the introduction, this result may explain observed differences between the banking sectors in the United States and the United Kingdom. In the former country deposit insurance levels are relatively high; in the latter they are lower. If these policies are hard to change, proposition 5 suggests that the regulator in the United States will encourage a high level of competition while competition in the United Kingdom should be less intense. This is precisely what we observe in practice.

We now examine the variation of the optimal levels of m and β with w (equivalently, with α). We require firstly the following technical result:

Proposition 6 *Bank opacity ϕ has the following higher order properties:*

1. $\phi_{mm} > 0$;

2. *There exists* $m^* \in (0, M)$ *such that:*

   (a) *If* $m \leq m^*$ *then* $\phi_{mw}(m, w) > 0$;

   (b) *If* $m > m^*$ *then there exists* $\gamma^*(m) \in \left(\gamma, \frac{1}{2}\right)$ *such that:*

      i. $\phi_{mw}(m, w) \begin{cases} < 0, & \text{if } w < \gamma^*(m) \\ = 0, & \text{if } w = \gamma^*(m) \\ > 0, & \text{if } w > \gamma^*(m) \end{cases}$

      ii. γ^* *is an increasing function of* m.

We are now in a position to examine the comparative statics $\bar{m}(w)$, $\bar{\beta}(w)$.

Proposition 7 *Interior solutions are not possible when condition 8 is satisfied.*

$$\eta < Rf(q-p)\frac{1-\gamma}{\gamma}\frac{1-2\gamma}{E-4Rf\gamma} \tag{8}$$

When 8 is not satisfied:

1. *There exists* w^* *such that interior solutions are possible if* $w = w^*$ *and are impossible for* $w > w^*$;

2. *If* $\eta \leq -Rf\phi_m(M, \gamma)$ *then there exists* w^M *such that:*

   (a) *For* $w^M \in \left(w^M, w^*\right)$ *the optimal rent level is increasing in reputation;*

   (b) *For* $w \leq w^M$ *the optimal rent level is constant at* M;

3. *If* $\eta > -Rf\phi_m(M, \gamma)$ *then*

   (a) *If* $\eta \geq -Rf\phi_m(m^*, \gamma)$ *then the optimal rent level is increasing in reputation for* $w \in (\gamma, w^*)$;

   (b) *If* $\eta < -Rf\phi_m(m^*, \gamma)$ *then there exist* $w_1 \leq w_2$ *such that:*

      i. *The optimal rent level is increasing in reputation for* $w \in (w_2, w^*)$;

      ii. *The optimal rent level is decreasing in reputation for* $w \in (\gamma, w_1)$;

iii. *If $w_1 < w_2$ then the optimal rent level is constant at M for $w \in [w_1, w_2]$;*

iv. *$w_1 = w_2$ precisely when for every $w \in [\gamma, w^*]$, $\eta > -Rf\phi_m(M, w)$;*

4. *Bailout policy is decreasing in regulator reputation at every interior solution w.*

The intuition behind proposition 7 is as follows. Recall that the parameter η reflects the social cost of providing rent to bankers: it may for example reflect inefficiencies which are introduced through the suppression of competition. If condition 8 holds then this cost is so high that rents are never a viable policy tool.

If condition 8 is not satisfied then when regulator fallibility exceeds w^* bankers cannot be sure that high levels of effort will be rewarded and the effectiveness of rent will therefore be insufficient to defray its social costs. For fallibilities which are less than or equal to w^*, regulatory screening activities provide a sufficiently powerful incentive to banker effort to render optimal the provision of some rent.

Reductions in w below w^* increase the potency of the regulator's screening activities and the regulator will initially respond by increasing charter value and reducing the size of the insurance policy which he offers. Every possible solution incorporates a region where this happens.

If at some value w^M the optimal charter value is M with $\bar{m}'\left(w^M\right) < 0$ the regulator would prefer to increase charter value for w above w^M. This will not be possible and so he continues to charge M. This occurs in part 2 of the proposition and also in the region $[w_1, w_2]$ in part 3(b).

If the regulator's reputation becomes very strong (in other words, if γ is low enough) then the regulator's screening activities will be so effective that he can start to *reduce* charter value whilst simultaneously reducing insurance payments. This effect arises in the region $[\gamma, w_1]$ in part 3(b). This could arise in two ways. Firstly, it may occur as the reputation increases sufficiently for policy to emerge from an exterior region in which charter values have been constant at M, as in the previous paragraph. Secondly, it may arise when every solution to the problem is an interior one so that the solution curve $\bar{m}(w)$ has a turning point. In this case $w_1 = w_2$.

If γ is too high for this effect to obtain for any value of w and optimal charter value never reaches M then charter value will simply increase with reputation at every value w: this is what occurs in part 3(a) of the proposition.

[Figure 2]

Figure 2 summarises the results of this section for part 3(b) of the proposition when $w_1 = w_2 \equiv w^R$ so that all solutions are interior ones. It shows a plot of (m, w) space. The dashed line XBY is the locus of $\gamma^*(m)$ along which $\phi_{mw} = 0$. For points South East of this line $\phi_{mw} < 0$ and for points North West of it, $\phi_{mw} > 0$. The arrows show the direction of increasing ϕ_m.

The bold line ABC is the locus of points $\bar{m}(w)$ along which $\phi_m = -\frac{\eta}{Rf}$. For $w > w^*$ this line falls outside the feasible part of (m, w) space which we have drawn. For $w \in [w^R, w^*]$, $\phi_{mw} > 0$ along ABC; lowering w thus reduces ϕ_m and m must be increased to compensate. At B, $\bar{m}(w)$ cuts $\gamma^*(m)$ with $\bar{m}'(w) = 0$ as shown; it follows as in the proof of proposition 7 that at $w^R + dw$, $\bar{m}(\bar{w})$ must be below XBY. In this region $\phi_{mw} < 0$ so that decreasing w will diminish $\bar{m}(w)$, as shown. BC cannot intersect XY because ϕ_m could not then reassume the value $-\frac{\eta}{Rf}$ for higher w, as detailed in the proof.

[Figures 3, 4, 5]

Figures 3, 4 and 5 illustrate cases 2, 3(a) and 3(b) when $w_1 \neq w_2$ respectively. Their interpretation is similar to that of figure 2: in each case the bold line shows the locus of solution points $(\bar{m}(w), w)$ and the dashed line shows the locus of $\gamma^*(m)$.

The result of proposition 7 has further interesting implications for banking regulation in the United Kingdom. If over time it has been possible to modify β as well as m to the optimal level, a forced decrease in m as a consequence of political interference will lead to suboptimal management of the banking system. If the regulator has a fallibility w which is above w^R then the current low level of competition in the United Kingdom is indicative of regulator competence.

4 Conclusion

In this paper we consider the consequences of the assumption that banks increase social welfare by performing monitoring. We argue that an important role of banking regulators is to protect this activity. This contrasts with traditional stories of regulation in which intervention is justified either to protect dispersed and uninformed bank depositors or to counter the effects of banking runs and thus prevent unnecessary and costly premature liquidation of projects. We avoid consideration of liquidity crises by considering single period deposit contracts and we allow depositors to use alternative investment vehicles so that they will desert banks when there is sufficient danger that bankers will abstract funds.

Banks in our model use their monitoring skills to achieve higher returns on investments but the proportion of the returns which is verifiable is stochastic. Banks abstract the non-verifiable project returns. In a free banking system this effect will be *ex post* so severe as to destroy the *ex ante* demand for deposits. Alternative investment vehicles will then be employed and project returns will be reduced. Regulators will act to prevent this from happening, although they are not *per se* concerned with distribution.

Regulators have two policy tools: they can vary the rent which accrues to the holder of a banking license and they can supply deposit insurance. They will combine these to ensure the survival of the banking system at the lowest social cost. Regulators have only one skill: they can screen banks to determine whether or not they are exerting effort to increase the verifiable portion of their returns.

Bankers can only receive a license if they pass a prudential audit by the regulator. If the regulator is skilled at screening then bankers will exert a high level of effort so as to receive a license and hence to earn rent. If the regulator is not competent then bankers will exert no effort to increase the verifiable part of their returns. It follows that the appropriate policy mix is determined by the regulator's perceived ability: the most able regulators will rely more upon bank charter value and will reduce deposit insurance. Less capable regulators will rely upon deposit insurance. Furthermore, for a given level of regulator competence there is a trade-off between deposit insurance and charter value: an exogenously-imposed increase in one is optimally countered by a reduction in the other.

These results have clear policy implications. The first indicates that the appropriate response to improved regulator reputation is a reduction in deposit insurance levels and a simultaneous rise in bank charter value. Charter value could be modified in several ways: for example, deposit interest rate ceilings will increase the rent derived from a bank license. Competition policy can also be used to modify charter value. Our model therefore reaches the counter-intuitive conclusion that banking sector competition should be suppressed in response to improved regulator reputation.

The second of the above results is of more immediate relevance. Political interference in the banking sector may result in an exogenous change in deposit insurance levels or in charter value. For example, the recent government-commissioned Cruickshank Report (Cruickshank, 2000) recommends an imposed increase in United Kingdom banking sector competition. This will reduce the charter value of a U.K. banking license.

The appropriate response to a ruling of this nature is not clear. If existing charter values are an optimal response to current deposit insurance policies then increased levels of competition should be accompanied by an increase in deposit insurance provisions. The counter-argument is that the proposed competition policy will shift charter values to the optimum level. This debate can be resolved in practice only with reference to the specifics: in the U.K. one might search for any preexisting policy on charter values. The absence of such a policy may be an indication of existing inefficiencies.

Appendix

Proof of Proposition 1

For the first part, assumption A5 implies

$$(1-2\gamma)M + Rfq - 3Rfq\gamma + Rf\gamma p \leq E - 4Rfq\gamma + 4Rfp\gamma$$

which implies immediately that $\sigma(\gamma, M) \leq 1$. Assumption A6 implies that $q - \gamma(3q-p) < 0$ whence it follows immediately that $\frac{Rf(q(1-3w)+pw)}{E-4Rfw(q-p)} < 0$ and hence that

$$\sigma(w,0) = \max\left(\frac{Rf(q(1-3w)+pw)}{E-4Rfw(q-p)}, 0\right) = 0.$$

Finally, note that

$$\sigma\left(\frac{1}{2}, m\right) = \max\left(-\frac{1}{2}\frac{Rf(q-p)}{E-2Rf(q-p)}, 0\right) = 0.$$

For the second part, direct differentiation of equation 2 yields the following:

$$\begin{aligned}
\frac{\partial\sigma}{\partial w} &= \frac{-E(2m+3Rfq-Rfp)+4Rf(q-p)(Rfq+m)}{(E-4Rfw(q-p))^2} \\
&\leq \frac{-(2m+3Rfq-Rfp)+2(Rfq+m)}{(E-4Rfw(q-p))^2} \\
&= -\frac{fR(q-p)}{(E-4Rfw(q-p))^2} < 0 \\
\frac{\partial\sigma}{\partial m} &= \frac{1-2w}{E-4Rfw(q-p)} > 0, \text{ and } \frac{\partial^2\sigma}{\partial m^2} = 0. \\
\frac{\partial^2\sigma}{\partial m\partial w} &= -2\frac{E-2Rf(q-p)}{(E-4wRf(q-p))^2} < 0 \\
\frac{\partial^2\sigma}{\partial w^2} &= 8Rf\frac{(q-p)(-2mE-fRE(3q-p)+4fR(q-p)(Rfq+m))}{(E-4Rfw(q-p))^3} \\
&< 8(-2m-fR(3q-p)+2(Rfq+m))Rf\frac{q-p}{(E-4Rfw(q-p))^3}, \\
&\qquad \text{since } E \geq 1 \text{ and } 4fR(q-p) \leq 2 \\
&= -8fR(q-p)Rf\frac{q-p}{(E-4Rfw(q-p))^3} < 0
\end{aligned}$$

Proof of Proposition 2

Direct differentiation of equation 3 yields

$$\begin{aligned}\frac{\partial \phi}{\partial w} &= \frac{-w\sigma_w (1-w)(q-p)+\sigma(1-\sigma)(q-p)}{(w+\sigma-2w\sigma)^2} > 0 \\ \frac{\partial \phi}{\partial m} &= -\sigma_m w \frac{(q-p)(1-w)}{(w+\sigma-2w\sigma)^2} < 0\end{aligned}$$

Proof of Proposition 4

The result is a trivial consequence of the Envelope Theorem:

$$\begin{aligned}\frac{dC}{d\alpha} &= \frac{\partial L}{\partial \alpha}\left(\bar{m},\bar{\beta};\alpha\right) \\ &= Rf\frac{\partial \phi}{\partial \alpha}(\bar{m},\alpha)\,\bar{\beta} - \lambda\left(1-\bar{\beta}\right)\frac{\partial \phi}{\partial \alpha}(\bar{m},\alpha) \\ &= Rf\frac{\partial \phi}{\partial \alpha} < 0.\end{aligned}$$

Proof of Proposition 5

Write $G(m;\beta,w) = \phi(m,w)(1-\beta)$. Then the first order conditions for the minimization problem are

$$\begin{aligned}\frac{\partial C}{\partial m} - \lambda\frac{\partial G}{\partial m} &= 0 \\ G &= b.\end{aligned}$$

Taking total derivatives of both of these yields

$$\begin{pmatrix} \frac{\partial^2 C}{\partial m^2} - \lambda\frac{\partial^2 G}{\partial m^2} & -\frac{\partial G}{\partial m} \\ -\frac{\partial G}{\partial m} & 0 \end{pmatrix} \begin{pmatrix} dm \\ d\lambda \end{pmatrix} = -\begin{pmatrix} \frac{\partial^2 C}{\partial m \partial \beta} - \lambda\frac{\partial^2 G}{\partial m \partial \beta} \\ -\frac{\partial G}{\partial \beta} \end{pmatrix} d\beta,$$

so that

$$\frac{dm}{d\beta} = -\frac{1}{\left(\frac{\partial G}{\partial m}\right)^2}\frac{\partial G}{\partial m}\frac{\partial G}{\partial \beta} = \frac{1}{\left(\frac{\partial G}{\partial m}\right)^2}(1-\beta)\,\phi\frac{\partial \phi}{\partial m} < 0.$$

Proof of Proposition 6

We will require the following lemma:

Lemma 8 *1. If $\phi_{mw} = 0$ then $\phi_{mww} > 0$;*

2. $\phi_{mwm} < 0$.

Proof. Direct differentiation and manipulation yields the following:

$$\phi_{mw} = -\frac{(q-p)}{(w+\sigma-2w\sigma)^3}\left[\sigma_{mw} w(1-w)(w+\sigma-2w\sigma) - \sigma_m\left(w-\sigma-2w\sigma_w(1-2w)(1-w)\right)\right] \quad (9)$$

Note that $\sigma_m = F\sigma_{mw}$,where

$$\begin{aligned} F &= -\frac{1}{2}(1-2w)\frac{E-4Rfw(q-p)}{E-2Rf(q-p)} \\ &\leq -\frac{1}{2}(1-2w), \text{ as } w \leq 0.5. \end{aligned}$$

Substitute for σ_{mw} in equation 9:

$$\phi_{mw} = -\frac{(q-p)\sigma_{mw}}{(w+\sigma-2w\sigma)^3} f(w,\sigma), \quad (10)$$

where

$$f(w,\sigma) = \left(w(1-w)(w+\sigma-2w\sigma) + F\left(-w+\sigma+2w\sigma_w(1-2w)(1-w)\right)\right) \quad (11)$$

It is clear from equation 10 that $\phi_{mw} = 0$ if and only if $f(w,\sigma) = 0$. Differentiate equation 10 with respect to w to obtain

$$\begin{aligned} \phi_{mww} &= D_w\left[-\frac{(q-p)\sigma_{mw}}{(w+\sigma-2w\sigma)^3}\right] f(w,\sigma) - \frac{(q-p)\sigma_{mw}}{(w+\sigma-2w\sigma)^3} D_w[f(w,\sigma)] \\ &= -\frac{(q-p)\sigma_{mw}}{(w+\sigma-2w\sigma)^3} D_w[f(w,\sigma)] \text{ when } \phi_{mw} = 0. \end{aligned}$$

The first part of the lemma is equivalent to the statement that $f_w(w,\sigma) > 0$. Differentiating equation 11 yields the following:

$$\begin{aligned} f_w(w,\sigma) &= w(2-3w) - F + \sigma\left(1-6w+6w^2\right) \\ &\quad - \sigma_w(1-2w)(w(w-1+6F)-3F) + 2Fw\sigma_{ww}(1-2w)(1-w) \end{aligned}$$

This is positive provided

$$w(2-3w) - F + \sigma\left(1-6w+6w^2\right) > 0. \tag{12}$$

To show this we firstly derive an upper bound for $\sigma(m,w)$. The proof of proposition 1 yields

$$\begin{aligned} \frac{\partial\sigma}{\partial w} &\leq -\frac{fR(q-p)}{(E-4Rfw(q-p))^2} \\ &\leq -fR(q-p) \text{ when } w = 0. \end{aligned}$$

It follows since $\sigma_{ww} < 0$ that

$$\sigma(m,w) \leq 1 - Rfw(q-p). \tag{13}$$

Since equation 12 can only fail when $1-6w+6w^2 < 0$ a sufficient condition for its satisfaction is its truth when σ takes the maximum value of equation 13 and F assumes its lower bound $-\frac{1}{2}(1-2w)$. In this case the left hand side of equation 12 becomes

$$\begin{aligned} & w(2-3w) - F + \sigma\left(1-6w+6w^2\right) \\ &\geq w(2-3w) + \frac{1-2w}{2} + (1-Rfw(q-p))\left(1-6w+6w^2\right) \\ &= -5w + 3w^2 + \frac{3}{2} - Rfw(q-p)\left(1-6w+6w^2\right) \\ &\geq -5w + 3w^2 + \frac{3}{2} - \frac{1}{2}\left(1-6w+6w^2\right) \\ &= 1-2w \geq 0, \end{aligned}$$

as required so that the first part of the lemma is proved.

For the second part, differentiate equation 9 with respect to m to show that ϕ_{mmw} has the same sign as

$$\begin{aligned}&-\left[-\sigma_m\left(w\left(3w-2\right)+\sigma\left(1-2w\right)\right)\right.\\&\quad\left.-2\sigma_{mw}w\left(1-w\right)\left(1-2w\right)\left(w+\sigma-2w\sigma\right)+3w\left(\sigma_m\right)^2\left(1-w\right)\left(1-2w\right)^2\right]\end{aligned}$$

The second and third terms in this expression are positive so the result is proved if $w\left(3w-2\right)+\sigma\left(m,w\right)\left(1-2w\right)<0$. This is certainly the case if $w\left(3w-2\right)+\left(1-2w\right)<0$. The roots of this equation are $w=\frac{1}{3}$ and $w=1$. Assumption A6 gives us

$$w\geq\frac{q}{3q-p}>\frac{q}{3q}=\frac{1}{3}.$$

It follows that $w\in\left(\frac{1}{3},\frac{1}{2}\right)$ and hence that $\phi_{mmw}<0$ as required. ■

The first part of the proposition follows by direct differentiation:

$$\begin{aligned}\phi_{mm}&=w\left(q-p\right)\left(1-w\right)\frac{2\left(\sigma_m\right)^2\left(1-2w\right)-\sigma_{mm}\left(w+\sigma-2w\sigma\right)}{\left(w+\sigma-2w\sigma\right)^3}\\&=w\left(q-p\right)\left(1-w\right)\frac{2\left(\sigma_m\right)^2\left(1-2w\right)}{\left(w+\sigma-2w\sigma\right)^3}>0,\end{aligned}$$

where the second line follows because $\sigma_{mm}=0$.

For the second part, note that

$$\begin{aligned}\phi_{mw}\left(m,0\right)&=-F\left(q-p\right)\frac{\sigma_{mw}}{\left(\sigma\left(m,w\right)\right)^2}<0\\\phi_{mw}\left(m,\frac{1}{2}\right)&=-\left(q-p\right)\sigma_{mw}>0,\end{aligned}$$

where the second equation is a consequence of the fact that $F=0$ when $w=\frac{1}{2}$. It follows that for every $m\in[0,M]$ there is at least one value $\gamma^*\left(m\right)\in\left(0,\frac{1}{2}\right)$ such that $\phi_{mw}\left(m,\gamma^*\left(m\right)\right)=0$. If there was more that one such value then for at least one of them ϕ_{mw} would be decreasing in w. Since by part one lemma 8 ϕ_{mww} is strictly positive at each such value this cannot be the case so that $\gamma^*\left(m\right)$ is a well-defined function.

Suppose now that for some m, $\gamma^*(m+dm) < \gamma^*(m)$. Then

$$\begin{aligned} 0 &= \phi_{mw}(m+dm, \gamma^*(m+dm)) \\ &= \phi_{mmw}(m, \gamma^*(m))\,dm + \phi_{mww}(m, \gamma^*(m))\,(\gamma^*(m+dm) - \gamma^*(m)) \quad (14) \\ &< 0; \end{aligned}$$

since by part two of lemma 8 the first term in equation 14 is negative and by part one of the lemma and by assumption the second term is also negative. This gives us the desired contradiction and it follows that $\gamma^*(m)$ is increasing. m^* is the value at which $\gamma^*(m) = \gamma$.

Proof of Proposition 7

We know

$$\phi_m(0,w) = -\frac{\partial\sigma(0,w)}{\partial m} w \frac{(q-p)(1-w)}{(w+\sigma(0,w) - 2w\sigma(0,w))^2}.$$

Note that $\phi_m(0,0.5) = -(q-p)\frac{\partial\sigma\left(0,\frac{1}{2}\right)}{\partial m} = 0$ and that by part two of proposition 6, $\phi_{mw}(0,w) > 0$. Since $\phi_{mm}(m,w) > 0$ it follows from lemma 3 that interior solutions are not possible when $\phi_m(0,\gamma) > -\frac{\eta}{Rf}$; this reduces to

$$\begin{aligned} \phi_m(0,\gamma) &= -\frac{1-2\gamma}{E - 4Rf\gamma(q-p)}\gamma\frac{(q-p)(1-\gamma)}{(\gamma+\sigma(0,\gamma) - 2\gamma\sigma(0,\gamma))^2} \\ &= -\frac{1-2\gamma}{E - 4Rf\gamma(q-p)}(q-p)\frac{(1-\gamma)}{\gamma}, \text{ since } \sigma = 0 \text{ when } m = 0 \\ &> -\frac{\eta}{Rf}, \end{aligned}$$

which is equivalent to condition 8.

When condition 8 is not satisfied it follows that $\phi_m(0,\gamma) \leq -\frac{\eta}{Rf}$ and hence by part two of proposition 6 that there is a unique $w^* \in \left(\gamma, \frac{1}{2}\right)$ such that $\phi_m(0,w^*) = -\frac{\eta}{Rf}$. Then $\left(0, \frac{\phi(0,w^*)-b}{\phi(0,w^*)}\right)$ is an interior solution to problem 4 when $w = w^*$. This proves the first part of the proposition.

To prove the remainder of the result we require the following lemmas:

Lemma 9 *At interior solutions,* $\operatorname{sign} \bar{m}'(w) = -\operatorname{sign} \phi_{mw}(\bar{m}(w), w)$.

Proof. At any interior solution, differentiation of the first order condition

$$\eta + Rf\phi_m(\bar{m}, w) = 0$$

yields

$$\frac{d\bar{m}}{dw} = -\frac{\phi_{mw}(\bar{m}, w(\bar{m}))}{\phi_{mm}(\bar{m}, w(\bar{m}))}. \tag{15}$$

Since $\phi_{mm} > 0$ it follows that $\frac{d\bar{m}}{dw} < 0$ iff $\phi_{mw} > 0$. ■

Lemma 10 *If* $\phi_{mw}(\bar{m}(w_1), w_1) < 0$ *then there exists* $w_2 > w_1$ *such that* $\bar{m}(w_2) = \bar{m}(w_1)$ *and* $\phi_{mw}(\bar{m}(w_2), w_2) > 0$.

Proof. Note that $w^* > w_1$ and that $0 = \bar{m}(w^*) < \bar{m}(w_1)$. If the result is false then for every $w > w_1$, $\bar{m}(w) < \bar{m}(w_1)$. Since by lemma 9 $\bar{m}'(w_1) > 0$ this is not possible. If $\phi_{mw}(\bar{m}(w_2), w_2) < 0$ then $w_2 < \gamma^*(\bar{m}(w_2))$ and by part b(i) of proposition 6 $\phi_m(\bar{m}(w_1), w_1) > \phi_m(\bar{m}(w_1), w_2)$. Since by definition $\phi_m(\bar{m}(w), w) = -\frac{\eta}{Rf}$ this is a contradiction. ■

Lemma 11 *If* $\phi_{mw}(\bar{m}(w_1), w_1) < 0$ *then for every* $\tilde{w} \in [\gamma, w_1]$, $\phi_{mw}(\bar{m}(\tilde{w}), \tilde{w}) < 0$ *and hence by lemma 9* $\bar{m}'(\tilde{w}) > 0$.

Proof. Assume for a contradiction that for some $\tilde{w} < w_1$, $\phi_{mw}(\bar{m}'(\tilde{w}), \tilde{w}) > 0$. There must be $\tilde{x} \in (\tilde{w}, w_1)$ such that $\phi_{mw}(\bar{m}(\tilde{x}), \tilde{x}) = 0$. By lemma 10 for every $x \in (\tilde{x}, w_1)$ there is w_x for which $\bar{m}(w_x) = \bar{m}(x)$. By continuity of ϕ, there is $w_{\tilde{x}}$ such that $\bar{m}(w_{\tilde{x}}) = \bar{m}(x)$ and since $\bar{m}'(w_x) < 0$ for every $x > \tilde{x}$, $w_{\tilde{x}} \neq \tilde{x}$. Since $\phi_{mw}(\bar{m}(\tilde{x}), \tilde{x}) = 0$, part four of proposition 6 implies that $\phi_m(\bar{m}(\tilde{x}), w_{\tilde{x}}) > \phi_m(\bar{m}(\tilde{x}), \tilde{x})$. But both sides of this expression have value $-\frac{\eta}{Rf}$ which is the desired contradiction. ■

Lemma 12 *Let* $\kappa(w)$ *be the inverse of* $\gamma^*(m)$. *If* $\bar{m}(w^R) = \kappa(w^R)$ *then:*

1. *For every* $w_1 < w^R$, $\phi_{mw}\left(\bar{m}(w_1), w^R\right) < 0$;

2. w^R *is the unique intercept for* $\bar{m}(w)$ *and* $\kappa(w)$.

Proof. We prove both parts simultaneously. Let w^R be the highest value of w where $\bar{m}(w) = \kappa(w)$. For $w > w^R$ we clearly have $w > \gamma^*(\bar{m}(w))$ and hence $\phi_{mw}(\bar{m}(w), w) > 0$ and $\bar{m}'(w) < 0$. By definition $\phi_{mw}\left(\bar{m}\left(w^R\right), w^R\right) = 0$ so that $\bar{m}'\left(w^R\right) = 0$. Since $\gamma^*(m)$ is increasing we must have $\kappa'\left(w^R\right) > 0$ and so $\bar{m}\left(w^R - dw\right) > \kappa\left(w^R - dw\right)$. Since $\gamma^*\left(\bar{m}\left(w^R - dw\right)\right) > w^R - dw$ it follows from part four of proposition 6 that

$$\phi_{mw}\left(\bar{m}\left(w^R - dw\right), w^R - dw\right) < 0, \tag{16}$$

By lemma 11 for every $\tilde{w} < w^R - dw$, $\bar{m}'(\tilde{w}) > 0$, which proves the first part of the proposition. Since $\bar{m}'(w) = 0$ whenever $\bar{m}(w) = \kappa(w)$ w^P must be the unique crossing point. ■

Now suppose that $\eta \leq -Rf\phi_m(M, \gamma)$. Part 1 of proposition 6 then implies that $\bar{m}(\gamma) = M$ and this with lemma 11 implies that no interior solution $(\bar{m}(w), w)$ exists with $\bar{m}(w) > \kappa(w)$. Since for every interior solution $\bar{m}(w) < \kappa(w)$, $\bar{m}(w)$ must intercept $m = M$ above $\gamma^*(M)$, at w^M. For $w < w^M$, $\bar{m}(w) = M$ and for $w < w^M$, $\bar{m}'(w) < 0$. This proves part 2 of the proposition.

Suppose now that $\eta > -Rf\phi_m(M, \gamma)$. Part 1 of proposition 6 then implies that $\bar{m}(\gamma) < M$.

If $\phi_m(m^*, \gamma) \geq -\frac{\eta}{Rf}$ then $m^* \geq \bar{m}(\gamma)$ and it follows from lemma 9 and part two of proposition 6 that $\bar{m}'(\gamma) < 0$. Lemma 11 then implies that $\bar{m}'(w) < 0$ for every $w \in [\gamma, w^*]$ which proves part 3(a) of the proposition.

If $\phi_m(m^*, \gamma) < -\frac{\eta}{Rf}$ then $m^* < \bar{m}(\gamma)$ and it follows from lemma 9 and part two of proposition 6 that $\bar{m}'(\gamma) > 0$. Lemma 10 implies that there is $w_\gamma > \gamma$ such that $\bar{m}(w_\gamma) = \bar{m}(\gamma)$ with $\gamma^*(\bar{m}(w_\gamma)) < w_\gamma$. It follows that either there is a unique w^R for which $\left(\bar{m}\left(w^R\right), w^R\right)$ is an internal solution with $\gamma^*\left(\bar{m}\left(w^R\right)\right) = w^R$ or that there exist $w_1 \leq w_2$ with internal solutions in $[\gamma, w_1]$ and $[w_2, w^*]$ such that $\gamma^* (\bar{m}(w)) < w$ in $[w_2, w^*]$, $\gamma^* (\bar{m}(w)) > w$ in $[\gamma, w_1]$ and $\bar{m}(w) = M$ in $[w_1, w_2]$. The latter effect will obtain precisely when for w in some range $[w_1, w_2]$, we have $\phi_m (M, w) < -\frac{\eta}{Rf}$. This proves part 3(b) of the proposition.

Finally, since equation 5 must bind at the interior solutions (the regulator will never provide the investors with more utility than is necessary to ensure the operation of the banking system), $\beta = \frac{\phi - b}{\phi}$ and $\beta_w = \frac{\phi_w b}{\phi^2} > 0$, so that β is decreasing in auditor reputation. This concludes the proof of the proposition.

References

Besanko, David & Anjan V. Thakor (1993), Relationship banking, deposit insurance and bank portfolio choice, *in* C.P.Mayer & X.Vives, eds, 'Capital Markets and Financial Intermediation', Cambridge University Press, Cambridge, U.K., pp. 292 – 319.

Bhattacharya, Sudipto, Arnoud W. A. Boot & Anjan V. Thakor (1998), 'The economics of bank regulation', *Journal of Money, Credit and Banking* **30**(4), 745 – 770.

Boot, Arnoud W. A. & Anjan V. Thakor (2000), 'Can relationship banking survive competition?', *Journal of Finance* **55**(2), 679 – 713.

Boot, Arnoud W. A. & S. I. Greenbaum (1993), Bank regulation, reputation and rents, *in* C.Mayer & X.Vives, eds, 'Capital Markets and Financial Intermediation', Cambridge University Press, Cambridge.

Caminal, Ramon & Carmen Matutes (1997*a*), Bank solvency, market structure and monitoring incentives, Discussion Paper 1665, CEPR, London.

Caminal, Ramon & Carmen Matutes (1997*b*), Can competition in the credit market be excessive?, Discussion Paper 1725, CEPR, London.

Cruickshank, Don (2000), *Competition in UK Banking: A Report to the Chancellor of the Exchequer*, HM Treasury Stationery Office, London.

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

Gorton, Gary (1995), 'Bank regulation when 'banks' and 'banking' are not the same', *Oxford Review of Economic Policy* **10**(4), 106–119.

Grossman, S. & O. Hart (1983), 'An analysis of the principal -agent problem', *Econometrica* **51**, 7–45.

Hellwig, M. (1991), Banking, financial intermediation and corporate finance, *in* A.Giovanni & C.Mayer, eds, 'European Financial Integration', Cambridge University Press.

Keeley, M. (1990), 'Deposit insurance, risk, and market power in banking', *The American Economic Review* **80**(5), 1183 – 1200.

Marcus, Alan (1990), 'Deregulation and bank financial policy', *Journal of Banking and Finance* **8**, 557–65.

Matutes, Carmen & Xavier Vives (1996), 'Competition for deposits, fragility, and insurance', *Journal of Financial Intermediation* **5**, 184 – 216.

Matutes, Carmen & Xavier Vives (2000), 'Imperfect competition, risk taking, and competition in banking', *European Economic Review* **44**(1), 1–34.

Mayer, Colin P. (1988), 'New issues in corporate finance', *European Economic Review* **32**, 1167–88.

Petersen, Mitchell A. & Raghuram G. Rajan (1994), 'The benefits of lending relationships: Evidence from small business data', *Journal of Finance* **49**(1), 3 – 37.

Petersen, Mitchell A. & Raghuram G. Rajan (1995), 'The effect of credit market competition on lending relationships', *Quarterly Journal of Economics* **110**, 407 – 443.

Sharpe, S.A. (1990), 'Asymmetric information, bank lending and implicit contracts: a stylized model of customer relationships', *Journal of Finance* **45**, 1069–87.

Captions for Figures

Figure 1. Time Line. Each banker has only one chance to apply for a banking license. The probability of winning a license in increasing in the costly effort which is exerted by the banker. The banker's effort is increasing in the charter value of a banking license.

Figure 2. Optimal regulation policies in (m, w) space when all solutions are interior and $\phi_m(\kappa(\gamma), \gamma) < -\frac{\eta}{Rf}$. This illustrates case 3(b) of proposition 7 when $w_1 = w_2 \equiv w^R$. For $w > w^*$ if it is cost effective to ensure the existence of a banking system then rent levels will be zero. For $w \geq w^*$ the regulator will select a rent level m which lies on the line ABC. For $w^* \leq w \leq w^R$ rent levels increase to substitute for deposit insurance as regulator reputation increases. For $w > w^R$ the regulator is so effective that the need for incentives in the form of license rent grows less as his reputation increases.

Figure 3. Optimal regulation policies in (m, w) space when solutions are interior for $w \geq w^M$. This illustrates case 2 of proposition 7. For all fallibility levels below w^M the regulator would prefer to pay more than M. This is not possible so the maximum rent level is supplied.

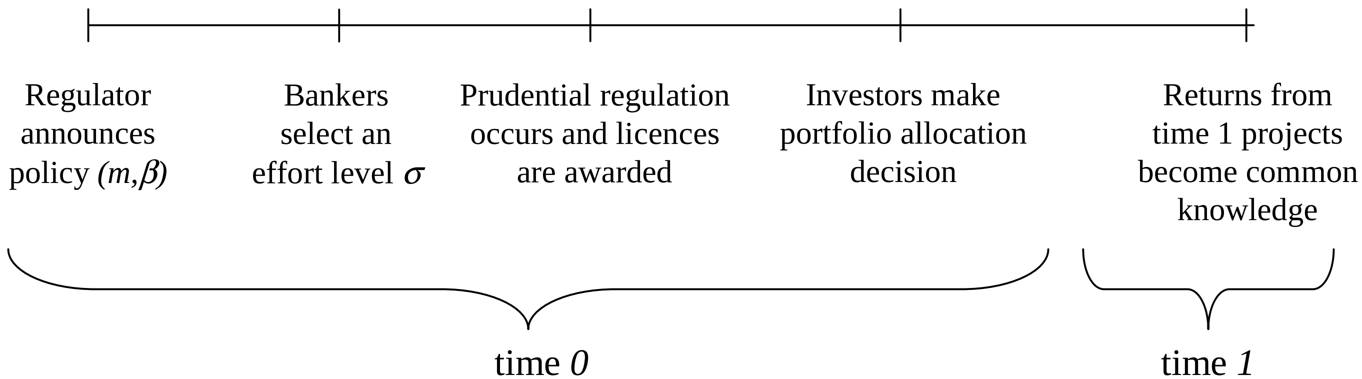
Figure 4. Optimal regulation policies in (m, w) space when all solutions are interior and $\phi_m(\kappa(\gamma), \gamma) \geq -\frac{\eta}{Rf}$. This illustrates case 3(a) of proposition 7. For all fallibility levels in $[\gamma, w^*]$ the regulator will increase rent levels in response to improved reputation. Reputation cannot become so strong that the regulator is able to reduce effort levels.

Figure 5. Optimal regulation policies in (m, w) space when solutions are exterior in a range $[w_1, w_2]$. This illustrates case 3(b) of proposition 7 when $w_1 < w_2$. In $[w_1, w_2]$ the regulator is unable to increase rents to their optimal value and he therefore leaves them at M. In $[\gamma, w_1]$ the regulator's reputation is

so strong that as it improves he reduces rent levels and in $[w_2, w^*]$ the regulator will respond to increased reputation by increasing his reliance upon rents.

Figure 6. Variation of $\alpha_2(m, l)$ with m and l. For fixed m, $\alpha_2(m, l)$ is a decreasing convex function of the number l of bank frauds. $\alpha_2(m, l)$ is increasing in m when l is below its expected value $N\phi(N, m)$ and decreasing otherwise.

Figure 1



Regulator announces policy (m,β)
Bankers select an effort level σ
Prudential regulation occurs and licences are awarded
Investors make portfolio allocation decision
Returns from time 1 projects become common knowledge
time *0*
time *1*

Figure 2

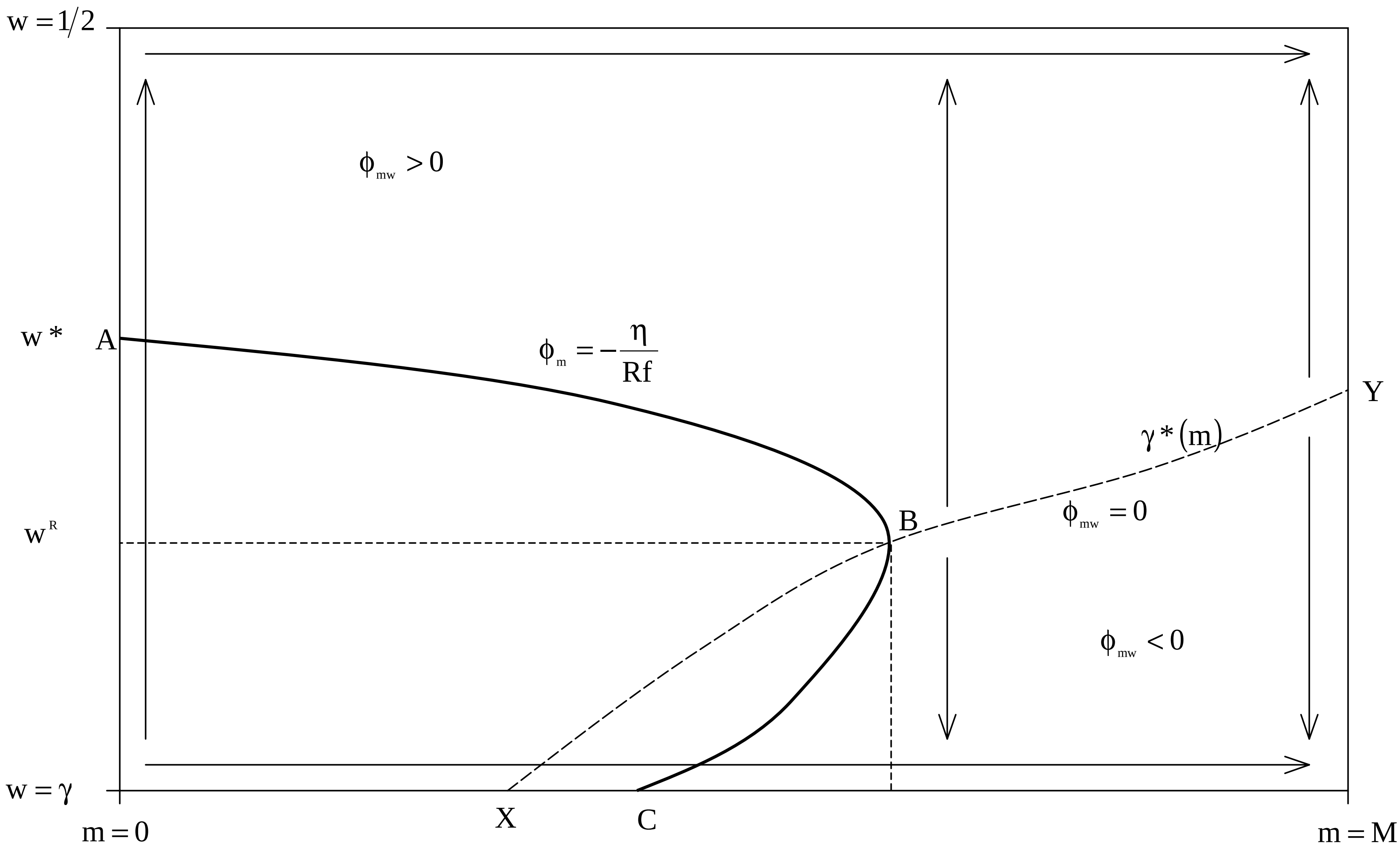
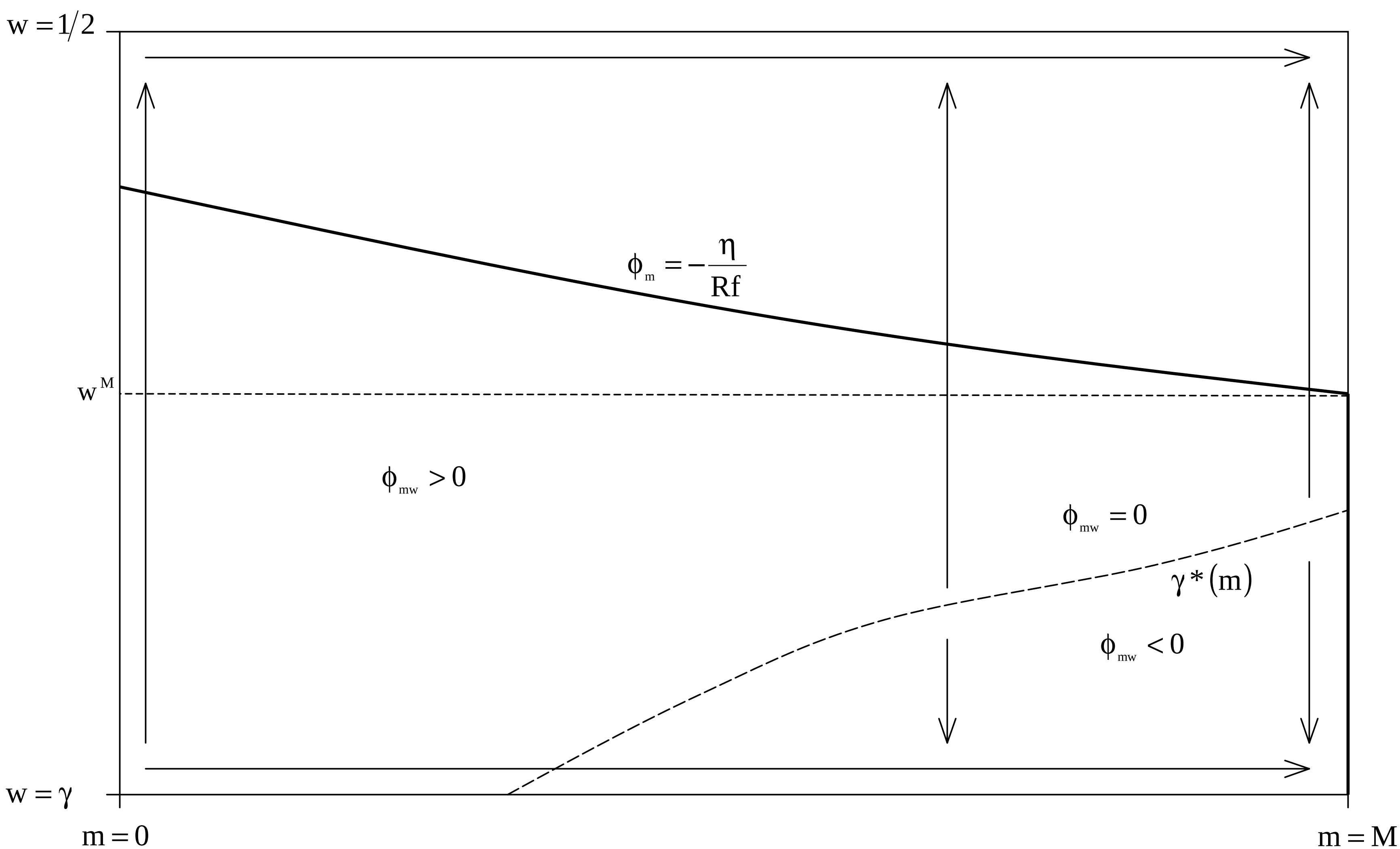
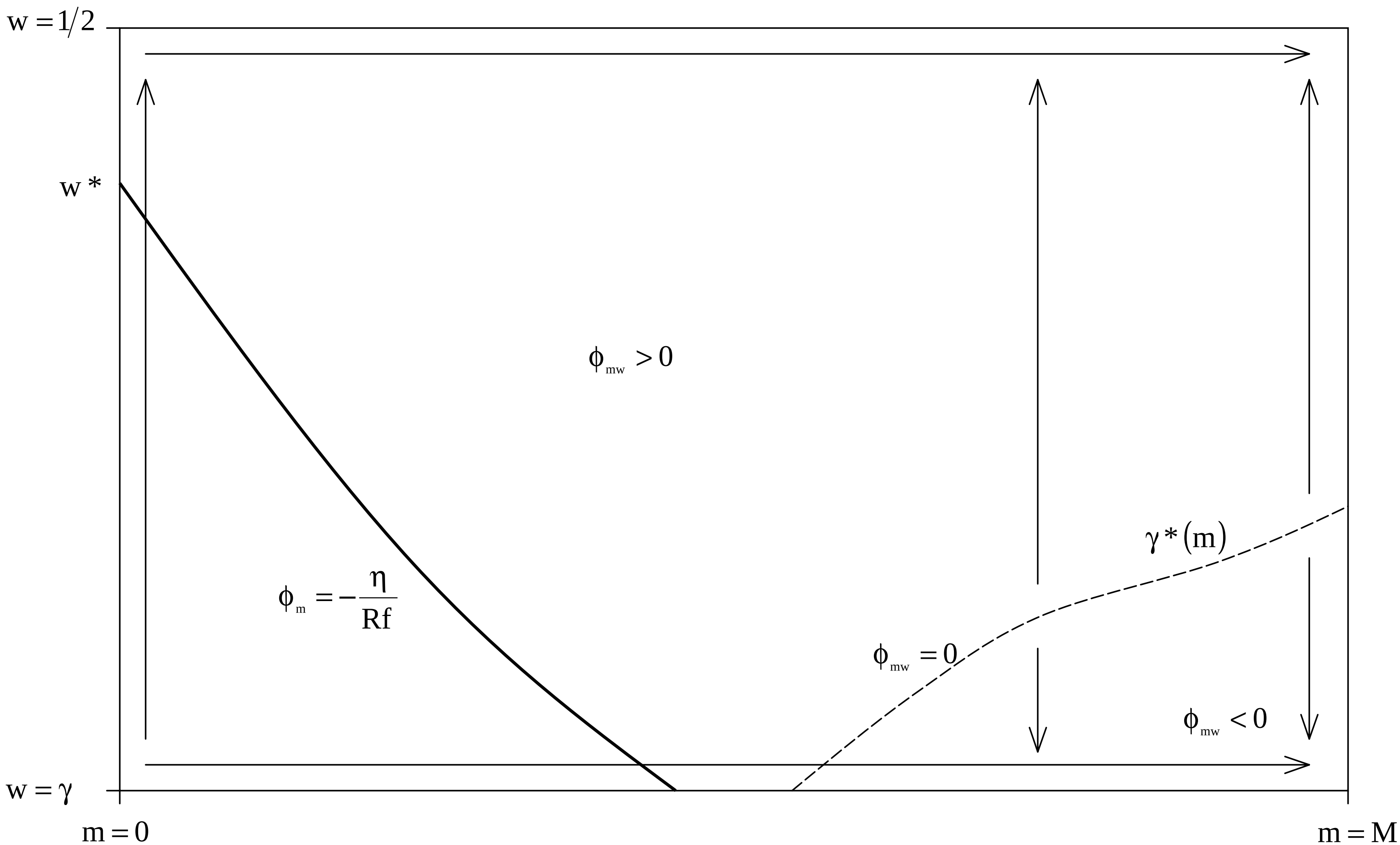


Figure 3



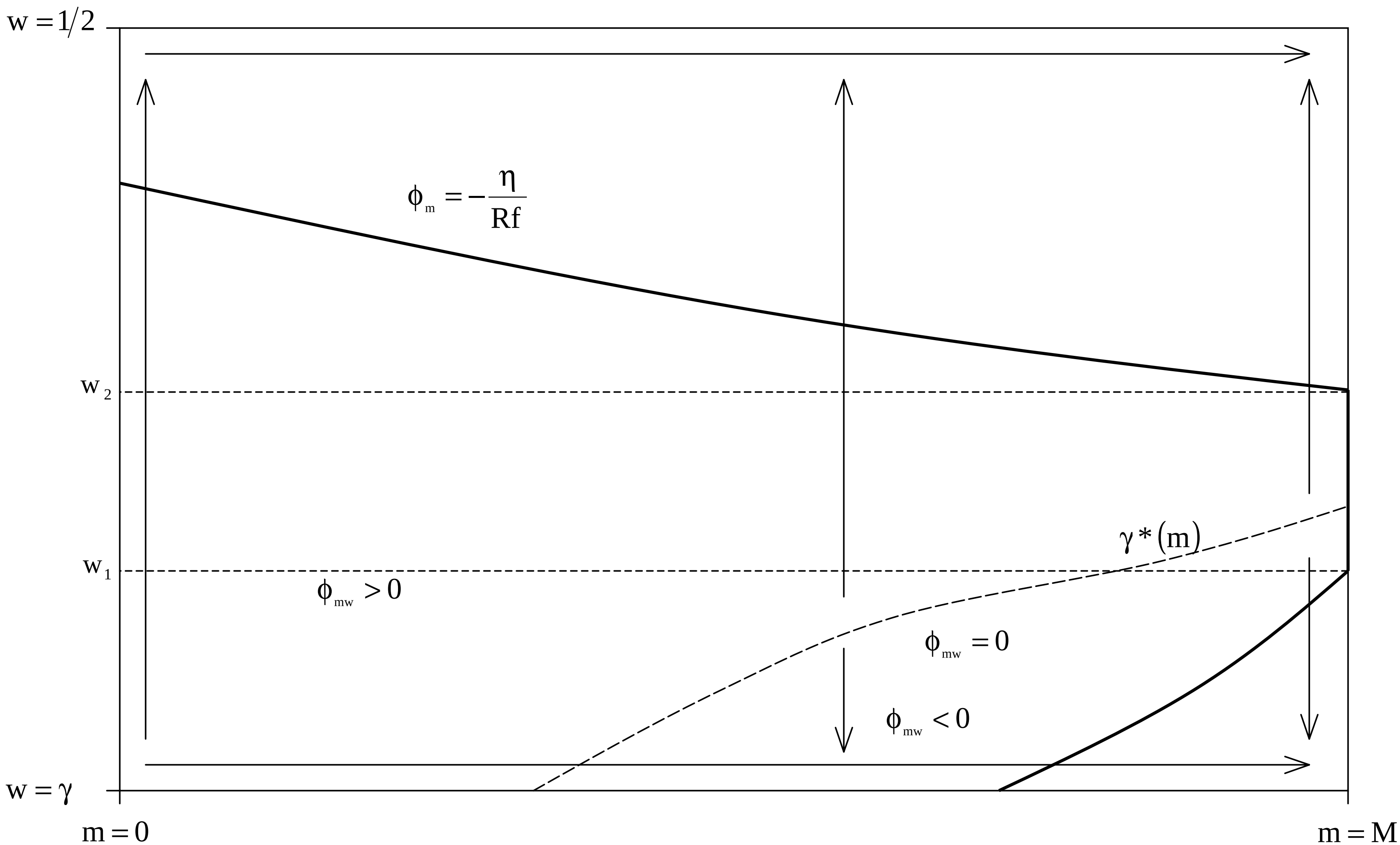
$w = 1/2$
w^M
$w = \gamma$
$m = 0$
$m = M$
$\phi_m = -\frac{\eta}{Rf}$
$\phi_{mw} > 0$
$\phi_{mw} = 0$
$\gamma^*(m)$
$\phi_{mw} < 0$

Figure 4



$w = 1/2$
w^*
$w = \gamma$
$m = 0$
$m = M$
$\phi_{mw} > 0$
$\phi_m = -\frac{\eta}{Rf}$
$\phi_{mw} = 0$
$\gamma^*(m)$
$\phi_{mw} < 0$

Figure 5


$w = 1/2$
$\phi_m = -\frac{\eta}{Rf}$
w_2
$\gamma^*(m)$
w_1
$\phi_{mw} > 0$
$\phi_{mw} = 0$
$\phi_{mw} < 0$
$w = \gamma$
$m = 0$
$m = M$