Profit Taxation and Bank Risk Taking*

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Abstract

How can taxation improve financial stability? Recent studies point to large potential stability gains from a reform that eliminates the debt bias in corporate taxation. It is well known that such a reform reduces bank leverage. This paper emphasizes a novel, complementary channel, namely, bank risk taking. We model the portfolio choice of banks under moral hazard and thereby highlight the ‘incentive function’ of equity. We find that (i) introducing an allowance for corporate equity and lowering the corporate tax rate discourages risk taking and offers stability and welfare gains, (ii) a revenue-neutral tax reform unambiguously improves financial stability, and (iii) capital regulation influences how banks respond to taxes and higher tax rates may even reduce risk taking if capital standards are tight.

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1 Introduction

Taxes influence bank behavior and financial stability. In particular, corporate taxation is usually not neutral with respect to the capital structure because in most countries the interest expense on debt is tax-deductible, whereas the cost of equity is not. This well-known debt bias creates an incentive for banks and non-financial firms to rely on debt instead of equity and may contribute to the build-up of excessive leverage. It runs counter to the primary goal of prudential regulation, namely, strengthening the capitalization and resilience of banks. According to studies in the aftermath of the financial crisis (e.g., Langedijk et al., 2015), a tax reform that eliminates the debt bias like such as an allowance for corporate equity (ACE) promises large potential financial stability gains.

One can think of at least two sources of such stability gains at the individual bank level: Banks may respond to a tax reform by reducing their leverage such that they have larger capital buffers and can better absorb losses. Banks may also have more ‘skin in the game’ leading to stronger incentives for investing a safer, better diversified portfolio. While the first channel is well understood, little is known about how the corporate income tax affects bank risk taking and portfolio quality.

The present paper studies the risk-taking channel of corporate taxation. Our analysis aims at identifying the main channels through which taxes affect risk-taking incentives of banks and at evaluating potential financial stability and welfare gains from tax policy. Specifically, we distinguish between the effects of a tax reform with an allowance for corporate equity and the effects of changes in tax rates. The allowance grants a partial or full deduction of the notional cost of equity from the tax base and thereby mitigates the debt bias.

This paper develops a principal-agent model of bank risk taking. A bank can invest
either in a *prudent* or in a *gambling* portfolio. The latter promises higher returns but it is more likely to cause bank failure. Moral hazard emerges because depositors only observe the realized return but not the underlying portfolio choice. Indebted banks thus have an incentive for gambling. The use of equity is solely motivated by the ‘incentive function’: Equity raises a bank’s ‘skin in the game’, alleviates moral hazard, and ensures that it invests in the prudent portfolio.

With a discrete portfolio choice, we emphasize risk taking at the extensive margin and picture differences in bank profitability as a source of heterogeneity. This approach is consistent with various interpretations (e.g., differences in loan collection costs or charter values). The model rationalizes different risk-taking strategies in equilibrium because profitable banks ceteris paribus have stronger incentives to avoid insolvency.

Our analysis yields three sets of novel results: First, an allowance for corporate equity discourages risk taking as more banks prefer the prudent over the gambling portfolio. The ACE thus promises financial stability and welfare gains. A lower corporate tax rate has comparable effects. Intuitively, both policies reduce the extra costs of equity used to set proper risk-taking incentives. These results also hold in a dynamic model, in which permanent tax changes also influence risk taking through a bank’s charter value.

Second, risk taking is insensitive to a neutral corporate income tax which falls on rents and allows for the deduction of the entire costs of capital. This property is consistent with the finding of Bond and Devereux (1995) who demonstrate that a tax on rents leaves the ranking of risky investment projects unchanged. Consequently, a revenue-neutral tax reform that (i) introduces a full allowance for equity and (ii) raises tax rates to compensate for the revenue shortfall unambiguously reduces risk taking.

Third, how banks respond to taxation importantly depends on capital regulation.
High capital requirements tend to diminish the tax sensitivities of risk taking and may even reverse them. Intuitively, satisfying regulatory requirements is relatively more costly for gambling banks because they must offer shareholders higher returns that are only partly tax-deductible. Mitigating the debt bias ceteris paribus benefit them relatively more. This effect only prevails if capital requirements are very tight. Especially higher corporate tax rates may then reduce risk taking.

Theoretical and empirical research in public economics suggests that the corporate income tax distorts the capital structure and contributes to inefficiently high leverage of firms due to the debt bias (see surveys by Auerbach, 2002; Graham, 2003, 2008). These findings have motivated several reform proposals for a more neutral tax system such as the aforementioned allowance for corporate equity.

Unlike non-financial firms, banks cannot freely choose their leverage because of capital regulation. Keen and de Mooij (2016) examine the joint effects of regulatory constraints and the debt bias on the capital structure of banks. Their theoretical analysis highlights that leverage of capital-abundant banks with large voluntary equity buffers is more responsive to taxation than leverage of those with small buffers. The latter is often dictated by capital requirements. Using a cross-country sample of banks, they estimate tax elasticities of bank leverage between 0.14 in the short and 0.25 in the long run. These effects are mainly driven by the behavior of capital-abundant banks. Other studies that explore cross-country differences in tax rates find comparable elasticities (e.g., Hemmelgarn and Teichmann, 2014; Gu et al., 2015; Horváth, 2018). Bond et al. (2016) consider the Italian tax on productive activities, which does not allow deducting the cost of equity either, and estimate similar effects especially on the leverage of capital-abundant banks.

These studies generally use cross-country or regional variations in corporate tax rates.
An alternative approach exploits tax reforms: Schepens (2016) and Céléri et al. (2019) study the introduction of a tax allowance (ACE) in Belgium 2006 and find significant increases in capital ratio and equity volume of banks. Martin-Flores and Moussu (2018) find comparable effects for a tax allowance on marginal equity that temporarily existed in Italy between 1997 and 2002.

These findings suggest that by reducing bank leverage such reforms promise large potential financial stability gains: The empirical results of De Mooij et al. (2014) imply that an ACE can significantly reduce the likelihood and the expected output losses of a financial crisis. According to Langedijk et al. (2015), such a reform can decrease the public finance costs of financial crises (e.g., for bailouts) in the range of 40 to 77 percent.

A complementary source of stability gains usually not considered in these quantitative studies is lower asset risk. Empirical evidence from tax reforms in Belgium (Schepens, 2016; Céléri et al., 2019) and Italy (Martin-Flores and Moussu, 2018) implies that introducing an allowance for equity improves the quality of loan portfolios reflected in a significant reduction in the share of non-performing loans and an increase in the Z-score. However, only few studies analyze the effects of the corporate tax rate on portfolio quality, and the evidence is mixed (Horváth, 2018; Gambacorta et al., 2017).

In this context, some authors also analyze how taxes influence the composition of bank portfolios between loans and securities and point to the role of risk weights in capital regulation. A declining relative cost of equity relaxes binding regulatory constraints on banks’ capital structure. As a result, banks allocate the additional equity to assets - typically loans - with higher regulatory risk weights. Theoretical and empirical research shows that an ACE (Céléri et al., 2019) or a levy on bank liabilities (Devereux et al., 2015) increase the portfolio share of loans and thus the average regulatory risk weight.¹

¹In a similar spirit, Horváth (2018) argues that a higher corporate tax rate tightens regulatory con-
The present paper sets out one of the first theoretical models of corporate taxation and bank risk taking and sheds light on the financial stability and welfare implications of taxes. While the well-understood effects of taxation on the capital structure play an important role in our analysis, we take a entirely different route: We emphasize the ‘incentive function’ of equity in alleviating moral hazard as a novel channel through which taxation may enhance financial stability and abstract from the more conventional role of equity as a buffer. Our main findings are consistent with the empirical results in the tax literature, and especially the model extension with bank regulation can rationalize the mixed evidence on the risk-taking effects of corporate tax rates.

Compared to the model of Célérier et al. (2019), our approach differs in at least three ways: First, we consider a different outcome, namely, the choice between portfolios with distinct risk and return characteristics that determine the risk of bank failure instead of portfolio composition. Second, the main channel is fundamentally different: In line with banking theory, we model risk taking as an agency problem importantly influenced by a bank’s capital structure rather than as being driven by differences in regulatory risk weights. Third, our analysis is informative about capital-abundant banks, whose leverage is especially responsive to taxation (e.g., Keen and de Mooij, 2016), and about banks constrained by the new - unweighted - leverage ratio in Basel III.

Moreover, our work builds on the theoretical banking literature, which provides a comprehensive analysis of risk taking typically modeled as the portfolio choice of banks. Risk taking is usually not contractible giving rise to moral hazard and inducing indebted banks to take excessive risks (risk shifting). Hence, a high capital ratio and large (future) profits of banks reflected in the charter value alleviate moral hazard and discourage risk taking (Hellmann et al., 2000). The theoretical literature has especially emphasized constraints thereby inducing banks to shift funds from loans to securities.
petition in deposit and loan markets (e.g., Keeley, 1990; Allen and Gale, 2000; Repullo, 2004; Boyd and De Nicolò, 2005) and capital regulation (e.g., Besanko and Kanatas, 1996; Repullo, 2004; Hakenes and Schnabel, 2011; Repullo, 2013), which both influence capital structure and charter value, as more fundamental determinants of bank risk taking.

Our paper shares several key model elements with the risk-taking literature. The role of bank equity as a disciplining device that alleviates risk shifting is especially important for our reasoning because taxes influence the capital structure of banks. More specifically, the model of the portfolio choice as well as the extension with an endogenous charter value follow Hellmann et al. (2000). Our paper contributes to this literature as it identifies corporate taxation as a novel institutional determinant of risk taking in addition to established factors like competition, regulation, and deposit insurance.

The remainder of this paper is organized as follows: Section 2 sets out the model. Section 3 introduces the corporate income tax and derives its effects on bank risk taking and financial stability. Section 4 adds two extensions. Eventually, Section 5 concludes.

2 Model

At the core of this model is a bank’s choice between a prudent portfolio with low risk and an intermediate return if successful and gambling portfolio with high risk and return. The portfolio choice is unobservable giving rise to moral hazard. Hence, the capital structure becomes a key determinant of risk taking. Banks are heterogeneous and pursue different risk-taking strategies in equilibrium. Unlike in the related model of Hellmann et al. (2000), deposits are correctly priced, and equity does not require a fixed excess return. Importantly, the debt bias in corporate taxation will provide a microfoundation for a differential cost.
2.1 Banks and Portfolios

There is a continuum of measure one of banks. Each is operated by a license holder with no private wealth (bank owner), who is the residual claimant. A bank raises funds of size one consisting of deposits and equity, which are elastically supplied and require an expected return of $1 + r$. Since deposits are risky, it offers a risk-adjusted interest rate $i$.

The bank can invest either in a prudent or in a gambling portfolio. Portfolio $j = \{P, G\}$ offers (i) an intermediate payoff $1 + \alpha_m > 1 + r$ with probability $\theta^j_m$, (ii) a high payoff $1 + \alpha_h > 1 + \alpha_m$ with probability $\theta^j_h$, (ii) an intermediate payoff $1 + \alpha$ with probability $\theta^j_m$, and (iii) zero with the complementary probability $\theta^j_l = 1 - \theta^j_h - \theta^j_m$. Figure 1 illustrates these outcomes. In case of a zero payoff, the bank cannot repay outstanding deposits and fails. Defining the success probability as $\theta^j \equiv \theta^j_h + \theta^j_m$, the expected net portfolio return is $r^j \equiv \theta^j (1 + \alpha_m) + \theta^j_h (\alpha_h - \alpha_m) - (1 + r)$.

![Figure 1: Portfolio Returns](image)

Portfolio $j = \{G, P\}$ offers the high (gross) return $1 + \alpha_h$ with probability $\theta^j_h$, the intermediate return $1 + \alpha_m$ with probability $\theta^j_m$, and zero else.

The payoffs of the two portfolios are the same but the corresponding probabilities are drawn from two different distributions:

**Assumption 1.** The gambling portfolio is more likely to offer the high payoff, $\theta^G_h > \theta^P_h$, but less likely to offer the intermediate payoff than the prudent portfolio, $\theta^G_m < \theta^P_m$.

The probability of a positive payoff is higher when investing in the prudent portfolio, $\theta^P \equiv \theta^P_h + \theta^P_m > \theta^G_h + \theta^G_m \equiv \theta^G$. 
Gambling banks have a better chance to earn an extra return $\Delta \alpha \equiv \alpha_h - \alpha_m$ but exhibit a higher risk of failure than prudent banks. Intuitively, the prudent asset may represent a well-diversified loan portfolio that offers a constant, intermediate return in most cases, whereas the gambling portfolio consists of more correlated loans subject to positive or negative common shocks. To assure an interior solution, we assume that the expected net return on the gambling is not lower than on the prudent portfolio, $r^G \geq r^P$.

Modeling a portfolio with three possible outcomes allows us to capture a trade-off between risk and return in a setup with an unobservable portfolio choice and observable payoffs. Once a bank raised deposits and equity, it can invest in either portfolio. Outsiders observe the realized payoff but not the underlying portfolio choice.

With a discrete portfolio choice, the model pictures the extensive margin of risk taking. This requires heterogeneous banks. We follow Repullo (2013) and introduce differences in banks’ returns:

**ASSUMPTION 2.** Each bank earns a specific return $\Omega$ in addition to the portfolio return provided that it is solvent. Types are observable. They are distributed on $\Omega \sim [0, \Omega]$ with cumulative density $F(\Omega)$.

In total, a bank of type $\Omega$ earns $1 + \alpha_m + \Omega$ or $1 + \alpha_h + \Omega$ if its portfolio yields an intermediate or a high payoff, respectively. If the portfolio return is zero, however, the bank-specific return $\Omega$ is forgone. Types influence risk taking: Banks with the potential to earn high additional returns are ceteris paribus less inclined to gamble. Therefore, equilibrium exhibits differences in risk taking. This general approach is consistent with several specific interpretations:

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2With only two payoffs (e.g., $\alpha^j > 0$ and 0), gambling would be strictly dominated due to the lower success probability if those payoffs were the same, $\alpha^P = \alpha^G$. If they were different, $\alpha^P \neq \alpha^G$, one could infer the portfolio choice from the realized payoff, which would eliminate moral hazard in the first place.

3If the bank received $\Omega$ irrespective of performance and solvency, the latter would have no effect risk taking as long as deposits and equity are priced on a risk-adjusted basis.
• Costs of loan collection and ex post monitoring of borrowers: Banks incur some costs to ensure the proper repayment of loans in the spirit of Diamond (1984).\footnote{Suppose the bank first learns the aggregate state (i.e., share of performing loans) and then incurs this cost to ensure repayment. The latter is zero in the bad state when all borrowers default and no loans are collected.} A low specific return \( \Omega \) characterizes banks with high costs of loan collection.

• Rents on existing assets: Banks have some debt-funded assets or loans in place, on which they earn rents. The latter requires some ex post monitoring effort of the bank owner, which she exerts only if she receives a positive payoff (i.e., if the bank is solvent). Otherwise, rents are forgone. Heterogeneous rents may arise due to differences in assets in place, for example.\footnote{Consider a bank with existing safe assets and deposits worth \( n \). The interest rate is \( r \). Owners of solvent banks exert effort to raise the return to \((1+\varphi)r\). Their profits \( \Omega = \varphi rn \) may differ due to different initial asset holdings \( n \).}

• Charter values: The bank-specific return may represent the present value of future profits in reduced form. Differences in charter values cross banks reflect different future profit opportunities or discount factors of shareholders. We explore this aspect in a dynamic variant of the model in Section 4.2.

The timing is as follows: (i) banks attract deposits and equity and offer a financing contract to depositors that specifies the deposit interest rate, (ii) banks choose the portfolio, and (iii) returns are realized.

\section{2.2 Risk Taking}

For any given deposit interest rate \( i \) and capital ratio \( e \), the expected profit of a bank of type \( \Omega \) from investing in portfolio \( j = \{G, P\} \) equals:

\[
\pi^j(e, i; \Omega) = \theta^j[1 + \alpha_m + \Omega - (1 + i)(1 - e)] + \theta^j_h \Delta \alpha - (1 + r)e = r^j + \theta^j \Omega + [(1 + r) - \theta^j(1 + i)](1 - e).
\]
With probability \( \theta^j = \theta^j_h + \theta^j_m \), the bank earns at least the intermediate return \( 1 + \alpha_m \) plus its specific return \( \Omega \), succeeds, and repays deposits \( 1 + i \); with probability \( \theta^j_m \), it receives the extra return \( \Delta \alpha = \alpha_h - \alpha_m \) as well. Outside shareholders are promised an expected return on equity of \( 1 + r \).\(^6\) The second line rewrites profit as the total expected return, \( r^j + \theta^j \Omega \), plus a limited liability effect from a potential default on deposits.

**Portfolio Choice and Capital Structure:** Once a bank raised funds and agreed on a deposit rate, it chooses the portfolio. This choice is not contractible, which causes moral hazard (risk shifting). A bank of type \( \Omega \) with capital ratio \( e \) and deposit rate \( i \) only invests in the prudent portfolio if \( \pi^P(e, i; \Omega) \geq \pi^G(e, i; \Omega) \) or, equivalently,

\[
r^G - r^P + \Delta \theta(1 + i)(1 - e) \leq \Delta \theta \Omega, \quad \Delta \theta \equiv \theta^P - \theta^G > 0. \tag{2}
\]

This *no-gambling condition* ensures that the gains from risk-taking on the left-hand side must be smaller than the expected loss of the bank-specific return \( \Delta \theta \Omega \). Gains result from the higher expected return of the gambling portfolio if \( r^G > r^P \) and from the typical risk-shifting effect due to limited liability (i.e., the gambling bank defaults more often on deposits), \( \Delta \theta(1 + i)(1 - e) \).

Equity plays the typical disciplining role and helps banks alleviate moral hazard and reduce risk shifting. Solving the no-gambling condition (2) for \( e \) defines the *minimum capital ratio* that preserves the incentive to invest in the prudent portfolio

\[
e \geq e_0(i; \Omega) \equiv 1 + \frac{\tilde{r} - \Omega}{1 + i}, \quad \tilde{r} \equiv \frac{r^G - r^P}{\Delta \theta} \geq 0. \tag{3}
\]

Only with a capital ratio of at least \( e_0 \), a bank will choose the prudent portfolio. Otherwise, it is privately optimal to gamble. Minimum equity decreases in the bank’s type \( \Omega \). Intuitively, banks with large and profitable assets in place or with attractive future

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\(^6\)This is equivalent to a more detailed formulation like in Repullo (2013), who explicitly pictures that outside equityholders are promised a share \( z \) of profits satisfying their participation constraint \( z \pi = (1 + r)e \), and that bank owners maximizes their expected surplus \((1 - z)\pi\).
lending opportunities already have an especially strong incentive to avoid failure.

Some banks with a very high specific return always prefer the prudent portfolio even with no equity. The risk of losing this return is so large that they are better off by choosing the safer portfolio. This motivates the zero-equity cut-off

$$\Omega^0(i) = 1 + i + \tilde{r},$$

which pins down the type who prefers the prudent portfolio with zero equity, \( e_0(i; \Omega) = 0 \).

In contrast, low types with \( \Omega < \tilde{r} \) cannot be provided with incentives for the prudent portfolio even if they are completely financed with equity, \( e = 1 < e_0 \). As long as gambling offers an expected gain, \( \tilde{r} > 0 \), such banks always opt for the gambling portfolio.

**Bank Value and Deposit Rate:** In the beginning, the bank raises deposits \( d \) and equity \( e \) and promises a deposit rate \( i \). Depositors require an expected return \( r \) and a compensation for bearing the risk of bank failure. This motivates the standard pricing condition for deposits:

$$1 + r = \theta^j (1 + i^j).$$

It determines the risk-adjusted deposit rate \( i^j \) depending on the subsequent portfolio choice \( j = \{G, P\} \). Due to \( \theta^P > \theta^G \), a gambling bank pays a higher deposit rate, \( i^G > i^P \). Correct pricing ensures that expected bank profit defined in (1) simply equals the expected portfolio return, \( \pi^j = r^j \).

However, risk taking is not observable and banks take capital structure and interest rate as given when deciding about the portfolio later on. Such a time line is typical for many principal-agent models of bank risk taking (e.g., Hakenes and Schnabel, 2011; Repullo, 2013; Martinez-Miera and Repullo, 2017). Therefore, depositors cannot condition the interest rate directly on the portfolio choice. They instead impose the minimum
equity requirement (3) and charge the low interest rate $i^P$ only if a bank is sufficiently capitalized with $e \geq e_0(i^P; \Omega)$. Depositors anticipate that it will subsequently choose the prudent portfolio. Otherwise, they expect gambling and charge the high deposit rate $i^G$.

Each bank therefore chooses between two options or strategies: First, consider a bank that intends to invest in the prudent portfolio. It can attract deposits at interest rate $i^P = (1 + r)/\theta^P - 1$ and must have a capital ratio $e \geq e_0(i^P; \Omega)$. Substituting for $i^P$ and (3) gives the constrained maximization problem

$$V^P(\Omega) = \max_{e, \lambda} \pi^P(e, i^P; \Omega) + \lambda[e - e_0(i^P; \Omega)]$$

with $\pi^P(e, i^P; \Omega) = r^P + \theta^P \Omega$ on account of (1) and (8) and $\lambda$ denoting the multiplier. The first-order condition for equity implies $\lambda = 0$ such that the constraint on equity does not bind and any capital ratio $e \geq e_0(i^P; \Omega)$ is optimal. Banks may raise additional equity in excess of $e_0$ as it is no more expensive or scarcer than debt. The ex ante bank value is equal to the expected return, $V^P(\Omega) = r^P + \theta^P \Omega$.

Next, consider a bank that plans to invest in the gambling portfolio. It needs to offer depositors the higher interest rate $i^G = (1 + r)/\theta^G - 1$ and its capital ratio satisfies $e < e_0(i^G; \Omega)$ giving the constrained maximization problem

$$V^G(\Omega) = \max_{e, \lambda} \pi^G(e, i^G; \Omega) + \lambda[e - e_0(i^G; \Omega)]$$

with $\pi^G(e, i^G; \Omega) = r^G + \theta^G \Omega$. Again, one obtains $\lambda = 0$ such that any capital ratio $e < e_0(i^G; \Omega)$ is optimal. The corresponding bank value is $V^G(\Omega) = r^G + \theta^G \Omega$.

Equations (6) and (7) characterize two strategies - a combination of capital structure, deposit rate, and portfolio choice - that are both incentive-compatible and profit-maximizing. Each bank initially compares them and decides whether it (i) raises some equity $e \geq e_0$, offers the deposit rate $i^P$, and invests in the prudent portfolio or (ii) raises little or no equity, offers the deposit rate $i^G$, and gambles.
2.3 Equilibrium

A bank's type $\Omega$ influences the ex ante bank value directly, and, if it opts for the prudent strategy, also via minimum equity $e_0$. Some banks can therefore achieve a higher value from raising equity and investing in the prudent portfolio, while the gambling strategy is more attractive for others.

The pivotal bank of type $\Omega^*$ is indifferent between the two portfolios, $V^P(\Omega^*) = V^G(\Omega^*)$. Substituting for the ex ante values yields the risk-taking cut-off:

$$\Omega^* = \hat{r}.$$  \hfill (8)

The expected gains from gambling, $R^G - r^P$, exactly offset the loss of the bank-specific return, $\Delta \theta \Omega$. High types, $\Omega \geq \Omega^*$, choose the prudent strategy, whereas low types, $\Omega < \Omega^*$, gamble. Should gambling not offer any gains (i.e., if $r^G = r^P$ and $\hat{r} = 0$), no bank gambles. At least some prudent banks need to raise positive equity to have proper incentives because the risk-taking cut-off is smaller than the zero-equity cut-off, $\Omega^* < \Omega^*(i^P) = (1 + r)/\theta^P + \Omega^*$. Substituting (8) into minimum equity (3) reveals that the pivotal bank is all-equity financed, $e(\Omega^*) = 1$. Consequently, three groups of banks emerge in equilibrium:

- $\Omega \geq \Omega^*(i^P)$: Highly profitable banks invest in the prudent portfolio even with no equity. They succeed with probability $\theta^P$.

- $\Omega^*(i^P) > \Omega \geq \Omega^*$: The bank-specific return alone is not large enough to provide discipline. Such banks have a strictly positive capital ratio, $e \geq e_0 > 0$, and choose the prudent portfolio. They succeed with probability $\theta^P$.

- $\Omega < \Omega^*$: Banks that are rather unprofitable gamble, have a capital ratio smaller than $e_0$, and are successful with probability $\theta^G$. 


3 Corporate Income Tax

This section introduces a corporate income tax, which potentially discriminates between debt and equity (‘debt bias’). The tax rate equals \( \tau \). The tax base is profit equal to realized payoff, which is either \( \alpha_m + \Omega \) or \( \alpha_h + \Omega \), net of the interest expense on deposits, \( i(1 - e) \). A fraction \( s \in [0, 1] \) of the notional cost of equity can be deducted from the tax base. Since taxes are levied ex post on solvent banks, the notional cost is equal to the risk-adjusted return on equity that coincides with the deposit interest rate \( i \). After all, both types of funds require the same expected return \( r \) at the outset. The tax-deductible cost of equity thus equals \( sie \). The parameter \( s \) characterizes the allowance for equity: \( s < 1 \) characterizes a distortionary tax that exhibits a debt bias. In contrast, \( s = 1 \) describes a neutral tax that allows for the deduction of the entire cost of capital and exclusively falls on economic rents.

Depending on which portfolio return is realized, a bank’s tax liability is:

\[
T_m = \tau[\alpha_m + \Omega - i(1 - e) - sie], \quad T_h = \tau[\alpha_h + \Omega - i(1 - e) - sie], \quad T_l = 0. \tag{9}
\]

A bank’s expected tax burden when investing in portfolio \( j = \{G, P\} \) is

\[
T^j = \theta^j_m T_m + \theta^j_h T_h = \theta^j T_m + \theta^j \tau \Delta \alpha. \tag{10}
\]

By substituting and collecting terms, one obtains:

\[
T^j = \tau[\theta^j (\alpha_m + \Omega - i(1 - s)e) + \theta^j \Delta \alpha] = \tau[r^j + \theta^j \Omega + (1 + r) - \theta^j (1 + i) + (1 - s)\theta^j ie] \tag{10}
\]

If the tax is distortionary with \( s < 1 \), equity increases the expected tax burden. Otherwise, the tax base is independent of the capital structure.

Noting (1), the after-tax profit from investing in portfolio \( j \) equals

\[
\pi^j(e, i; \Omega) = r^j + \theta^j \Omega + [(1 + r) - \theta^j (1 + i)](1 - e) - T^j
\]

\[
= (1 - \tau)(r^j + \theta^j \Omega) + [(1 + r) - \theta^j (1 + i)](1 - \tau - e) - \tau(1 - s)\theta^j ie. \tag{11}
\]
3.1 Risk Taking

Portfolio Choice and Capital Structure: For a given deposit rate and capital ratio, the bank of type \( \Omega \) chooses the prudent portfolio as long as \( \pi^P(e, i; \Omega) - \pi^G(e, i; \Omega) \geq 0 \). Substituting (10) and (11) and dividing by \( \Delta \theta \) yields the no-gambling condition:

\[
(1 - \tau) \hat{r} + (1 + i)(1 - e) - \tau[1 + i - (1 - s)ie] \leq (1 - \tau)\Omega. \tag{12}
\]

The gains from gambling on the left-hand side reflect a higher expected return on the gambling portfolio, \( \hat{r} \geq 0 \), and more opportunities to default and not repay deposits, \((1 + i)(1 - e)\). Taxes diminish these gains but they also hurt prudent banks via the specific return \((1 - \tau)\Omega\). Intuitively, taxes also reduce future profits or profits on other assets, which is more important for prudent banks as they have a higher solvency probability.

Solving (12) yields the minimum capital ratio which prevents gambling

\[
e \geq e_0(i; \Omega) = \frac{(1 - \tau)(1 + i + \hat{r} - \Omega)}{1 + i'} \tag{13}
\]

with \( i' \equiv i[1 - \tau(1 - s)] \). This capital ratio is zero, \( e_0(i; \Omega^o) = 0 \), whenever the bank-specific return enough, \( \Omega > \Omega^o = 1 + i + \hat{r} \).

Bank Value and Deposit Rate: Each bank chooses between two incentive-compatible and profit-maximizing options. First, a bank which invests in the prudent portfolio offers the deposit rate \( 1 + i^P = (1 + r)/\theta^P \) and must have a minimum capital ratio \( e \geq e_0(i^P; \Omega) \),

\[
V^P(\Omega) = \max_{e, \lambda} \pi^P(e, i^P, \Omega) + \lambda[e - e_0(i^P; \Omega)] \tag{14}
\]

with \( \pi^P(e, i^P; \Omega) = (1 - \tau)(r^P + \theta^P \Omega) - \tau(1 - s)\theta^P i^P e \) by (11). The first-order conditions imply a binding constraint, \( \lambda = \tau(1 - s)\theta^P i^P > 0 \). Since equity is more expensive than deposits due to the debt bias, the bank exactly raises minimum equity, \( e = e_0 \). The prudent strategy yields an ex ante value \( V^P(\Omega) = (1 - \tau)(r^P + \theta^P \Omega) - \tau(1 - s)(1 + r - \theta^P)e_0 \).

It consists of the expected after-tax return minus a term that represents the extra tax
cost of equity due to the debt bias. Highly profitable banks, $\Omega \geq \Omega^*$, need no equity and incur no such cost. Their value depends only on the tax rate but not on the allowance.

The value of a prudent bank rises with the type $\Omega$ but falls with the minimum capital ratio $e_0$ because the asymmetric tax treatment renders equity is more expensive:

$$dV^P = (1 - \tau)\theta^p \cdot d\Omega - \tau(1 - s)(1 + r - \theta^P) \cdot de_0 + \tau(1 + r - \theta^P)e_0 \cdot ds$$

$$- [r^P + \theta^P \Omega + (1 - s)(1 + r - \theta^P)e_0] \cdot d\tau.$$  \hspace{1cm} (15)

A larger allowance for equity $s$ directly boosts bank value by reducing tax costs, while higher tax rate $\tau$ lowers the after-tax return and magnifies the cost of equity. Once a zero capital ratio is sufficient, $\Omega > \Omega^*$, bank value is insensitive to the tax allowance and responds less strongly to tax rate changes.

Second, a bank that subsequently gambles offers the high deposit rate $1 + i^G = (1 + r)/\theta^G$ and its capital ratio has to satisfy $e < e_0(i^G; \Omega)$. It maximizes

$$V^G(\Omega) = \max_{e,\lambda} \pi^G(e, i^G; \Omega) + \lambda[e_0(i^G; \Omega) - e]$$

with $\pi^G(e, i^G; \Omega) = (1 - \tau)(r^G + \theta^G \Omega) - \tau(1 - s)\theta^G i^G e$. The first-order condition for equity implies $\lambda = -\tau(1 - s)\theta^G i^G < 0$. The constraint is fulfilled with zero equity giving an ex ante value equal to the expected after-tax return, $V^G(\Omega) = (1 - \tau)(r^G + \theta^G \Omega)$. The latter increases in the type and decreases in the tax rate but is insensitive to the allowance because such banks raise no equity:

$$dV^G = (1 - \tau)\theta^G \cdot d\Omega - (r^G + \Omega^G) \cdot d\tau.$$ \hspace{1cm} (17)

### 3.2 Equilibrium

The pivotal type $\Omega^*$ is indifferent between the two strategies set out above, $V^P(\Omega^*) = V^G(\Omega^*)$. Substituting (14) and (16) yields:

$$\Omega^* = \tilde{r} + \frac{\tau(1 - s)(1 + r - \theta^P)e_0(i^P; \Omega^*)}{\Delta \theta(1 - \tau)}. \hspace{1cm} (18)$$
Minimum equity $e_0(i^P; \Omega^*)$ itself depends on the cut-off according to (13). The closed-form solution of the risk-taking cut-off is

$$\Omega^* = \hat{r} + \chi(1 + i^P).$$

(19)

$\chi \in [0, 1)$ is a measure of the tax distortion. It reflects the extra tax cost of equity:

$$\chi = \frac{\tau(1 - s)(1 + r - \theta^P)}{\Delta \theta(1 + i') + \tau(1 - s)(1 + r - \theta^P)}.$$  

(20)

Recall $i' = i^P[1 - \tau(1 - s)]$. Only if the bank can deduct the full cost of equity from the tax base, $s = 1$, the distortion disappears, $\chi = 0$, giving $\Omega^* = \hat{r}$ like in the no-tax equilibrium. Hence, a neutral tax does influence risk taking of banks.

In equilibrium, the risk-taking cut-off is always smaller than the zero-equity cut-off, $\Omega^* = \hat{r} + \chi(1 + i^P) \leq 1 + i^P + \hat{r} \equiv \Omega^*(i^P)$, due to $\chi < 1$. Some banks with $\Omega \in (\Omega^*, \Omega^*)$ must attract some equity to subsequently invest in the prudent portfolio. Three different groups emerge in equilibrium as illustrated in Figure 2:

- $\Omega \geq \Omega^*(i^P)$: Highly profitable banks do not need equity because the prudent portfolio promises a higher value than gambling. Accordingly, they raise no equity, opt for the prudent portfolio, and succeed with probability $\theta^P$.

- $\Omega^*(i^P) > \Omega \geq \Omega^*$: The bank-specific return is not large enough to provide discipline alone. Such banks choose the prudent portfolio only with some positive equity, $e_0 > 0$. Despite the extra cost of equity, the latter is more profitable than gambling. Those banks raise equity, invest in the prudent portfolio, and succeed with probability $\theta^P$.

- $\Omega < \Omega^*$: The bank-specific return is so small that gambling is more attractive. Accordingly, these banks raise no equity, gamble, and succeed with probability $\theta^G$. 

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This figure depicts minimum equity $e_0$ (in red, left axis) and bank values from prudent and gambling portfolio $V^P$ and $V^G$ (in blue and violet, right axis) and the risk-taking and zero-equity cut-offs $\Omega^*$ and $\Omega^\circ$ in the presence of a distorting corporate income tax with $\tau > 0$ and $s < 1$. The arrows indicate that a higher tax rate $\tau$ reduces both $V^P$ and $V^G$ as well as $e_0$ and that a larger tax allowance $s$ raises $V^P$ and reduces $e_0$.

## 3.3 Results

### 3.3.1 Capital Structure and Risk Taking

Equity helps some banks set correct risk-taking incentives and avoid gambling. Differentiating individual minimum equity in (13) gives:

$$
d e_0 = \frac{1 - \tau}{1 + \nu^*} \cdot d \Omega - \frac{\tau e_0}{1 + \nu^*} \cdot ds - \frac{(1 + s \nu) e_0}{(1 - \tau)(1 + \nu^*)} \cdot d \tau. \tag{21}
$$

It decreases in the bank’s type because a higher specific return strengthens incentives as explained earlier. The corporate income tax affects the capital ratio of an individual bank as follows:

**LEMMA 1.** The minimum capital ratio of an individual bank decreases in the corporate tax rate $\tau$ and in the allowance for equity $s$. ■

**Proof:** Follows from Equation (21).

These sensitivities mirror how the tax affects risk-taking incentives: A more generous allowance diminishes the gains from gambling because only solvent banks can deduct their costs of equity, see (12). On net, a rising tax rate also renders gambling relatively less
attractive. This portfolio promises higher expected returns that are disproportionately reduced by higher tax rates. A lower capital ratio thus suffices in both cases to preserve risk-taking incentives.

To evaluate how corporate taxation influences the portfolio decision of banks, we derive the sensitivities of the cut-off $\Omega^*$ representing the pivotal bank. If the latter increases, more banks will gamble and take risks. Starting from $dV^P(\Omega^*) = dV^G(\Omega^*)$, we substitute (15) and (17). Collecting terms and dividing by $\Delta \theta$ gives

$$\left[1 - \tau - \tau (1 - s) \zeta \frac{de_0}{d\Omega}\right] \cdot d\Omega^* = -\tau \zeta \left[e_0 - (1 - s) \frac{de_0}{ds}\right] \cdot ds$$

$$- \left[\tilde{r} - \Omega^* - (1 - s) \zeta \left(e_0 + \tau \frac{de_0}{d\tau}\right)\right] \cdot d\tau.$$  \hspace{1cm} (22)

This formulation uses $\zeta \equiv (1 + r - \theta^P)/\Delta \theta > 0$. The coefficients of $s$ and $\tau$ mirror how the tax affects the relative bank values. It influences those values directly and, in case of $V^P$, also via the minimum capital ratio because of the debt bias.

A larger allowance for equity boosts the value of prudent banks because only such banks have equity and benefit from the smaller tax cost. Declining minimum equity $e_0$ magnifies this effect. A rising corporate tax rate, in turn, involves three effects: First, it diminishes the after-tax return on assets $(1 - \tau)(r^j + \theta^j \Omega)$. At the risk-taking cut-off, this decline is stronger for a prudent bank because its total expected return is higher reflected in $r^P + \theta^P \Omega^* \geq r^G + \theta^G \Omega^*$ or, equivalently, $\tilde{r} - \Omega^* = -\chi(1 + i^P) < 0$. Through this channel, a rising tax rate induces more risk taking. In addition, the total tax costs of equity incurred by prudent banks only, $\tau (1 - s)(1 + r - \theta^P)e_0$, may rise or fall. While the higher tax rate unambiguously magnifies the tax cost per unit, the amount of equity $e_0$ also declines, see (21).

We summarize the net effects of taxes on risk taking in the following proposition:
PROPOSITION 1. The risk-taking cut-off \( \Omega^* \) responds to the tax according to

\[
d\Omega^* = -\sigma_s \cdot ds + \sigma_\tau \cdot d\tau
\]

with coefficients

\[
\sigma_s = \chi \frac{(1 - \chi)(1 + i^P)^2}{(1 - s)(1 + i')}, \quad \sigma_\tau = \frac{\chi (1 - \chi) (1 + i^P)}{\tau (1 + i')} > 0.
\]

A larger allowance for equity \( s \) and a lower corporate tax rate \( \tau \) unambiguously discourage risk taking. The cut-off falls, and more banks invest in the prudent portfolio.

Proof: Equation (23) and the coefficients follow from substituting the sensitivities of minimum equity (21) into Equation (22). We evaluate those sensitivities at the cut-off \( \Omega^* \) with \( e_0(\Omega^*) = (1 - \tau)(1 - \chi)(1 + i^P) / (1 + i') \) and use \( \tilde{r} - \Omega^* = -\chi (1 + i^P) \) on account of Equation (19).

First, banks can deduct a larger share of the return on equity from the tax base if the allowance is increased. This boosts the ex ante value from investing in the prudent portfolio but leaves the value from gambling unchanged. Raising equity and investing in the prudent portfolio becomes more attractive for a larger share of banks. This finding is consistent with the empirical evidence, which suggests that introducing a tax allowance for equity tends to improve portfolio quality in terms of a declining share of non-performing loans (e.g., Schepens, 2016; Martin-Flores and Moussu, 2018).

Second, a higher tax rate increases the cut-off and leads to more risk taking because it impairs the value of prudent relative to gambling banks. The higher tax rate diminishes the expected total return of prudent banks, which is higher at the cut-off, more strongly in addition to magnifying the cost of equity. The latter hampers the use of equity as a disciplining device. Gambling thus becomes relatively more attractive, and more banks opt for this portfolio. On the empirical side, this prediction is in line with Gambacorta
et al. (2017) but conflicts with Horváth (2018).\footnote{Gambacorta et al. (2017) study the Italian tax on productive activities, which is quite similar to the corporate income tax, and estimate that higher tax rates impair portfolio quality reflected in a higher ratio of bad loans to total assets. Horváth (2018) provides cross-country evidence and finds a negative effect of tax rates on the share of non-performing loans.} We explore this aspect further in an extension (see Section 4.1) and demonstrate that the model can also rationalize a negative effect of the tax rate on risk taking in the presence of tight capital requirements. After all, the evidence of Gambacorta et al. (2017) suggests that their estimated increase in risk taking is driven by weakly capitalized banks.

An important case is a neutral tax, which grants a full deduction of the cost of equity from the tax base (i.e., $s = 1$):

**PROPOSITION 2.** If the tax system is neutral, bank risk taking is insensitive to the corporate tax rate.

**Proof:** A full tax allowance, $s = 1$, eliminates the tax distortion, $\chi = 1$, on account of (20). Evaluating the coefficient of Equation (23) suggests $\sigma_\tau = 0$. \hfill $\blacksquare$

A neutral corporate income tax exclusively falls on economic rents. Issuing equity does not entail any extra costs that could impair the value of prudent banks. The tax proportionately scales down the ex ante values $V^P$ and $V^G$ and thereby preserves their ranking. This property echoes the central result of Bond and Devereux (1995) who demonstrate that a tax on economic rents does not affect investment decisions of firms under uncertainty.

The key implication of this finding is a revenue-neutral tax reform, that is, first introducing a full allowance for equity and then increasing the tax rate to account for the revenue shortfall, unambiguously discourages risk taking: The allowance eliminates the debt bias and boosts the relative value of prudent banks such that the cut-off $\Omega^*$ falls. Once the tax is neutral, raising the tax rate does not affect risk taking as $d\Omega^*/d\tau|_{s=1} = 0$.\footnote{Gambacorta et al. (2017) study the Italian tax on productive activities, which is quite similar to the corporate income tax, and estimate that higher tax rates impair portfolio quality reflected in a higher ratio of bad loans to total assets. Horváth (2018) provides cross-country evidence and finds a negative effect of tax rates on the share of non-performing loans.}
3.3.2 Financial Stability

Reduced risk taking is one source of potential stability gains of tax reform. We thus characterize how corporate taxation influences two common measures of financial stability: average failure risk and aggregate equity in the banking sector.

The average probability of bank failure $\pi$ reflects that a fraction $F(\Omega^*)$ of banks gambles and fails with higher probability $1 - \theta^G$:

$$\pi = 1 - \theta^P + \Delta \theta F(\Omega^*).$$  \hfill (24)

Noting the changes in the share of gambling banks $F(\Omega^*)$ implied by Propositions 1 and 2, average failure risk in the banking sector falls if the debt bias is reduced with a larger allowance for equity. A higher corporate tax rate, in contrast, has a destabilizing effect as long as the tax is distortionary. Otherwise, changes in the tax rate leave the probability of bank failure unchanged.

Corporate taxation also influences the aggregate capital ratio of the banking sector:

$$\bar{e}_0 = \int_{\Omega^*}^{\Omega^\circ} e_0(\Omega) dF(\Omega).$$  \hfill (25)

In equilibrium, only intermediate types, $\Omega \in (\Omega^*, \Omega^\circ)$, have a positive capital ratio that ranges between $e_0(i^P; \Omega^\circ) = 0$ and $e_0(i^P; \Omega^*) = (1 - \tau)(1 - \chi)(1 + i^P)/(1 + i^*) < 1$.

By applying the Leibniz rule, one observes that a larger allowance for equity and a higher corporate tax rate affect the aggregate capital ratio as follows:

$$d\bar{e}_0 = \sum_{h \in \{s, \tau\}} \left[ \int_{\Omega^*}^{\Omega^\circ} \frac{de_0(\Omega)}{dh} dF(\Omega) - e_0^*(\Omega^*) \frac{d\Omega^*}{dh} \right] \cdot dh$$  \hfill (26)

The net effect reflects how banks with positive equity adjust their capital ratio $e_0(\Omega)$ and whether their share, determined by the risk-taking cut-off $\Omega^*$, grows or shrinks. It is clearly negative for a higher tax rate but more ambiguous for a larger allowance because all banks with positive equity reduce their capital ratio but their share expands.
The following proposition summarizes the financial stability effects of tax policies:

**PROPOSITION 3.** A larger allowance for bank equity reduces the average probability of bank failure and raises the aggregate capital ratio of the banking sector. A higher tax rate increases the average probability of bank failure and reduces the aggregate capital ratio.

**Proof:** The effects on the average probability of bank failure follow from differentiating (24) and substituting the tax sensitivities (Proposition 1), which yields

\[ d\pi = \Delta \theta f(\Omega^*)[-\sigma_s \cdot ds + \sigma_r \cdot d\tau]. \]

The aggregate capital ratio falls with the tax rate on account of the lower individual capital ratio \( de_0/d\tau < 0 \) and the rising cut-off \( d\Omega^*/d\tau > 0 \), see (21) and (23). Appendix A derives the effect of the allowance on the aggregate capital ratio assuming \( \Omega \sim U[0,\bar{\Omega}] \).

The finding that a larger allowance for equity reduces bank failure risk is consistent with De Mooij et al. (2014) who estimate that such reforms lower the probability of a financial crisis. Moreover, the predictions about aggregate bank equity are in line with the empirical evidence, namely, positive effects of introducing an ACE (e.g., Schepens, 2016; Célérier et al., 2019) and negative effects of a higher corporate tax rate (e.g., Hemmelgarn and Teichmann, 2014; Keen and de Mooij, 2016; Horváth, 2018).

### 3.3.3 Welfare

We finally evaluate tax policies based on their welfare effects. Welfare equals the aggregate surplus of the banking sector plus tax revenue, \( W = V + T \). Depositors and outside shareholders are adequately compensated and earn a zero surplus. Using the definitions

\[ V = \int_0^{\Omega^*} V^G(\Omega)dF(\Omega) + \int_{\Omega^*}^{\bar{\Omega}} V^P(\Omega)dF(\Omega), \quad T = \int_0^{\Omega^*} T^G dF(\Omega) + \int_{\Omega^*}^{\bar{\Omega}} T^P(\Omega)dF(\Omega), \]
and substituting (10), (14), and (15) gives:

$$W = \int_0^{\Omega^*} r^G + \theta^G \Omega dF(\Omega) + \int_{\Omega^*}^\tilde{\Omega} r^P + \theta^P \Omega dF(\Omega). \quad (27)$$

The welfare contribution of an individual bank is equal to its expected total return. Risk taking represented by the cut-off $\Omega^*$, which importantly depends on taxation, influences welfare according to

$$dW = -(\Omega^* - \tilde{r}) \Delta \theta^f(\Omega^*) \cdot d\Omega^* = -\chi (1 + i^P) \Delta \theta^f(\Omega^*) \cdot d\Omega^* < 0. \quad (28)$$

The second equality substitutes (19) for $\Omega^*$ to get the welfare effects of risk taking in market equilibrium. Taking into account how the cut-off $\Omega^*$ responds to taxes (Proposition 1), one obtains:

**PROPOSITION 4.** If the corporate income tax is distortionary, too many banks gamble. Increasing the allowance for equity and decreasing the tax rate reduces excessive risk taking and raises welfare.

**Proof:** According to Equation (28), the risk-taking cut-off is too high in market equilibrium whenever the corporate income tax is distortionary with $s < 1$ and $\chi > 0$. A larger tax allowance and a lower tax rate improve welfare because they lower the risk-taking cut-off (see Proposition 1).

The corporate income tax is a source of excessive risk taking whenever it is distortionary and does not allow for the full deduction of the cost of equity. This feature hampers the use of equity that is necessary to set correct incentives and induces some banks with types $\Omega \in [\tilde{r}, \tilde{r} + \chi(1 + i^P)]$ to gamble. In the absence of a tax distortion, these banks would choose the prudent portfolio instead.

Alleviating the debt bias thus promises welfare gains: A larger allowance for equity and a lower tax rate alleviate distortions of the capital structure and discourages risk
taking. With a full allowance for equity (i.e., $s = 1$ such that $\chi = 0$), bank risk taking is efficient, $\Omega^* = \tilde{\gamma}$. Any changes in the tax rate have no welfare implications in such a case. Therefore, a tax hike to compensate for the smaller tax base after introducing an allowance for equity does not diminish the welfare gains of such a reform.

Eventually, corporate tax reform can only reduce distortions of risk taking caused by the tax system itself, namely, by the debt bias. It cannot limit the degree of bank risk taking below $\Omega^* = \tilde{\gamma}$. If the latter is considered inefficiently high for reasons outside the model like, for example, social costs of bank failure or government guarantees, a reform of the corporate income tax alone can typically not solve this problem. Instruments like capital regulation or Pigovian taxes appear more suitable.

### 4 Extensions

The first extension introduces capital requirements, which oblige all banks to raise positive equity irrespective of their portfolio choice and charter value. This extension sheds light on how capital regulation influences the tax sensitivities of bank risk taking. The second extension explicitly models future bank profits and charter value thereby endogenizing the bank-specific returns.

#### 4.1 Capital Requirements

Suppose each bank has to maintain a capital ratio of at least $k$. Such capital requirements are similar to the leverage ratio in Basel III, which defines minimum equity relative to total (unweighted) bank assets.\(^8\) As long as capital requirements are rather low, some banks may still need to raise voluntary equity $\varepsilon$ in excess of the regulatory minimum to

\(^8\)It would be difficult to add risk-weighted capital requirements like in Célérier et al. (2019) in this framework, in which the portfolio choice of the bank is unobservable.
set proper incentives giving a total capital ratio of $e = k + \varepsilon$.

4.1.1 Risk Taking

**Portfolio Choice and Capital Structure:** Bank profit (11) and the no-gambling condition (12) are unchanged as they depend on the total capital ratio $e$ only. Minimum voluntary equity that ensures no-gambling is therefore given by:

$$\varepsilon \geq \varepsilon_0(i; \Omega) \equiv \frac{(1 - \tau)(1 + i + \hat{r} - \Omega)}{1 + i'} - k.$$  \hfill (29)

A bank will invest in the prudent portfolio only if its voluntary equity is at least $\varepsilon_0(i; \Omega)$. The total capital ratio, $e_0 = k + \varepsilon_0$, is independent of regulatory requirements and is solely determined by the no-gambling condition.

Regulatory capital requirements provide sufficient discipline and avoid gambling for some types that do not need any voluntary equity, $\varepsilon_0(i; \Omega^o) = 0$. This concerns highly profitable banks, $\Omega \geq \Omega^o(i) = 1 + i + \hat{r} - (1 + i')k/(1 - \tau)$. Obviously, the tighter capital standards are, the larger the share of such banks.

**Bank Value and Deposit Rate:** A prudent bank attracts deposits at the interest rate $1 + i^P = (1 + r)/\theta^P$ and must have minimum voluntary equity $\varepsilon \geq \varepsilon_0$. It maximizes expected bank value

$$V^P(\Omega) = \max_{\varepsilon, \lambda} \pi^P(k + \varepsilon, i^P; \Omega) + \lambda[\varepsilon - \varepsilon_0(i^P; \Omega)]$$  \hfill (30)

with $\pi^P(k + \varepsilon, i^P; \Omega) = (1 - \tau)(r^P + \theta^P\Omega) - \tau(1 - s)\theta^Pi^P(k + \varepsilon)$. The first-order condition for voluntary equity implies $\varepsilon = \varepsilon_0$. Investing in the prudent portfolio promises an ex ante value $V^P(\Omega) = (1 - \tau)(r^P + \theta^P)\Omega - \tau(1 - s)(1 + r - \theta^P)(k + \varepsilon_0)$.

A gambling bank must offer the high interest rate $1 + i^G = (1 + r)/\theta^G$ and solves

$$V^G(\Omega) = \max_{\varepsilon, \lambda} \pi^G(k + \varepsilon, i^G; \Omega) + \lambda[\varepsilon_0(i^G; \Omega) - \varepsilon]$$  \hfill (31)
with $\pi^G(k+\varepsilon, i^G; \Omega) = (1-\tau)(r^G + \theta^G \Omega) - \tau(1-s)\theta^G i^G(k+\varepsilon)$ by (11). Capital requirements bind, $\varepsilon = 0$, giving an ex ante value of gambling banks $V^G(\Omega) = (1-\tau)(r^G + \theta^G \Omega) - \tau(1-s)(1+r-\theta^G)k$.

Ex post, gambling banks need to offer outside shareholders a higher return on equity because they exhibit a higher insolvency risk. It coincides with the risk-adjusted interest rate on deposits, $i^G > i^P$. The fact that only part of this cost is tax-deductible therefore hurts gambling banks more than prudent banks:

$$\tau(1-s)\theta^G i^G = \tau(1-s)(1+r-\theta^G) > \tau(1-s)(1+r-\theta^P) = \tau(1-s)\theta^P i^P.$$  

They incur a higher tax cost per unit of equity. Through this specific channel, alleviating the debt bias may benefit gambling banks relatively more. Nevertheless, some prudent banks may still incur larger total costs of equity, $\tau(1-s)\theta^P i^P(k+\varepsilon_0)$, because of voluntary equity $\varepsilon_0$ on top of the regulatory minimum.

### 4.1.2 Equilibrium

In parallel to the standard model, equalizing ex ante bank values from the two portfolio options, $V^P(\Omega^*) = V^G(\Omega^*)$, determines the risk-taking cut-off:

$$\Omega^* = \tilde{\hat{r}} + \frac{\tau(1-s)(1+r-\theta^P)\varepsilon_0(i^P; \Omega^*)}{(1-\tau)\Delta \theta} - \frac{\tau(1-s)}{1-\tau}k.$$  

Substituting (29) for $\varepsilon_0(i^P; \Omega^*)$ gives the closed-form solution

$$\Omega^* = \tilde{\hat{r}} + \chi(1+i^P) - \frac{\tilde{\chi}(1+\i^P)k}{1-\tau}$$  

with $\tilde{\chi} \equiv \chi \cdot (1+r-\theta^G)/(1+r-\theta^P) > \chi$ and $\chi \in [0,1)$ being a measure of the tax distortion defined in (20). Unless the capital standard $k$ is very tight, some banks need to raise equity in excess of the regulatory minimum to set incentives for the prudent
portfolio, $\Omega^* < \Omega^0$. Otherwise, an alternative equilibrium will emerge in which no bank attracts voluntary equity, and the very high capital requirements $k > \tilde{k}$ bind for all banks. Some with high specific returns will invest in the prudent portfolio, whereas others might still exploit the gains from gambling despite their high capital ratio.\(^{10}\)

4.1.3 Results

Capital regulation does reduce risk taking in terms of a lower cut-off $\Omega^*$, see (33). Tighter regulatory requirements allow prudent banks to reduce costly voluntary equity $\varepsilon_0$, which makes this option more attractive, see (29). Moreover, satisfying the regulatory standards is more expensive for gambling banks: Since they must offer higher returns to shareholders that are only partially tax-deductible, the debt bias hurts them more than prudent banks.

In a neutral tax system, however, equity is no more expensive than deposits, and capital regulation does not influence the portfolio choice. It only affects risk taking as long as equity is more expensive than debt either due to tax distortions or other factors outside the model (e.g., government guarantees). Therefore, tax reforms like an ACE tend to diminish the sensitivity of bank risk taking to capital requirements:

**Lemma 2.** If the corporate income tax is neutral, the portfolio choice is insensitive to capital requirements.

\(^9\)The inequality $\Omega^* < \Omega^0$ requires:

$$k < \frac{(1 - \tau)(1 - \chi)(1 + i^P)}{(1 + i^P)(1 - \chi)} = \frac{1 - \tau}{1 - \tau(1 - s)} \equiv \tilde{k}.$$

The second equality uses the definition of $\chi$ in (20). This inequality plausibly holds under realistic parameter assumptions: The corporate tax rate $\tau$ typically ranges between 20\% and 30\% implying that $\tilde{k}$ is between 70\% to 80\% even if $s = 1$. This ceiling is an order of magnitude higher than a typical leverage ratio such as 3\% of total assets in Basel III.

\(^{10}\)In such an equilibrium, raising no voluntary equity, offering depositors the low interest rate $i^P$, and investing in the prudent portfolio is a potential strategy. It promises an ex ante bank value of $V^P = (1 - \tau)(r^P + \theta^P \Omega) - \tau(1 - s)\theta^P i^P k$, which exceeds $V^G$ in (31) if the charter value satisfies $\Omega \geq \Omega' = \tilde{r} - \tau(1 - s)k/(1 - \tau)$. Obviously, this cut-off decreases in $\tau$ and $k$ and increases in $s$. Such an allocation can only be incentive-compatible if the no-gambling condition (29) holds for all prudent banks with $\Omega \geq \Omega'$. One can show that latter is satisfied exactly if capital requirements satisfy $k \geq \tilde{k}$.
Proof: Equation (33) suggests \( d\Omega^*/dk = 0 \) if \( s = 1 \) such that \( \tilde{\chi} = \chi = 0 \). □

Next, we consider how the corporate income tax influences risk taking of banks constrained by capital requirements. We differentiate \( dV^P = dV^G \) and obtain:

\[
\left[ 1 - \tau - \tau(1 - s)\zeta \frac{d\varepsilon_0}{d\Omega} \right] \cdot d\Omega^* = \left[ \Omega^* - \tilde{r} + (1 - s)\zeta \left( \varepsilon_0 + \tau \frac{d\varepsilon_0}{d\tau} \right) - (1 - s)k \right] \cdot d\tau \\
- \tau \left[ \zeta \left( \varepsilon_0 - (1 - s) \frac{d\varepsilon_0}{ds} \right) - k \right] \cdot ds. \tag{34}
\]

Again, we use \( \zeta \equiv (1 + r - \theta^P)/\Delta \theta > 0 \). One can show that voluntary equity \( \varepsilon_0 \) responds to taxes in exactly the same way than total equity \( e_0 \) in the baseline model: It decreases both in the tax rate \( \tau \) and in the allowance for equity \( s \) and also falls with the type \( \Omega \).

In addition to the channels emphasized earlier, namely, relative expected returns, cost of equity, and equity volume, a distortionary corporate income tax also influences risk taking by making equity relatively more costly for gambling banks on a per-unit basis. Since they must offer a higher return on equity, gambling banks are disproportionately affected by the debt bias. Through this channel, a larger allowance for equity benefits them relatively more, while the reverse is true for a rising tax rate. These two effects are captured by the terms proportional to \( k \). Solving (34) establishes:

**Lemma 3.** The risk-taking cut-off \( \Omega^* \) responds to the tax according to

\[
d\Omega^* = -\sigma_s \cdot ds + \sigma_\tau \cdot d\tau \tag{35}
\]

with the coefficients defined as

\[
\sigma_s = \frac{\chi(1 - \chi)(1 + i^P)^2}{(1 - s)(1 + i')} - \frac{\tau(1 - \chi)(1 + \zeta)k}{1 - \tau}
\]

\[
\sigma_\tau = \frac{\chi(1 - \chi)(1 + i^P)^2}{\tau(1 + i')} - \left[ (1 - s)(1 + \zeta) + \frac{\tilde{\chi}(1 + i')}{1 - \tau} \right] \frac{(1 - \chi)k}{1 - \tau}.
\]

Proof: The coefficients follow from differentiating voluntary equity (29), which gives

\[
d\varepsilon_0 = -\frac{1 - \tau}{1 + i'} \cdot d\Omega - \frac{\tau i e_0}{1 + i'} \cdot ds - \frac{e_0(1 + s i)}{(1 - \tau)(1 + i')} \cdot d\tau,
\]

substituting these sensitivities into (34), and rearranging. □
How banks adjust their portfolio choice to taxes importantly depends on the magnitude of regulatory capital standards. If the latter are low, both coefficients $\sigma_s$ and $\sigma_\tau$ are obviously positive, and banks respond to taxes much like in the baseline model. A larger share of them invests in the prudent asset if the allowance for equity is increased or the tax rate reduced. Once capital standards are tighter, the risk-taking effects of corporate taxation become more ambiguous or are even reversed:

**PROPOSITION 5. If the corporate income tax is distortionary, bank adjust risk taking differently depending on capital requirements:**

- **With low capital requirements**, $k \leq k_0$, a larger tax allowance and a lower tax rate discourage risk taking. They both lower the risk-taking cut-off and induce more banks to invest in the prudent portfolio ($\sigma_s > 0$ and $\sigma_\tau > 0$).

- **With intermediate capital requirements**, $k_0 < k \leq k_1$, a larger tax allowance and a higher tax rate discourage risk taking ($\sigma_s \geq 0$ and $\sigma_\tau < 0$).

- **With high capital requirements**, $k > k_1$, a larger tax allowance and a lower tax rate induce more banks to invest in the gambling portfolio ($\sigma_s < 0$ and $\sigma_\tau < 0$).

A neutral corporate income tax has no effect on bank risk taking.

**Proof:** The three cases follow from evaluating the coefficients in (35). Appendix A derives the thresholds $k_0$ and $k_1$. If the tax is neutral with $s = 1$ such that $\chi = 0$, one obtains $\sigma_\tau = 0$. □

As long as minimum capital requirements are low, a more generous allowance for equity mitigates the debt bias and discourages risk taking. The reverse is true for a higher tax rate that induces more risk taking. The presence of capital standards weakens but does not fundamentally change the tax sensitivities compared to the standard model.
Although gambling banks are ceteris paribus more exposed to the debt bias, they have so little equity that differences in the per-unit tax costs of equity have negligible effects. Once capital standards are tight, gambling banks are also well capitalized, while voluntary equity $\varepsilon_0$ of prudent banks is small. There are no large differences in the capital ratios between prudent and gambling banks. Consequently, the fact the debt bias hurts the latter relatively more on a per-unit basis matters. A larger tax allowance thus boosts the ex ante value of gambling banks more in spite of the fact that the marginal prudent bank has more equity in total. It therefore contributes to increased risk taking. In the same spirit, a higher tax rate discourages risk taking because the stronger debt bias disproportionately hurts gambling banks. These results hold a fortiori whenever capital standards are so high that they bind for all banks (i.e., if $k > \bar{k}$).

The role of capital regulation is especially important for how changes in the corporate tax rate influence bank risk taking. This effect already becomes positive for some intermediate capital requirements, in which case a higher tax rate as well as a larger allowance for equity discourage risk taking (second case). The reason why capital standards may reverse the effects of the tax rate but not of the allowance is that regulation itself reduces risk taking, see (33). Due to the declining specific return of the pivotal type $\Omega^*$, the positive gap in total expected returns between prudent and gambling portfolios, $\tilde{r} - \Omega^*$, shrinks the tighter capital standards are. Recall that the tax rate reduces the relative value of prudent banks both by diminishing this difference and by magnifying the extra cost of equity caused by the debt bias, whereas only the second channel matters for the tax allowance. Consequently, capital standards have a more pronounced effect on how the tax rate influences risk taking.

In the light of the empirical evidence, the first and the second case in Proposition 5
seem relevant. Capital requirements in the range \( k \leq k_1 \) rationalize the findings that an ACE always reduces risk taking, while the consequences of the tax rate can be of either sign. Specifically, the first case with low capital standards \( k \leq k_0 \) explains the positive effect of the tax rate on bad loans obtained by Gambacorta et al. (2017) exactly for weakly capitalized banks. For \( k_0 < k \leq k_1 \), the model is consistent with Horváth (2018), who estimates that tax hikes reduce the share of non-performing loans.

These results only hold if the corporate income tax is distortionary and renders equity more expensive than deposits. Once the entire cost of capital is tax-deductible (i.e., \( s = 1 \)), the tax does not change the ranking of portfolios and does not influence risk taking. This property thus holds irrespective of capital requirements.

4.2 Charter Value

One interpretation of the bank-specific return is that it reflects a bank’s charter value, that is, the present value of its future profits. Changes in the tax code usually last for some years and thus influence future profits and charter value as well.

This extension endogenizes the charter value and adopts a dynamic variant of the model. Following Hellmann et al. (2000), we consider banks that operate for \( t = 0, 1, 2, ..., T \) periods. In each period, they attract deposits and equity, invest in either of the two portfolios, and pay out dividends if successful. Portfolio returns and interest rates are constant over time. In case of failure, the bank’s license is revoked.\(^{11}\)

Given a per-period expected profit from portfolio \( j = \{G, P\} \), \( \pi^j_t \), the discounted value of future bank profits equals

\[
V^j = \sum_{t=0}^{T} (\delta^t) \pi^j_t; \quad \delta \in [0, 1]
\]

denotes the discount factor. Like Hellmann et al. (2000), we consider the limit with \( T \to \infty \). Banks will choose

\(^{11}\)For each bank which exits, the regulator assigns a license to a new bank to preserve a competitive banking market.
their strategies corresponding to an infinitely repeated Nash equilibrium. Omitting time
indices, discounted expected profits thus equal \( V^j = \pi^j / (1 - \delta^j) \).

To preserve bank heterogeneity, we assume that banks differ in their discount factors:

**ASSUMPTION 3.** Discount factors \( \delta \) are observable and distributed with cumulative
density \( F_t(\delta) \) over the unit interval.

Some banks are more forward-looking than others, for example, due to different time
preferences of owners or managers. One might argue that privately owned banks tend to
focus more on creating long-term value, while publicly traded banks owned by dispersed
shareholders put more emphasis on the current performance.\(^{12}\)

### 4.2.1 Risk Taking

**Portfolio Choice and Capital Structure:** The per-period after-tax profit from port-
folio \( j \) is given by (11). With constant returns, interest rates, and taxes, the discounted
bank profit \( \bar{\pi}^j = \pi^j / (1 - \delta^j) \) equals:

\[
\bar{\pi}^j(e, i; \delta) = \frac{(1 - \tau)r^j + [(1 + r) - \theta^j (1 + i)](1 - \tau - e) - \tau (1 - \theta)e}{1 - \delta^j}. \tag{36}
\]

All banks earn the same per-period profit \( \pi^j \) but they evaluate future profits differently,
which is the very reason why bank values \( \bar{\pi}^j \) differ across types.

For any given interest rate and capital ratio, a bank invests in the prudent portfolio
as long as \( \bar{\pi}^P \geq \bar{\pi}^G \). Rearranging gives the no-gambling condition \( \pi^G - \pi^P \leq \Delta \theta \delta \bar{\pi}^P \).

The short-term gain from gambling must be smaller than the long-term expected loss
resulting from a higher probability of losing the charter value \( \delta \bar{\pi}^P \). We first reformulate

\(^{12}\)The distribution of discount factors may change over time. For example, if impatient banks gamble
and fail more often and the discount factor of new entrants is drawn from the original distribution,
patient types will gradually have a stronger representation.
the no-gambling condition by substituting (36) and dividing by $\Delta \theta$:

$$
(1 - \tau)\tilde{r} + (1 + i)(1 - e) - \tau[1 + i - (1 - s)iE] \leq \frac{\delta [(1 - \tau)rE + [(1 + r) - \thetaE(1 + i)](1 - \tau - e) - \tau(1 - s)\thetaE iE]}{1 - \delta\thetaE}.
$$

(37)

The corporate income tax diminishes the gains from gambling (left-hand side) in parallel to the baseline model. It also affects the charter value (right-hand side): A higher tax rate impairs future profits and charter value, while the reverse is true for a larger allowance.

The last effect, which is not present in the static model, suggests that an allowance for equity renders gambling less attractive both in the short and in the long run. One can solve the no-gambling condition for the minimum capital ratio $e_0$:

$$
e_0(i; \delta) = (1 - \tau)e_0(i; \delta), \quad \tilde{e}_0(i; \delta) = \frac{1 + i + \tilde{r} - \tilde{\delta}[rE + (1 + r) - \thetaE(1 + i)]}{1 + \tilde{\delta}[(1 + r) - \thetaE(1 + i) + \tau(1 - s)\thetaE iE]}.
$$

(38)

This formulation uses the definitions $\tilde{\delta} \equiv \delta/(1 - \delta\thetaE) > \delta$ and $\tilde{\delta} \equiv i[1 - \tau(1 - s)]$.

**Bank Value and Deposit Rate:** In each period, the bank attracts deposits and equity and promises a risk-adjusted deposit rate, $\thetaE(1 + i^E) = 1 + r$. Deposit rate and capital structure need to be incentive-compatible.

A bank that intends to invest in the prudent portfolio offers a deposit rate $1 + i^E = (1 + r)/\thetaE$ if its capital ratio satisfies $e \geq e_0(i^E; \delta)$ and solves

$$
V^E(\delta) = \max_{e, \lambda} \tilde{\pi}^E(e, i^E; \delta) + \lambda[e - e_0(i^E; \delta)]
$$

with $\tilde{\pi}^E(e, i^E; \delta) = [(1 - \tau)rE - \tau(1 - s)\thetaE iE]/(1 - \delta\thetaE)$. The constraint on equity binds, which implies $e = e_0(i^E; \delta)$. The ex ante bank value is $V^E(e, i^E; \delta) = [(1 - \tau)rE - \tau(1 - s)(1 + r - \thetaE)e_0(i^E; \delta)]/(1 - \delta\thetaE)$.

A bank that intends to gamble needs to offer depositors a higher interest rate $1 + i^G = (1 + r)/\thetaG$. It maximizes

$$
V^G(\delta) = \max_{e, \lambda} \tilde{\pi}^G(e, i^G; \delta) + \lambda[e_0(i^G; \delta) - e]
$$

(40)
with \( \pi^G(e, \epsilon^G; \delta) = [(1 - \tau)r^G - \tau(1 - s)\theta^G \epsilon^G]/(1 - \delta\theta^G) \). Again, zero equity is optimal, \( e = 0 \), and the ex ante value equals \( V^G(\delta) = (1 - \tau)r^G/(1 - \delta\theta^G) \).

### 4.2.2 Equilibrium

With correct deposit pricing, the equilibrium capital ratio of a prudent bank is:

\[
e_0(\delta) = (1 - \tau)\tilde{e}_0(\delta), \quad \tilde{e}_0(\delta) \equiv \frac{1 + r + \theta^P(\hat{r} - \tilde{\delta}r^P)}{1 + r - \tau(1 - s)(1 + r - \theta^P)(1 + \tilde{\delta}r^P)}.
\]

(41)

Substituting this into \( V^P \) and setting \( V^P(\delta) \geq V^G(\delta) \) gives

\[
\frac{r^P - \tau(1 - s)(1 + r - \theta^P)\tilde{e}_0(\delta)}{1 - \delta\theta^P} \geq \frac{r^G}{1 - \delta\theta^G} > 0.
\]

(42)

Like in the static model, influences the portfolio choice only through the total costs of bank equity. It is captured by the term \( \tau(1 - s)(1 + r - \theta^P)\tilde{e}_0 \).

### 4.2.3 Results

We first show how taxes influences the capital ratio the minimum capital ratio that prevents gambling in equilibrium, \( e_0(\delta) = (1 - \tau)\tilde{e}_0(\delta) \):

\[
de_0 = (1 - \tau) \cdot d\tilde{e}_0 - \tilde{e}_0 \cdot d\tau
\]

(43)

with

\[
d\tilde{e}_0 = -\frac{\theta^P}{(1 - \tilde{\delta}r^P)^2} \frac{r^P - \tau(1 - s)(1 + r - \theta^P)\tilde{e}_0}{1 + r - \tau(1 - s)(1 + r - \theta^P)(1 + \tilde{\delta}r^P)} \cdot d\delta
\]

\[
+ \frac{\tilde{e}_0(1 + r - \theta^P)(1 + \tilde{\delta}r^P)}{1 + r - \tau(1 - s)(1 + r - \theta^P)(1 + \tilde{\delta}r^P)} [(1 - s) \cdot d\tau - \tau \cdot ds].
\]

The first term is always positive on account of (42). Forward-looking banks with a high discount factors value continuation more and can thus afford a lower capital ratio without weakening risk-taking incentives.

Like in the static model, a larger tax allowance \( s \) decreases the minimum capital ratio because prudent banks with a higher probability of being solvent benefit relatively more from this deduction both in the current and in future periods. The effect of a higher tax
rate $\tau$ is more ambiguous, however: It lowers the short-term gains from gambling but also depresses future profits and charter value. The second effect is captured by the increase in $\tilde{e}_0$. The net effect follows from substituting for $d\tilde{e}_0$ in (43):

$$
\frac{de_0}{d\tau} = -\tilde{e}_0 \frac{1 + r - (1 - s)(1 + r - \theta P)(1 + \tilde{\delta} \theta P)}{1 + r - \tau(1 - s)(1 + r - \theta P)(1 + \tilde{\delta} \theta P)}.
$$

It is usually negative such that a higher tax rate allows for a lower capital ratio. A rising tax rate unambiguously reduces minimum equity if either the tax system is neutral with $s \to 1$ or if the bank is myopic with $\delta \to 0$. Otherwise, the effect of larger tax costs of equity in the future can be quite strong for forward-looking banks. Minimum equity may thus rise with the tax rate for $\delta \to 1$ [and $\tilde{\delta} \to 1/(1 - \theta P)$] provided that the tax is distortionary.

To evaluate how profit taxation influences risk taking, we differentiate the pivotal discount factor $\delta^*$ starting with $dV^P(\delta^*) = dV^G(\delta^*)$ and find:

**PROPOSITION 6.** The risk-taking cut-off $\delta^*$ responds to the tax according to

$$
\sigma_\delta \cdot d\delta^* = -\sigma_s \cdot ds + \sigma_\tau \cdot d\tau
$$

with all coefficients defined positive. If the tax is distortionary, the cut-off decreases in the allowance for equity and increases in the tax rate. Otherwise, it is insensitive to taxation.

**Proof:** See Appendix A.

How the corporate income tax influences bank risk taking largely mirrors the effects derived in the static model: A larger allowance induces even rather impatient types to invest in the prudent portfolio. Such a reform discourages risk taking and enhances financial stability. A higher tax rate, in contrast, induces more risk taking and weakens financial stability. Again, a neutral tax does not affect risk taking.
5 Conclusion

The stability of an individual bank rests on a robust capital structure with large equity buffers that absorb losses and a safe, well-diversified loan or asset portfolio. Corporate taxation influences both margins. Stability gains from a tax reforms that addresses the debt bias can thus result from smaller leverage and from lower portfolio risk.

This paper provides a first theoretical analysis of the risk-taking channel and we develops a principal-agent model that emphasizes the incentive function of equity in influencing risk taking of banks. Corporate taxation matters for risk taking mainly because of its effect on the costs of equity relative to deposits (debt bias).

Our analysis yields three sets of results: First, an allowance for corporate equity and a lower corporate tax rate discourage bank risk taking thereby improving financial stability and welfare. Intuitively, these policies mitigate the debt bias in taxation and thereby facilitate the use of equity as a disciplining in setting proper risk-taking incentives. These results are obtained in both a static and a dynamic model, in which permanent tax changes also influence risk taking through future profits and charter value.

Second, the corporate income tax has no effect on risk taking if is is neutral and allows for the deduction of the entire costs of capital. This property mirrors prior results in the business taxation literature. Since risk taking is insensitive to tax rate changes in this case, introducing an ACE in a revenue-neutral fashion unambiguously reduces risk taking and enhances financial stability.

Third, capital requirements influence the risk-taking effects of taxes and may even reverse them. Intuitively, the debt bias makes satisfying capital requirements relatively more costly for gambling banks because they must offer shareholders higher returns that are only partly tax-deductible. Through this channel, all measures that mitigate the debt
bias ceteris paribus benefit such banks relatively more. This specific channel becomes important whenever capital requirements are tight. In this case, a higher tax rate may reduce risk taking and, to a lesser extent, a larger tax allowance may increase it.

References


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Income Taxation and the Costs of Banking Crises. European Commission Taxation Papers No. 50.


A Appendix

Proof of Proposition 3: We need to show that a larger allowance for equity $s$ raises aggregate capital ratio in (26) if types are uniformly distributed:

$$
\frac{d\bar{c}_0}{ds} = \int_{\Omega^e} \frac{d\bar{c}_0(\Omega)}{ds} dF(\Omega) - e^*_0 f(\Omega^*) \frac{d\Omega^*}{ds}
$$

$$
= - \frac{\tau \bar{r}_P}{1 + \bar{r}'} \int_{\Omega^e} e_0(\Omega) dF(\Omega) + e^*_0 f(\Omega^*) \sigma_s
$$

$$
= \frac{1}{\Omega} \left[ e^*_0 \sigma_s - \frac{\tau \bar{r}_P}{1 + \bar{r}'} \left( \frac{(1 + \bar{r})(\Omega_o - \Omega^*)}{1 + \bar{r}' - \Omega^*} - \frac{\Omega^2 - \Omega^*}{2(1 + \bar{r}')} \right) \right]
$$

$$
= \frac{1}{\Omega} \left[ e^*_0 \sigma_s - \frac{(1 - \tau) \tau \bar{r}_P}{1 + \bar{r}'} \left( \frac{(1 + \bar{r})(\Omega_o - \Omega^*)}{1 + \bar{r}' - \Omega^*} - \frac{\Omega^2 - \Omega^*}{2} \right) \right]
$$

$$
= e^*_0 \left[ \sigma_s - \frac{\tau \bar{r}_P}{1 + \bar{r}'} \left( \frac{\Omega_o - \Omega^*}{2} \right) \right] = e^*_0 \left[ \sigma_s - \frac{\bar{r}_P}{2(1 - \tau)} \frac{\bar{r}_P e^*_0}{(1 + \bar{r}')} \right]
$$

$$
= \frac{\tau \bar{r}_P e^*_0}{2(1 - \tau) \Omega} \frac{\theta P(1 + \bar{r}) + \theta^2(1 + \bar{r})}{\Delta \theta(1 + \bar{r}) + \tau(1 - \bar{r}) \theta P \bar{r}} > 0.
$$

We use $\Omega_o = 1 + \bar{r} + \tilde{r}$, $e_0^* = (1 - \tau)(1 - \chi)(1 + \bar{r})/(1 + \bar{r}')$, and $\Omega_o - \Omega^* = (1 - \chi)(1 + \bar{r}) = e_0^*(1 + \bar{r}')/(1 - \tau)$.

Proof of Proposition 2: A larger tax allowance decreases the risk-taking cut-off if

$$
\sigma_s > 0 \quad \Leftrightarrow \quad k < \frac{\chi(1 - \tau)(1 + \bar{r})^2}{\tau(1 + i')(1 + \zeta)(1 + \bar{r})} \equiv k_1.
$$

Similarly, a higher tax rate increases the risk-taking cut-off if

$$
\sigma_\tau > 0 \quad \Leftrightarrow \quad k < \frac{\chi(1 - \tau)(1 + \bar{r})^2}{\tau(1 + i')(1 + \zeta) + \tilde{\chi}\bar{r}_P \zeta} \cdot \frac{k_1}{1 + \frac{\tilde{\chi}(1 + \bar{r})}{(1 - \tau) \Omega \Delta \theta(1 + \bar{r}) + \tau(1 - \bar{r}) \theta P \bar{r}}} \equiv k_0.
$$

Obviously, we have $k_0 < k_1$: For some capital requirements, both a larger allowance for equity and a higher tax rate reduce the risk-taking cut-off.

One eventually needs to check whether capital requirements above those thresholds, $k > k_0$ and $k > k_1$, are feasible and that they do not become binding for all types. In
In this case, equations (32) - (33) would not be a solution. Noting $k_0 < k_1$, it suffices to show that $k_1 < \tilde{k}$ always holds:

\[
k_1 = \frac{\chi(1 - \tau)(1 + iP)}{\tau(1 - s)(1 + \zeta)(1 + i')} < \frac{(1 - \tau)(1 - \chi)(1 + i')}{(1 - \tilde{\chi})(1 + i')} = \tilde{k}
\]

\[
\Leftrightarrow \frac{\chi(1 + iP)}{\tau(1 - s)(1 + \zeta)} < \frac{1 - \chi}{1 - \tilde{\chi}}
\]

\[
\Leftrightarrow \frac{(1 + r - \theta P)(1 + iP)}{(1 + \zeta)} = \frac{\Delta \theta \zeta(1 + iP)}{(1 + \zeta)} < \frac{\Delta \theta (1 + i')}{1 - \tilde{\chi}}
\]

\[
\Leftrightarrow \frac{1 + r - \theta P}{1 + r - \theta G}(1 - \tilde{\chi})(1 + iP) = \frac{1 + r - \theta P}{1 + r - \theta G}(1 + iP) - \chi(1 + i') < 1 + i'
\]

\[
\Leftrightarrow \frac{\theta P(1 + iP)}{1 + r - \theta G} + \tau(1 - s)iP \left[ \frac{\theta P(1 + iP)}{\Delta \theta (1 + i') + \tau(1 - s)(1 + r - \theta P) - 1} \right] > 0
\]

\[
\Leftrightarrow \frac{\theta P(1 + iP)}{1 + r - \theta G} + \tau(1 - s)iP \frac{\theta G(1 + i')}{\Delta \theta (1 + i') + \tau(1 - s)(1 + r - \theta P)} > 0,
\]

which uses the definition of $\chi$ in (20) and $\zeta = (1 + r - \theta P)/\Delta \theta$. □

**Proof of Proposition 6:** We first differentiate $V^P(\delta^*) = V^G(\delta^*)$ and substitute the sensitivities of minimum equity, $de_0$, using (43). Rearranging and collecting terms gives equation (44) with the coefficients defined according to:

\[
\sigma_\delta = \frac{\Delta \theta V}{(1 - \delta \theta P)^2} \left[ \frac{1 - \delta \theta P}{1 - \delta \theta G} + \frac{\tau(1 - s)\theta P \zeta}{1 + r - \tau(1 - s)(1 + r - \theta P)(1 + \tilde{\delta} \theta P)} \right] > 0,
\]

\[
\sigma_s = \frac{\tau(1 + r - \theta P) e_0}{1 - \delta \theta P} \frac{1 + r}{1 + r - \tau(1 - s)(1 + r - \theta P)(1 + \tilde{\delta} \theta P)} > 0,
\]

\[
\sigma_\tau = \frac{(1 - s)(1 + r - \theta P) e_0}{1 - \delta \theta P} \frac{1 + r}{1 + r - \tau(1 - s)(1 + r - \theta P)(1 + \tilde{\delta} \theta P)} > 0.
\]

Note $V \equiv V^P(\delta^*) = V^G(\delta^*)$. By inspection, they are all non-negative. □