Profit Taxation and Bank Risk Taking*

Michael Kogler†

June 20, 2019

Abstract

How can tax policy 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. The corporate income tax influences risk-taking incentives through the cost of equity relative to deposits, the after-tax returns on different portfolios, and future bank profits. This analysis demonstrates that a tax reform which eliminates the debt bias discourages risk taking and lowers bank failure risk. In addition, raising the corporate tax rate can reduce risk taking in the short run, whereas permanent tax hikes have destabilizing long-term effects.

JEL classification: G21, G28, H25

Keywords: Corporate taxation, tax reform, risk taking, financial stability

*I am grateful to participants at the ZEW Public Finance Conference 2019 and to Olli Ropponen (the discussant) for helpful comments and discussions.

†University of St. Gallen, Institute of Economics (FGN-HSG), Varnbœulstrasse 19, CH-9000 St. Gallen, Switzerland. E-mail: michael.kogler@unisg.ch.
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 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, for example, 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: If banks respond to a tax reform by reducing their leverage, they can better absorb losses because of larger capital buffers. They 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 equity (ACE) as well as 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, the model emphasizes risk taking at the extensive margin. Banks have heterogeneous charter values reflecting different profit opportunities in the future. Since the charter value is forgone in case the bank fails and exists, it discourages risk taking. Equilibrium exhibits different risk-taking strategies: Banks with a large charter value attract equity and invest in the prudent portfolio, while others raise little or no equity and gamble.

Our analysis yields three sets of novel results: First, corporate taxation influences risk taking - a bank’s portfolio choice - through three main channels: Taxes affect (i) the capital structure via the relative cost of equity and deposits, (ii) the expected after-tax returns on the two portfolios, and (iii) future profits reflected in the charter value if tax changes are permanent. The risk-taking incentives depend on those three factors, which reinforce each other in case of changes in the tax allowance but tend to offset each other in case of tax rate changes.

Second, tax reforms like ACE that mitigate the debt bias discourage risk taking. Making the cost of equity tax-deductible facilitates the use of equity as a disciplining device that helps set proper risk-taking incentives. Such a reform offers financial stability gains, for example, by reducing the probability of bank failure. Provided that the debt bias is so severe that it leads to excessive risk taking, a larger tax allowance also contributes to higher welfare.
Third, raising the corporate tax rate may enhance financial stability and possibly welfare at least in the short run. Taxing the high return of a successful gamble renders such a portfolio less attractive. Unless the capital ratio is very high, banks take fewer risks despite the higher cost of equity. Consequently, a revenue-neutral tax reform that grants a full deduction of the cost of equity and raises tax rates to compensate for the shrinking tax base can substantially improve financial stability. While this result is true for a temporary tax hike, a permanently higher tax rate has counteracting effects as demonstrated in a dynamic model extension. It depresses future profits and impairs charter values and even encourages risk taking.

These findings describe the behavior of capital-abundant banks that do not face binding regulatory restrictions on their capital structure and are especially responsive to taxes. An extension, however, shows that the main results also hold in the presence of minimum capital requirements. In this case, mitigating the debt bias makes risk taking less sensitive to capital regulation because banks voluntarily raise more equity.

The present paper connects to two strands of the public economics and banking literature. First of all, many papers have analyzed how corporate taxation influences the capital structure of non-financial firms and, more recently, of banks and identified the main distortions caused by the debt bias. Theoretical and empirical research suggests that the corporate income tax raises firm leverage (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 corporate tax rates find similar 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. They estimate comparable effects on the capital structure of banks.

These studies generally use cross-country or regional variations in corporate tax rates. An alternative approach exploits tax reforms: Schepens (2016) and Célérier et al. (2019) study the introduction of a tax allowance (ACE) in Belgium 2006 and find significant increases in capital ratios and equity volume of banks. Schepens (2016), for example, estimates an increase in capital ratios of 13.5 percent. Martin-Flores and Moussu (2018) find comparable effects for a tax allowance on marginal equity that temporarily existed in Italy between 1997 and 2002.

Such findings suggest that eliminating the debt bias promises large financial stability gains by reducing bank leverage: The empirical results of De Mooij et al. (2014) imply 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 bank recapitalization) in the range of 40 to 77 percent.

A complementary source of stability gains usually not considered in these quantitative studies are safer asset portfolios of banks. Empirical evidence from tax reforms in Belgium (Schepens, 2016; Célérier et al., 2019) and Italy (Martin-Flores and Moussu, 2018)
suggests 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. Horváth (2018), in turn, uses cross-country data and finds that a high corporate tax rate reduces the share of non-performing loans. Therefore, tax reforms which reduce the debt bias and tax cuts may affect risk taking differently although they both reduce the cost of equity.

A related risk measure is the composition of portfolios between loans and securities. Motivated by a mean-variance model, Célérier et al. (2019) emphasize the role of risk weights in capital regulation. A tax allowance induces banks to attract more equity and thereby relaxes the binding regulatory constraints. As a result, banks allocate the additional equity to the assets - typically loans - that carry higher risk weights, and the portfolio share of loans as well as the average regulatory risk weight increase.¹

The present paper sets out one of the first theoretical models of corporate taxation and bank risk taking. In particular, it rationalizes the counteracting effects of tax allowance and tax cuts on portfolio risk observed in the data and sheds light on the financial stability and welfare implications of those policies. 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.

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

¹In a similar spirit, Horváth (2018) argues that higher tax rates tighten regulatory constraints thereby inducing banks to shift funds from loans to securities.
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 as shown in empirical studies (e.g., Keen and de Mooij, 2016), and about banks for which the new - unweighted - leverage ratio in Basel III represents the main constraint.

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 provide discipline, alleviate moral hazard, and discourage risk taking (Hellmann et al., 2000). The theoretical literature has especially emphasized competition 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 future profits, as more fundamental determinants of bank risk taking.

In this spirit, several papers explore the scope for Pigovian taxes in banking and analyze how such taxes influence the risk-taking incentives of banks. Examples are Perotti and Suarez (2011) who suggest a Pigovian tax on short-term funding, and Devereux et al. (2015) who study how a levy on bank liabilities influences leverage and asset risk.

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 im-
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

We build on the risk-taking model of Hellmann et al. (2000), which pictures the bank’s choice between a prudent portfolio with low risk and a low 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 and charter value of banks become key determinants of risk taking. In our baseline model, the charter value is taken as given. It is a source of bank heterogeneity that rationalizes different risk-taking strategies in equilibrium. We endogenize the charter value as an extension (see, Section 4.2). Unlike in 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 such an excess return.

2.1 Banks and Portfolios

There is a continuum of measure one of heterogeneous banks. Each bank raises funds of size one consisting of deposits and equity, which are elastically supplied by investors
who demand an expected gross return $1 + r$. Since deposits are risky, banks must offer a risk-adjusted deposit rate $i$.

The bank can invest either in a prudent or in a gambling portfolio. Portfolio $j = \{P, G\}$ offers (i) a high payoff $1 + \alpha + \gamma$ with $\alpha > 0$ and $\gamma > 0$ with probability $\theta^j_h$, (ii) an intermediate payoff $1 + \alpha$ with probability $\theta^j_m$, and (iii) zero with the complementary probability $\theta^j_l = 1 - \theta^j_h - \theta^j_m$. In case of a zero payoff, the bank fails; it cannot repay outstanding deposits and exits. Figure 1 illustrates these outcomes. Defining the success probability $\theta^j \equiv \theta^j_h + \theta^j_m$, the portfolio’s expected (net) return is $r^j \equiv \theta^j (1 + \alpha) + \theta^j_h \gamma - (1 + r)$.

Figure 1: Portfolio Returns

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

The returns or 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 the high return $\gamma$ but have 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.

Modeling a portfolio with three possible outcomes allows us to capture this classical trade-off between risk and return in a setup with an unobservable portfolio choice and observable payoffs.\(^2\) Once a bank raised deposits and equity, it can invest in either portfolio. While outsiders observe the realized payoff, they do not know whether it was generated by the prudent or the gambling portfolio.

Furthermore, each bank has a charter value \(\Omega\) that captures the net present value of its future profits in reduced form. Importantly, the charter value is forgone if the bank fails and its license is revoked, which occurs with probability \(1 - \theta^j\) depending on its portfolio. With a discrete portfolio choice, the model pictures the extensive margin of risk taking. For that purpose, we assume that banks are heterogeneous and differ in charter values:

**ASSUMPTION 2.** \(\Omega\) is distributed on \([0, \Omega]\) with cumulative density \(F(\Omega)\).

A large charter value reflects attractive long-term lending opportunities that promise high future profits. One could alternatively argue that heterogeneity stems from different discount factors of shareholders with which banks evaluate the very same future profits (see Section 4.2). In this setup, equilibrium exhibits differences in risk taking as banks with a large charter value are ceteris paribus less inclined to gamble. Heterogeneous risk-taking incentives are also emphasized in a related paper by Perotti and Suarez (2011).

The timing is as follows: (i) banks raise deposits and equity, they offer a financing

\(^2\)With 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.
contract to depositors that specifies the deposit interest rate, (ii) banks choose the portfolio, and (iii) the payoff is realized, if the bank fails, it is closed down and the license is revoked. Otherwise, it continues and can realize the charter value.

2.2 Risk Taking

For given interest rate on deposits $i$ and capital ratio $e$, a bank’s expected profit from investing in portfolio $j = \{G, P\}$ equals:

$$\pi^j(e, i) = \theta^j[1 + \alpha - (1 + i)(1 - e)] + \theta^j_h \gamma - (1 + r)e$$

$$= r^j + [(1 + r) - \theta^j(1 + i)](1 - e).$$

(1)

Depositors are repaid $1 + i$ if the bank succeeds, outside shareholders are promised an expected return on equity of $1 + r$. With probability $\theta^j = \theta^j_h + \theta^j_m$, the bank earns at least the intermediate return $1 + \alpha$, succeeds, and repays deposits; with probability $\theta^j_m$, it receives the extra return $\gamma$ as well. The second line rewrites profit as the portfolio’s expected net return $r^j$ plus a limited liability effect from a potential default on deposits. Taking into account that the charter value is forgone if the bank fails, the bank value is:

$$V^j(e, i; \Omega) = \pi^j(e, i) + \theta^j \Omega.$$  

(2)

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

$$\pi^G(e, i) - \pi^P(e, i) \leq \Delta \theta \Omega, \quad \Delta \theta \equiv \theta^P - \theta^G > 0.$$  

(3)

This no-gambling condition ensures that the (short-term) gain from risk-taking $\pi^G - \pi^P$ must be smaller than the (long-term) expected loss in charter value $\Delta \theta \Omega$. Substituting
for profits using (1) and dividing by $\Delta \theta$ gives
\[ \tilde{r} + (1 + i)(1 - e) \leq \Omega, \quad \tilde{r} \equiv \frac{r^G - r^P}{\Delta \theta}. \] (4)

The short-term gains from risk taking the left-hand side result from a 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), $\Delta \theta (1 + i)(1 - e)$.

The latter decreases in the capital ratio $e$ and vanishes if $e = 1$.

Equity plays the typical disciplining role and helps banks alleviate moral hazard. Solving the no-gambling condition (4) for $e$ defines the minimum capital ratio that preserves the incentive to invest in the prudent portfolio
\[ e \geq e_0(i; \Omega) \equiv 1 + \frac{\tilde{r} - \Omega}{1 + i}. \] (5)

Only with a capital ratio of at least $e_0$, a bank will choose the prudent portfolio. Otherwise, it is privately optimal to take more risks and gamble. Importantly, minimum equity is type-specific and decreases in charter value.

Banks with a very large charter value always prefer the prudent portfolio even with no equity. The risk of losing the charter value is so large that they are better off by choosing the safer portfolio that promises the highest chance of success and of being able to realize the large future profits. This reflects the standard result in the risk-taking literature that charter value and equity have comparable incentive effects. The zero-equity cut-off
\[ \Omega^0(i) = 1 + \tilde{r} \] (6)
pins down the type who prefers the prudent portfolio with zero equity, $e_0(i; \Omega^0) = 0$.

In contrast, some banks with very small charter values, $\Omega < \tilde{r}$, 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 because the forgone charter value is very small.

**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:

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

(7)

It pins down 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, \( \pi^j = r^j \).

Most importantly, risk taking is not observable and banks take capital structure and interest rate as given at a later stage when deciding about the portfolio. 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 (5) and charge the low interest rate \( i^P \) only if a bank is sufficiently capitalized. Depositors anticipate that such a bank will subsequently find it optimal to invest in the prudent portfolio. Otherwise, they expect that the bank will gamble later on and charge the high deposit rate \( i^G \).

Each bank must therefore choose between two options or strategies: First, consider first 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 (5) gives the constrained maximization problem

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

with $V^P(e, i^P; \Omega) = r^P + \theta^P \Omega$ and $\lambda$ denoting the multiplier. The first-order condition for equity gives $\lambda = 0$ such that according to complementary slackness, the minimum equity condition does not bind and any capital ratio $e \geq e_0(i^P; \Omega)$ is optimal. Banks may raise additional equity in excess of $e_0$. The reason is that equity is no more expensive or scarcer than debt. The maximum bank value is $V^P(\Omega) = r^P + \theta^P \Omega$.

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

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

with $V^G(e, i^G; \Omega) = r^G + \theta^G \Omega$. 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 (8) and (9) 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

Bank are heterogeneous in charter values that influence the ex ante bank value directly, and, if it opts for the prudent strategy, also via minimum equity $e_0$. Consequently, some banks have a higher ex ante value from raising equity and investing in the prudent portfolio, while the gambling strategy is more attractive for others.
The pivotal bank with charter value $\Omega^*$ that is indifferent between the two portfolios is defined by $V^P(\Omega^*) = V^G(\Omega^*)$. Substituting for bank values yields the risk-taking cut-off:

$$\Omega^* = \max\{\tilde{r}, 0\}. \quad (10)$$

Banks with a larger charter value, $\Omega \geq \Omega^*$, choose the prudent strategy, whereas others, $\Omega < \Omega^*$, gamble. Should gambling not offer any expected short-term gains (i.e., if $r^G \leq r^P$ and $\tilde{r} \leq 0$), no bank gambles. In any case, some prudent banks must raise positive equity to have proper incentives because the risk-taking cut-off is smaller than the zero-equity cut-off, $\Omega^* < \Omega^o(i^P) = (1+r)/\theta^P + \Omega^*$. Substituting (10) into minimum equity (5) reveals that the pivotal type is an all-equity financed bank, $e(\Omega^*) = 1$.

As a result, three groups of banks emerge in equilibrium:

- **$\Omega \geq \Omega^o(i^P)$:** Such banks invest in the prudent portfolio even with no equity because of their large charter value. They succeed with probability $\theta^P$.

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

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

In equilibrium, a fraction $1 - F(\Omega^*)$ of banks invests in the prudent and a fraction $F(\Omega^*)$ invests in the gambling portfolio. A share $F[\Omega^o(i^P)] - F(\Omega^*)$ attracts positive equity.

### 3 Corporate Income Tax

This section introduces a corporate income tax, which potentially discriminates between debt and equity (‘debt bias’). The tax rate equals $\tau$, and the tax base is profit equal to
the realized payoff, which is either \( \alpha \) or \( \alpha + \gamma \), net of the interest expense on deposits, \( i(1 - e) \). A fraction \( s \in [0, 1] \) of the cost of bank equity can be deducted from the tax base.

We assume that the notional return on equity is equal to the interest rate on deposits \( i \). 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: \( s = 0 \) reflects the traditional tax with the debt bias, and \( s = 1 \) describes a neutral tax with a full deduction of the cost of capital. This setup allows us to distinguish between the level effect of changes in the tax rate and the effect of a tax reform that addresses the debt bias with a larger allowance for equity.

Depending on which portfolio return is realized, the tax liability is:

\[
T_m = \tau[\alpha - i(1 - e) - sie], \quad T_h = \tau[\alpha + \gamma - i(1 - e) - sie], \quad T_i = 0. \tag{11}
\]

A bank’s expected tax burden when investing in portfolio \( j = \{G, P\} \) is \( T^j = \theta^j_m T_m + \theta^j_h T_h = \theta^j m T_m + \theta^j h \tau \gamma \); the second equality uses \( T_h = T_m + \tau \gamma \). By substituting and collecting terms, one obtains:

\[
T^j = \tau[\theta^j (\alpha - i(1 - s)e) + \theta^j h \gamma] = \tau[r^j + (1 + r) - \theta^j (1 + i) + (1 - s)\theta^j i e] \tag{12}
\]

Equity increases the expected tax burden because of the debt bias, \( s < 1 \). Only if the corporate income tax is neutral with \( s = 1 \), it is independent of the capital structure.

In any case, gambling banks pay a higher expected tax than prudent banks, \( T^G \geq T^P \): First, the expected portfolio return is higher as long as \( r^G \geq r^P \). Second, a gambling bank less likely to remain solvent, \( \theta^G < \theta^P \), and can thus benefit from fewer opportunities to deduct the costs of deposits from the tax base. Noting (1), the short-term after-tax profit from portfolio \( j \) equals

\[
\pi^j(e, i) = r^j + [(1 + r) - \theta^j (1 + i)](1 - e) - T^j
= (1 - \tau) r^j + [(1 + r) - \theta^j (1 + i)](1 - \tau - e) - \tau(1 - s)\theta^j i e. \tag{13}
\]
3.1 Risk Taking

**Portfolio Choice and Capital Structure:** For a given deposit rate and capital ratio, the bank chooses the prudent portfolio as long as \( \pi^G(e, i) - \pi^P(e, i) \leq \Delta \theta \Omega \). Substituting (12) and (13) and dividing by \( \Delta \theta \) yields the no-gambling condition:

\[
\tilde{r} + (1 + i)(1 - e) - \tau[1 + i + \tilde{r} - (1 - s)i e] \leq \Omega.
\] (14)

The short-term gains from gambling on the left-hand side reflect three factors: First, the gambling portfolio usually a higher expected pre-tax return, \( \tilde{r} \geq 0 \). Second, there are more opportunities to default and not repay deposits \( (1 + i)(1 - e) \). Third, gambling is associated with a larger expected tax burden. This effect, which is represented by the third term, diminishes those short-term gains.

Solving (14) yields the minimum capital ratio which prevents gambling

\[
e \geq e_0(i; \Omega) = \frac{(1 - \tau)(1 + i + \tilde{r}) - \Omega}{1 + i'}
\] (15)

with \( i' \equiv i[1 - \tau(1 - s)] \leq i \). This capital ratio is zero, \( e_0(i; \Omega^o) = 0 \), whenever the charter value is large enough, \( \Omega > \Omega^o = (1 - \tau)(1 + i + \tilde{r}) \). Compared to the model without taxes, more banks can afford zero equity without violating the no-gambling condition because taxes lower the gains from risk taking.

**Bank Value and Deposit Rate:** Each bank chooses between two incentive-compatible and profit-maximizing strategies. First, a bank which invests in the prudent portfolio can raise deposits at interest rate \( 1 + i^P = (1 + r)/\theta^P \) and must have a minimum capital ratio \( e \geq e_0(i^P; \Omega) \) according to (15),

\[
V^P(\Omega) = \max_{e, \lambda} V^P(e, i^P; \Omega) + \lambda[e - e_0(i^P; \Omega)]
\] (16)

with \( V^P(e, i^P; \Omega) = (1 - \tau)i^P - \tau(1 - s)\theta^P i^P e + \theta^P \Omega \) by (13). The first-order condition for equity implies 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 maximum value \( V^P(\Omega) = V^P(e_0, i^P; \Omega) = (1 - \tau)r^P - \tau(1 - s)(1 + r - \theta^P)e_0 + \theta^P\Omega \). The second term indicates how the tax disadvantage of equity impairs this value. Banks with very larger charter values, \( \Omega \geq \Omega^o \), have zero equity and are unaffected by such an extra cost. Their value depends only on the tax rate but not on the allowance, \( V^P(\Omega) = (1 - \tau)r^P + \theta^P\Omega \).

The value of a prudent bank rises with charter value \( \Omega \) but falls with the minimum capital ratio \( e_0 \) because equity incurs an extra tax cost due to the debt bias:

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

\[\quad - [r^P + (1 - s)(1 + r - \theta^P)e_0] \cdot d\tau.\]  
A larger allowance for equity \( s \) boosts bank value exactly because it reduces this tax cost. A higher tax rate \( \tau \), in contrast, lowers the after-tax return and magnifies the cost of equity. Once the charter value is so large that a zero capital ratio is sufficient, \( \Omega > \Omega^o \), bank value is insensitive to the tax allowance and responds less strongly to tax rate changes.

Second, a bank that subsequently gambles must offer the high deposit rate \( 1 + i^G = (1 + r)/\theta^G \) and its capital ratio has to be smaller than \( e < e_0(\Omega^G; \Omega) \),

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

with \( V^G(e, i^G; \Omega) = (1 - \tau)r^G - \tau(1 - s)\theta^G i^G e + \theta^G \Omega \) by (13). The first-order condition for equity implies \( \lambda = -\tau(1 - s)\theta^G i^G < 0 \). The constraint is fulfilled with zero equity giving bank value \( V^G(\Omega) = V^G(0, i^G; \Omega) = (1 - \tau)r^G + \theta^G \Omega \). The latter increases in the charter value and decreases in the tax rate but is insensitive to the allowance due to zero equity:

\[
dV^G = \theta^G \cdot d\Omega - r^G \cdot d\tau.
\]  

18
3.2 Equilibrium

The pivotal bank with charter value $\Omega^*$ is indifferent between the two strategies set out above, $V^P(\Omega^*) = V^G(\Omega^*)$. Substituting (16) and (18) yields:

$$\Omega^* = (1 - \tau)\tilde{r} + \frac{\tau(1 - s)(1 + r - \theta^P)e_0(i^P; \Omega^*)}{\Delta \theta}.$$  \hspace{1cm} (20)

Minimum equity $e_0(i^P; \Omega^*)$ itself depends on the pivotal type according to (15). The closed-form solution of the risk-taking cut-off is

$$\Omega^* = (1 - \tau)\left[\tilde{r} + \chi(1 + i^P)\right].$$  \hspace{1cm} (21)

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

$$\chi = \frac{\tau(1 - s)(1 + r - \theta^P)}{\Delta \theta(1 + i^P) + \tau(1 - s)(1 + r - \theta^P)}.$$  \hspace{1cm} (22)

Recall $i' = i^P[1 - \tau(1 - s)]$. If the tax is neutral and the bank can deduct the full cost of equity from the tax base, $s = 1$, the distortion disappears, $\chi = 0$, giving $\Omega^* = (1 - \tau)\tilde{r}$. A neutral tax thus reduces risk taking compared to the no-tax equilibrium with $\Omega^* = \tilde{r}$ because it diminishes the gains from gambling.

In equilibrium, the risk-taking cut-off is always smaller than the zero-equity cut-off, $\Omega^* = (1 - \tau)[\tilde{r} + \chi(1 + i^P)] \leq (1 - \tau)(1 + i^P + \tilde{r}) \equiv \Omega^0(i^P)$, due to $\chi < 1$. Some banks with $\Omega \in (\Omega^*, \Omega^0)$ raise equity and subsequently invest in the prudent portfolio. Three different groups emerge in equilibrium as illustrated in Figure 2:

- $\Omega \geq \Omega^0(i^P)$: These banks have such a large charter value that they do not need equity to invest in the prudent portfolio, $e_0 = 0$. The latter promises a higher value than gambling, $V^P > V^G$. Accordingly, they raise no equity, opt for the prudent portfolio, and succeed with probability $\theta^P$.

- $\Omega^0(i^P) > \Omega \geq \Omega^*$: The charter value is not large enough to provide discipline alone, and such banks choose the prudent portfolio only with some positive equity, $e_0 > 0$. 


Despite the extra cost of equity, the latter promises a larger value than gambling $V^P > V^G$. Those banks raise equity, invest in the prudent portfolio, and succeed with probability $\theta^P$.

- $\Omega < \Omega^\ast$: The charter value is so small that gambling is more attractive for these banks, $V^G > V^P$. Accordingly, they raise no equity, gamble, and succeed with the lower probability $\theta^G$.

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 $\Omega^\ast$ 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 ensures that the no-gambling condition holds. Differentiating individual minimum equity in (15) gives:

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

(23)

It decreases in the charter value because the latter has comparable incentive effects:

Banks that expect high future profits lose a lot if they fail, and they thus opt for the
prudent portfolio even with little equity. Noting \((1-s)e_0 < 1\), the corporate income tax affects the capital ratio of an individual bank as follows:

**Lemma 1.** The minimum capital ratio of an individual bank of type \(\Omega\) decreases in the corporate tax rate \(\tau\) and in the allowance for equity \(s\).

**Proof:** Follows from Equation (23).

These sensitivities mirror how the tax affects risk-taking incentives: A more generous allowance and a higher tax rate diminish the short-term gains from risk taking, see (14). As gambling becomes relatively less attractive, a lower capital ratio suffices to preserve the incentive for the prudent portfolio.

To evaluate how corporate taxation influences the portfolio decision of banks, we derive the sensitivities of the cut-off \(\Omega^*\) representing the marginal bank. If the latter increases, more banks will gamble and take risks. Starting from \(dV^P(\Omega^*) = dV^G(\Omega^*)\), we substitute (17) and (19). Collecting terms and dividing by \(\Delta\theta\) gives

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

This formulation uses \(\zeta \equiv (1+r - \theta^P)/\Delta\theta > 0\). The coefficients of \(s\) and \(\tau\) mirror how the tax affects the values of investing in either portfolio. It influences relative profits directly and via minimum equity. The latter affects the value from the prudent portfolio because the debt bias renders equity more expensive than deposits.

A larger allowance boosts the value from the prudent portfolio \(V^P\) 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 offsetting effects: First, if \(r^G > r^P\) such that \(\tilde{r} > 0\), a higher tax rate diminishes the expected after-tax return from the gambling relative to the prudent portfolio. In addition, prudent banks
may incur larger or smaller total tax costs of equity, \( \tau (1 - s)(1 + r - \theta^P)e_0 \): While the higher tax rate unambiguously magnifies the extra tax per unit of equity, the amount of equity \( e_0 \) falls, see (23).

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

\[
\sigma_s = \frac{\chi(1 + i^P)e_0(\Omega^*)}{1 - s} > 0, \quad \sigma_\tau = \bar{r} + \frac{\chi(1 + i^P)[\tau - e_0(\Omega^*)]}{\tau}.
\]

A larger allowance for equity \( s \) unambiguously discourages risk taking. The cut-off falls, and more banks invest in the prudent portfolio. A rising corporate tax rate \( \tau \) discourages risk taking if the capital ratio of the pivotal type \( \Omega = \Omega^* \) is low, \( e_0(\Omega^*) \leq \tau \). The risk-taking cut-off also falls in this case; otherwise, it may increase or decrease.

**Proof:** Equation (25) follows from substituting the sensitivities of minimum equity stated in (23) and evaluated for the pivotal type \( \Omega^* \) into Equation (24) and rearranging.

First, a more generous tax allowance allows banks to deduct a larger share of the return on equity from the tax base. Therefore, both the per-unit tax cost of equity falls, and smaller equity provides sufficient discipline. This boosts the value from investing in the prudent portfolio but leaves the value from gambling unchanged. Hence, a larger share of banks chooses the prudent portfolio and takes fewer risks.

Second, a higher tax rate can affect the cut-off in either way: It discourages risk taking, \( \sigma_\tau > 0 \), either if the tax distortion \( \chi \) is small or if the capital ratio of the pivotal bank \( e_0(\Omega^*) \) is not too high. The latter should not exceed the the tax rate by much such that the effect of the declining capital ratio offsets the higher per-unit costs of equity. In
these two cases, the maximum value from prudent portfolio $V^P$ always declines by less than the value of gambling $V^G$. Whenever $e_0(\Omega^*) > \tau$, however, the tax rate magnifies the total costs of equity. The net effect is still negative if the extra cost of using equity is small due to a small tax distortion $\chi$ or if the short-run gain from risk taking $\tilde{\tau}$ is large. Otherwise, the higher tax rate may induce more banks to gamble.

Both findings suggest that in a neutral tax system, which grants a full deduction of the cost of equity, $s = 1$ and $\chi = 0$, a higher tax rate unambiguously reduces risk taking. The reason is that it diminishes any gains from gambling without discouraging the use of equity as a disciplining device. Therefore, a revenue-neutral tax reform which eliminates the debt bias and then raises the tax rate to account for the revenue shortfall will reduce risk taking in two ways: The allowance boosts the value from the prudent portfolio relative to gambling such that the cut-off charter value $\Omega^*$ falls. Once the tax is neutral, raising the tax rate $\tau$ further discourages risk taking as $d\Omega^*/d\tau|_{s=1} < 0$.

Overall, these results are consistent with empirical findings which suggest that introducing a tax allowance for equity tends to improve portfolio quality in terms of non-performing loans (e.g., Schepens, 2016; Martin-Flores and Moussu, 2018), while a higher corporate tax rate is associated with lower asset risk measured by the average regulatory risk weight or non-performing loans (Horváth, 2018).

3.3.2 Financial Stability

Changes in risk taking are the source of potential stability gains of tax reform. We thus precisely 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 a high probability $1 - \theta^G$, whereas a fraction $1 - F(\Omega^*)$ chooses the prudent portfolio and fails with a lower probability $1 - \theta^P$:

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

(26)

Noting the changes in the share of gambling banks $F(\Omega^*)$ implied by Proposition 1, average failure risk responds to changes in taxation as follows:

$$d\pi = -\Delta \theta f(\Omega^*) \left[ \sigma_s \cdot ds + \sigma_\tau \cdot d\tau \right]$$

(27)

Reflecting the sensitivities of the risk-taking cut-off, mitigating the debt bias discourages risk taking thereby reducing the failure risk in the banking sector. Similarly, higher corporate tax rates have a stabilizing effect as long as minimum equity of the pivotal type is not too large or the tax distortion is rather small.

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

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

(28)

In equilibrium, only banks with intermediate charter values, $\Omega \in (\Omega^*, \Omega^\circ)$, have a positive capital ratio between $e_0(i^p; \Omega^\circ) = 0$ and $e_0(i^p; \Omega^*) = (1 - \tau)(1 - \chi)(1 + i^p)/(1 + i') < 1$.

Applying the Leibniz rule on (28) reveals that a larger allowance for bank equity and a higher corporate tax rate affect the aggregate capital ratio as follows:

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

(29)

Recall that $e_0(\Omega^\circ) = 0$ by construction. The net effect of taxation thus reflects how banks with positive equity adjust their individual capital ratio $e_0(\Omega)$ and of whether their share, which is related to the the risk-taking cut-off $\Omega^*$, grows or shrinks. The net effect is a priori ambiguous: On the one hand, all banks with positive equity reduce their capital ratio when facing a higher tax rate or a larger allowance, see (13). On the other hand, the share of such banks typically expands in both cases, see (25).
To make clear-cut predictions about the net effect on aggregate bank equity, we assume that charter values are uniformly distributed with density $f(\Omega) = 1/\bar{\Omega}$ and evaluate Equations (27) and (29):

**PROPOSITION 2.** 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 reduces both the average probability of bank failure and the aggregate capital ratio.

**Proof:** The effects on the average probability of bank failure directly follow from (27). The effects on the aggregate capital ratio are derived in Appendix A assuming a uniform distribution of charter values, $\Omega \sim U[0, \bar{\Omega}]$.

The finding that a larger tax allowance 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 how aggregate equity in the banking sector responds to taxation are in line with the empirical evidence, namely, positive effects of a tax reform which abolishes the debt bias (e.g., Schepens, 2016; Célérion 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) on either the capital ratio or the voluntary capital buffer.

### 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

$$V = \int_{0}^{\Omega^*} V^G(\Omega) dF(\Omega) + \int_{\Omega^*}^{\bar{\Omega}} V^P(\Omega) dF(\Omega), \quad T = \int_{0}^{\Omega^*} T^G(\Omega) dF(\Omega) + \int_{\Omega^*}^{\bar{\Omega}} T^P(\Omega) dF(\Omega),$$

25
and substituting (12), (16), and (17) gives:

\[ W = \int_{0}^{\Omega^*} r^G + \theta^G \Omega dF (\Omega) + \int_{\Omega^*}^{\bar{\Omega}} r^P + \theta^P \Omega dF (\Omega). \tag{30} \]

Intuitively, the welfare contribution of an individual bank is equal to its expected portfolio return plus charter value. Risk taking represented by the cut-off \( \Omega^* \), which importantly depends on taxation, influences welfare according to

\[ dW = - (\Omega^* - \bar{r}) \Delta \theta f (\Omega^*) \cdot d\Omega^* = - \left[ (1 - \tau) \chi (1 + \bar{i}) - \tau \bar{r} \right] \Delta \theta f (\Omega^*) \cdot d\Omega^*. \tag{31} \]

The second equality substitutes (21) for \( \Omega^* \) to evaluate the welfare effects in market equilibrium. Compared to a no-tax equilibrium (see Section 2.3), the corporate income tax causes distortions as the expression in square brackets is typically non-zero. Risk taking would only be efficient in the absence of a tax (i.e., \( \tau = 0 \) such that \( \chi = 0 \) and \( \Omega^* = \bar{r} \)).

The welfare effects mirror two main channels, namely, how corporate taxation influences the cost of equity compared to deposits and the relative portfolio returns. Taking into account the responses of the risk-taking cut-off \( \Omega^* \) in Proposition 1, we obtain:

**PROPOSITION 3.** A larger allowance of equity and a higher corporate tax rate promise welfare gains if the debt bias is severe or the gains from gambling are small:

\[ (1 - \tau) \chi (1 + r) - \theta^P \tau \bar{r} > 0. \tag{32} \]

Otherwise, raising the tax allowance or tax rates can be welfare-reducing.

**Proof:** Tax allowance and tax rate tend to lower the risk-taking cut-off, see Proposition 1. According to (31), they thereby increase welfare whenever the expression in square brackets is positive or, equivalently, inequality (32) holds.

The tax system may contribute to excessive risk taking especially if a pronounced debt bias creates a sizable tax distortion \( \chi \), which hampers the use of equity to set proper risk-
taking incentives, or if the expected portfolio returns are quite similar and the gains from
gambling \( \tilde{r} \) are small. Inequality (32) holds in this case. Increasing the allowance for
equity lowers the risk-taking cut-off and thereby improves welfare. A rising tax rate has
similar effects unless the capital ratio of the marginal bank \( \epsilon_0 (\Omega^*) \) is very high.

However, corporate taxation may also induce banks to be overly conservative. In
this case, the effect of diminishing the short-term gains from gambling outweighs the
distortions of the capital structure, which hamper investment in the prudent portfolio.
This requires gambling to be quite profitable and the debt bias to be weak such that
Inequality (32) is reversed. A lower tax rate or a smaller allowance for equity induce
more banks to gamble and thereby shift risk taking closer to the first best.

This finding suggests that once the tax is neutral (i.e., \( s = 1 \) such that \( \chi = 0 \)), tax
hikes discourage risk taking and enhance financial stability but reduce welfare. Banks
with low charter values are overly conservative and take too few risks. However, this
result only holds if bank failure entails no external costs in addition to the wealth losses
of depositors and the loss of charter value, which are already internalized. Otherwise,
social and private portfolio returns differ, and gambling is inefficient in the first place.
Risk taking is always excessive and any tax instrument that discourages gambling is
welfare-improving.

4 Extensions

The first extension introduces capital requirements, which oblige all banks to raise posi-
tive equity irrespective of their portfolio choice and charter value. This extension sheds
light on the interaction between bank regulation and taxes. The second extension ex-
PLICITLY models future bank profits and endogenizes the charter value. This establishes
another channel of how taxation influences risk taking that is especially important when considering permanent changes in taxation.

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 unweighted bank assets.\(^3\) We henceforth assume that capital requirements are rather low. Some banks may need to raise voluntary equity in excess of the regulatory minimum $\varepsilon$ to set proper incentives giving a total capital ratio of $e = k + \varepsilon$.

4.1.1 Risk Taking

**Portfolio Choice and Capital Structure:** Bank profit (13) and the no-gambling condition (14) are unchanged as they depend on the total capital ratio $e$ only. Using $e = k + \varepsilon$ gives minimum voluntary equity that ensures no-gambling:

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

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

The regulatory capital requirements provide sufficient discipline and avoid gambling for some banks even without voluntary equity, $\varepsilon_0(i; \Omega^c) = 0$. This concerns banks with large charter values, $\Omega \geq \Omega^c(i) = (1 - \tau)(1 + i + \tilde{r}) - (1 + i')k$. Obviously, the tighter capital standards are, the larger the share of such banks, $1 - F(\Omega^c)$.

\(^3\)It would be difficult to add risk-weighted capital requirements as suggested by Célérier et al. (2019) in this framework, in which the portfolio choice of the bank is unobservable.
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

$$V^P(\Omega) = \max_{\varepsilon, \lambda} V^P(k + \varepsilon, i^P; \Omega) + \lambda[\varepsilon - \varepsilon_0(i^P; \Omega)]$$ (34)

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

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

$$V^G(\Omega) = \max_{\varepsilon, \lambda} V^G(k + \varepsilon, i^G; \Omega) + \lambda[\varepsilon_0(i^G; \Omega) - \varepsilon]$$ (35)

with $V^G(k + \varepsilon, i^G; \Omega) = (1 - \tau)r^G - \tau(1 - s)\theta^G i^G(k + \varepsilon) + \theta^G \Omega$ by (13). Again, capital requirements bind, $\varepsilon = 0$, giving an ex ante value of gambling banks $V^G(\Omega) = V^G(k, i^G; \Omega) = (1 - \tau)r^G - \tau(1 - s)(1 + r - \theta^G)k + \theta^G \Omega$.

In this model, the notional return on equity that banks can deduct from the tax base equals the risk-adjusted interest rate on deposits. The latter is higher for gambling than for prudent banks, $i^G > i^P$, reflecting their higher failure risk. As a result, gambling banks are more affected by the debt bias than prudent banks because they incur a higher cost of raising equity, which is only partly tax-deductible:

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

Through this specific channel, alleviating the debt bias benefit gambling banks relatively more. Nevertheless, some prudent banks incur larger total costs of equity, $\tau(1 - s)^P i^P(k + \varepsilon_0)$, because of voluntary equity $\varepsilon_0$ on top of the regulatory minimum.
4.1.2 Equilibrium

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

$$\Omega^* = (1 - \tau)\tilde{r} + \frac{\tau(1 - s)(1 + r - \theta^P)\varepsilon_0(i^P; \Omega^*)}{\Delta \theta} - \tau(1 - s)k.$$ (36)

Substituting (33) for $\varepsilon_0(i^P; \Omega^*)$ gives the closed-form solution

$$\Omega^* = (1 - \tau)[\tilde{r} + \chi(1 + i^P)] - \tilde{\chi}(1 + i')k$$ (37)

with $\tilde{\chi} \equiv \chi \cdot (1 + r - \theta^G)/(1 + r - \theta^P) > \chi$ and $\chi \in [0, 1)$ being measures of the tax distortion. Unless the capital standard $k$ is very tight, we have $\Omega^* < \Omega^c$, and some banks raise equity in excess of the regulatory minimum to set correct risk-taking incentives.\(^4\)

Otherwise, an alternative equilibrium will emerge in which no bank attracts voluntary equity, and capital requirements bind for all banks. Banks with high charter values will invest in the prudent portfolio, whereas some with very low charters value might still exploit the short-term gains from gambling despite their high capital ratio.\(^5\)

4.1.3 Results

One observes the well-known effect that capital requirements reduce risk taking in terms of a lower cut-off $\Omega^*$, see (37). Satisfying regulatory standards is more expensive for

\(^4\)The inequality $\Omega^* < \Omega^c$ requires:

$$k < \frac{(1 - \tau)(1 - \chi)(1 + i')}{(1 + i') (1 - \tilde{\chi})} = \frac{1 - \tau}{1 - \tau(1 - s)} \equiv \bar{k}.$$ (38)

The second equality uses the definition of $\chi$ in (22). This inequality plausibly holds under realistic parameter assumptions: The corporate tax rate $\tau$ typically ranges between 20% and 30% implying that $\bar{k}$ 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.

\(^5\)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 $V^P = (1 - \tau)i^P - \tau(1 - s)\theta^P i^P k + \theta^P \Omega$, which exceeds $V^G$ if the charter value satisfies $\Omega \geq \Omega' = (1 - \tau)\tilde{r} - \tau(1 - s)k$. 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 (33) holds for all prudent banks with $\Omega \geq \Omega'$. One can show that latter is satisfied exactly if capital requirements satisfy $k \geq \bar{k}$. 

30
gambling banks: Since they must offer higher returns to shareholders that are only partially tax-deductible, they are more affected by the debt bias than prudent banks. Hence, capital requirements reduce the value of gambling banks compared to prudent banks.

In a neutral tax system, however, equity is no more expensive than deposits, and capital regulation does not influence bank value and 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, scarce equity). Therefore, tax reforms which favor equity tend to diminish the sensitivity of bank risk taking to capital requirements:

**Lemma 2.** A low tax rate and a large allowance for equity render capital regulation less effective in reducing bank risk taking. If the corporate income tax is neutral, the portfolio choice is insensitive to capital requirements.

**Proof:** Follows from equation (37).

Next, we consider how the corporate income tax itself influences capital structure and risk taking. Differentiating voluntary equity \( \varepsilon_0 \) defined in (33) gives:

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

with \( e_0 = \varepsilon_0 + k \). Its sensitivities are identical to those of the overall capital ratio \( e_0 \) in (23). To derive the responses of risk taking, we differentiate the cut-off \( \Omega^* \) in (36),

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

and use \( \zeta \equiv (1 + r - \theta^P)/\Delta \theta > 0 \). A more generous allowance for equity \( s \) has three effects: Like in the baseline model, it reduces the cost as well as the amount of voluntary equity \( \varepsilon_0 \), which boosts the value of prudent banks. Per unit of equity, however, gambling banks are disproportionately affected by the debt bias as discussed earlier and benefit
relatively more from the allowance. This effect, captured by the last term, makes the net response ambiguous.

A rising tax rate $\tau$ influences risk taking in comparable way like in the baseline model where the net effect is ambiguous but likely negative. In addition to these channels, the higher tax rate now magnifies the per-unit tax costs of equity and further depresses the value of gambling compared to prudent banks. Combining (38) and (39) establishes:

**Proposition 4.** The risk-taking cut-off $\Omega^*$ responds to the tax according to

$$d\Omega^* = - (\sigma_s \cdot ds + \sigma_\tau \cdot d\tau) \tag{40}$$

with the coefficients defined as

$$\sigma_s = \frac{\chi(1 + iP)e_0(\Omega^*)}{1 - s} - \tau(1 - \chi)(1 + \zeta)k$$

$$\sigma_\tau = \tilde{r} + \frac{\chi(1 + iP)[\tau - e_0(\Omega^*)]}{\tau} + (1 - s)(1 - \chi)(1 + \zeta)k.$$  

The cut-off tends to decrease in the allowance for equity $s$ and in the tax rate $\tau$. The larger allowance and higher tax rates induce more banks to invest in the prudent portfolio.

**Proof:** Follows from substituting (38) for $d\varepsilon_0$ in (39) and rearranging.

Compared to the standard model without capital regulation, the allowance for equity is less effective in limiting risk taking, while it is more plausible that higher tax rates discourage risk taking. These implications emerge from the fact that the debt bias in taxation makes satisfying capital requirements relatively more expensive for gambling banks.

Consequently, a generous tax allowance benefits both prudent and gambling banks. This makes the tax allowance less effective in discouraging risk taking than in the baseline model. When inspecting the coefficient $\sigma_\tau$ and noting that capital requirements are quite low, however, one concludes that the tax allowance usually boosts the value of prudent
banks relatively more such that fewer banks gamble.

The net effect of a rising tax rate on risk taking $\sigma_r$ is more likely to be negative, and a larger share of banks purchase the prudent portfolio. Not only does a tax hike diminish short-term gains from gambling and allow reducing voluntary equity, but it also makes complying with capital standards relatively more expensive for gambling banks.

### 4.2 Endogenous Charter Value

The charter value has so far been considered exogenous. However, taxes also influence future bank profits. Provided that tax changes are permanent and banks correctly anticipate the tax burden in the future, they affect the charter value and thus risk-taking incentives today. Future profits are a third channel through which the corporate income tax influences risk-taking incentives in addition to the expected after-tax portfolio returns and the relative costs of equity. In this spirit, all measures that lower the (future) tax burden will boost charter value and thus favor the prudent portfolio.

We adopt a dynamic variant of the model and endogenize the charter value. 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.\(^6\)

Given a per-period expected profit from portfolio $j = \{G, P\}$, $\pi^j_t$, the discounted value of future bank profits equals $V^j = \sum_{t=0}^{T} (\delta \theta^j)^t \pi^j_t$; $\delta \in [0, 1]$ denotes the discount factor. Like Hellmann et al. (2000), we consider the limit with $T \to \infty$. Banks will choose their strategies corresponding to an infinitely repeated Nash equilibrium. Omitting time

\(^6\)For each bank which exits, the regulator assigns a license to a new bank to preserve a competitive banking market.
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 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. Note that the distribution of discount factors may change over time.\(^7\)

### 4.2.1 Risk Taking

**Portfolio Choice and Capital Structure:** The per-period after-tax profit from portfolio $j$ is given by (13). With constant returns, interest rates, and taxes, the discounted bank profit $V^j = \pi^j / (1 - \delta^j)$ equals:

$$V^j(e, i; \delta) = \frac{(1 - \tau)r^j + [(1 + r) - \theta^j(1 + i)][1 - \tau - e] - \tau(1 - s)\theta^je}{1 - \delta^j}. \quad (41)$$

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

For any given interest rate and capital ratio, a bank invests in the prudent portfolio as long as $V^P \geq V^G$. Rearranging gives the no-gambling condition $\pi^G - \pi^P \leq \Delta \theta \delta V^P$. 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 $\delta V^P$. We first reformulate

\(^7\)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 (41) and dividing by $\Delta \theta$:

$$
\dot{r} + (1 + i)(1 - e) - \tau[\hat{r} + (1 + i^P) - (1 - s)ie] \leq \frac{1 + i + \hat{r} - \hat{\delta}[r^P + (1 + r) - \theta^P(1 + i)]}{1 + \hat{r} - \hat{\delta}[1 + r - \theta^P(1 + i) + \tau(1 - s)\theta^P i]}.
$$

(42)

The corporate income tax reduces the gains from risk taking on the left-hand side. Unlike in the baseline model, it also depresses future profits and charter value (right-hand side).

One can solve the no-gambling condition for the minimum capital ratio $e_0$:

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

(43)

This formulation uses the definitions $\hat{\delta} \equiv \delta/(1 - \delta \theta^P) > \delta$ and $\hat{i'} \equiv i[1 - \tau(1 - s)]$.

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

A bank that intends to invest in the prudent portfolio can offer a deposit rate $1 + i^P = (1 + r)/\theta^P$ if its capital ratio satisfies $e \geq e_0(i^P; \delta)$. Substituting for $i^P$ and (5) gives the constrained maximization problem

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

(44)

with $V^P(e, i^P; \delta) = [(1 - \tau)r^P - \tau(1 - s)\theta^P i^P e]/(1 - \delta \theta^P)$. Complementary slackness with $\lambda = \tau(1 - s)\theta^P i^P/(1 - \delta \theta^P) > 0$ implies $e = e_0(i^P; \delta)$. The bank value is $V^P(e, i^P; \delta) = [(1 - \tau)r^P - \tau(1 - s)(1 + r - \theta^P)e_0(i^P; \delta)]/(1 - \delta \theta^P)$.

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

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

(45)

with $V^G(e, i^G; \delta) = [(1 - \tau)r^G - \tau(1 - s)\theta^G i^G e]/(1 - \delta \theta^G)$. Higher equity reduces bank value $dV/de < 0$ such that $e = 0$ is optimal. The maximum bank value equals $V^G(\delta) = \ldots$
\[(1 - \tau)r^G/(1 - \delta \theta^G)\].

### 4.2.2 Equilibrium

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

\[e_0(\delta) = (1 - \tau)\tilde{e}_0(\delta), \quad \tilde{e}_0(\delta) \equiv \frac{1 + r + \theta^P(\tilde{r} - \tilde{\delta}r^P)}{1 + r - \tau(1 - s)(1 + r - \theta^P)(1 + \tilde{\delta} \theta^P)}\]. \quad (46)

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

\[\frac{r^P - \tau(1 - s)(1 + r - \theta^P)\tilde{e}_0(\delta)}{1 - \delta \theta^P} \geq \frac{r^G}{1 - \delta \theta^G}.\] \quad (47)

Unlike in the baseline model, the direct effect of the corporate income tax cancels out because it reduces the values from both portfolios proportionately. This leaves the total costs of bank equity captured by the term \(\tau(1 - s)(1 + r - \theta^P)\tilde{e}_0\) as the only channel through which taxation influences bank risk taking.

Solving (47) yields an implicit solution of the risk-taking cut-off in terms of banks’ discount factor:

\[\delta \geq \delta^* \equiv \frac{\tilde{r} + \tau(1 - s)\zeta \tilde{e}_0(\delta^*)}{\theta^G[\tilde{r} + \tau(1 - s)\zeta \tilde{e}_0(\delta^*)] + r^G}, \quad \zeta \equiv \frac{1 + r - \theta^P}{\Delta \theta}.\] \quad (48)

Unlike in the baseline model, this cut-off is independent of the tax rate whenever the tax system is neutral and allows for the full deduction of the cost of equity (i.e., \(s = 1\)).

### 4.2.3 Results

In equilibrium, the capital ratio of type \(\delta \geq \delta^*\) equals \(e_0(\delta) = (1 - \tau)\tilde{e}_0(\delta)\). Differentiating minimum equity yields

\[de_0 = (1 - \tau) \cdot \tilde{e}_0 - \tilde{e}_0 \cdot d\tau\] \quad (49)
with
\[ d\tilde{e}_0 = -\frac{\theta^P}{(1 - \delta\theta^P)^2} \left( \frac{r^P - \tau (1 - s)(1 + r - \theta^P)\tilde{e}_0}{1 + r - \tau (1 - s)(1 + r - \theta^P)(1 + \delta\theta^P)} \cdot d\delta \right. \\
+ \left. \frac{\tilde{e}_0(1 + r - \theta^P)(1 + \delta\theta^P)}{1 + r - \tau (1 - s)(1 + r - \theta^P)(1 + \delta\theta^P)} \right) \cdot [(1 - s) \cdot d\tau - \tau \cdot ds] . \]

The first term is always positive in equilibrium on account of equation (47). Forward-looking banks value continuation more and thus need less equity for having an incentive for the safer portfolio.

The tax allowance \( s \) essentially represents a tax cut, from which prudent banks with a higher chance of success benefit relatively more. This allows reducing equity without weakening incentives. The effect of a higher tax rate \( \tau \) on minimum equity is more ambiguous, however: It lowers the short-term gains from gambling but also depresses future profits and charter value, see (42). The second effect is captured by the increase in \( \tilde{e}_0 \). The net effect follows from substituting for \( d\tilde{e}_0 \) in (49):
\[ \frac{de_0}{d\tau} = -\tilde{e}_0 \left[ \frac{1 + r - (1 - s)(1 + r - \theta^P)(1 + \delta\theta^P)}{1 + r - \tau (1 - s)(1 + r - \theta^P)(1 + \delta\theta^P)} \right] . \]

It is usually negative such that a higher tax rate allows for a lower capital ratio in parallel to the baseline model. 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 even rise with the tax rate for \( \delta \to 1 \) [and \( \tilde{\delta} \to 1/(1 - \theta^P) \)] provided that the tax is distorting, \( s < 1 \).

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 5.** The risk-taking cut-off \( \delta^* \) responds to the tax according to
\[ \sigma_\delta \cdot d\delta^* = -\sigma_s \cdot ds + \sigma_\tau \cdot d\tau \quad (50) \]
with all coefficients defined positive. The cut-off decreases in the allowance for equity and increases in the tax rate.

**Proof:** Equation (50) follows from differentiating $\delta^*$ in (48) and substituting (49) for the sensitivities of minimum equity, $de_0$. Appendix A states and signs the three coefficients.

A larger tax allowance induces even rather impatient types to invest in the prudent portfolio. Like in the baseline model, such a reform discourages risk taking and enhances financial stability. Short- and long-term effects are qualitatively the same. A higher tax rate, however, increases the risk-taking cut-off such that more banks gamble. Permanently higher tax rates depress future profits and charter value, which is an important disciplining device. In the long run, a rising tax rate thus encourages bank risk taking. This result contrasts with the more ambiguous, likely negative risk-taking effect of a temporary tax hike explored in the baseline model.

Once the corporate income tax is neutral with a full allowance, $s = 1$, permanent changes in the tax rate do not affect bank risk taking and therefore entail no financial stability gains or losses. Short- and long-term effects - smaller gains from gambling today and lower profits in the future - exactly offset each other.

### 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 portfolio of assets. 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. Following
Hellmann et al. (2000), we develop a principal-agent model that emphasizes the incentive function of equity in influencing risk taking and portfolio choice of banks. Our analysis highlights three distinct channels through which taxation influences risk taking: the relative after-tax portfolio returns that determine (short-term) gains from risk taking, the cost of equity needed to set proper risk-taking incentives, and, in the long run, future profits and charter value.

The first set of results demonstrates that reforms which reduce the debt bias in corporate taxation enhance financial stability and, provided that the tax distortion is severe, promises welfare gains as well. Such a reform facilitates the use of equity to set incentives for investing in a comparably safe portfolio. In addition, a permanently larger allowance boosts future profits, which reinforces this effect.

A second set of results concerns changes in the tax rate. A higher corporate tax rate typically offers some financial stability and welfare gains at least in the short run. The tax diminishes the short-term gains from investing in a high-risk, high-return portfolio. This effect prevails unless prudent bank need a high capital ratio to alleviate moral hazard. As a result, a revenue-neutral tax reform with a full allowance for equity compensated by higher tax rates will substantially improve financial stability. Permanent tax hikes in a distorting tax system may, however, undermine financial stability. If banks correctly anticipate how the rising tax rate impairs future profits, they may take even more risks.

Eventually, the corporate income tax interacts with bank regulation: Eliminating the debt bias is less effective in reducing risk taking if capital standards are tight, whereas the reverse is true for tax hikes. In turn, reforms like ACE weaken the sensitivity of risk taking to regulation: Once equity is less expensive, banks voluntarily raise equity and take fewer risks in the first place.
References


Gu, G., R. de Mooij, and T. Poghosyan (2015). Taxation and Leverage in International


We first show that a larger allowance for equity $s$ raises aggregate capital ratio in (29) if charter values are uniformly distributed:

$$\frac{d\bar{e}_0}{ds} = \tau i^P \int_{\Omega^s} e_0(\Omega) dF(\Omega) + e_0^s f(\Omega^s) \sigma_s$$

$$= \frac{1}{\Omega} \left[ e_0^s \sigma_s - \frac{\tau i^P}{1 + i'} \left( \frac{(1 - \tau)(1 + i + \tilde{r})}{1 + i'} \Omega - \frac{\Omega^2}{2} \right) \right]$$

$$= \frac{1}{\Omega} \left[ e_0^s \sigma_s - \frac{\tau i^P}{1 + i'} \left( \frac{(1 - \tau)(1 + i + \tilde{r})}{1 + i'} \right) \right]$$

$$= \frac{e_0^s}{\Omega} \left[ \sigma_s - \frac{\tau i^P \Omega^s - \Omega^*}{2} \right] = \frac{e_0^s}{\Omega} \left[ \sigma_s - \frac{\tau i^P e_0^s}{2} \right]$$

$$= \frac{e_0^s}{\Omega} \left[ (1 + i^P)\chi - \frac{\tau i^P \theta^P}{2} \right] = \frac{\tau i^P e_0^s}{\Omega} \left[ \frac{\theta^P (1 + i^P)}{\Delta \theta(1 + i') + \tau(1 - s)\theta^G i^P} - \frac{1}{2} \right]$$

$$= \frac{\tau i^P e_0^s}{2\Omega} \frac{\theta^P (1 + i^P)}{\Delta \theta(1 + i') + \tau(1 - s)\theta^G i^P} > 0.$$  

We use $\Omega^s = (1 - \tau)(1 + i + \tilde{r})$, $e_0^s = (1 - \tau)(1 - \chi)(1 + i^P)/(1 + i')$, and $\Omega^s - \Omega^* = (1 - \tau)(1 - \chi)(1 + i^P) = e_0^s(1 + i')$,
Second, we derive the negative effect of the tax rate $\tau$ in (29):

$$
\frac{d\tilde{e}_0}{d\tau} = \int_{\Omega^*}^{\Omega} \frac{de_0(\Omega)}{d\tau} dF(\Omega) - e_0^* f(\Omega^*) \frac{d\Omega^*}{d\tau}
$$

$$
= \frac{1}{\Omega} \left[ \frac{(1 + \bar{i}^P + \bar{r})(\Omega^* - \Omega^*)}{1 + i'} + \frac{(1 - s)i^P}{1 + i'} \int_{\Omega^*}^{\Omega} e_0(\Omega)d\Omega - e_0^* \sigma_\tau \right]
$$

$$
= - \frac{1}{\Omega} \left[ e_0^*(1 + i^P + \bar{r}) - e_0^* \sigma_\tau - \frac{(1 - s)i^P (1 - \tau)(1 + i + \bar{r})\Omega - \Omega^* / 2}{1 + i'} \right]
$$

$$
= - \frac{1}{\Omega} \left[ e_0^*(1 + i^P + \bar{r}) - e_0^* \sigma_\tau - \frac{(1 - s)i^P e_0^* \Omega^* - \Omega^*}{2} \right]
$$

$$
= - \frac{\epsilon_0^*}{\Omega} \left[ 1 + i + \bar{r} - \sigma_\tau - \frac{(1 - s)i^P e_0^*}{2} \right]
$$

$$
= - \frac{\epsilon_0^*}{\Omega} \left[ (1 + i)(1 - \chi) + \frac{\chi(1 + i^P)e_0^*}{\tau} - \frac{(1 - s)i^P e_0^*}{2} \right]
$$

$$
= - \frac{\epsilon_0^*}{\Omega} \left[ (1 + i)(1 - \chi) - \frac{(1 - s)i^P e_0^{*2}}{\Omega} \right] \frac{\theta^P(1 + i^P)}{\Delta \theta(1 + i') + \tau(1 - s)\theta^P i^P - \frac{1}{2}}
$$

$$
= - \frac{\epsilon_0^*}{\Omega} \left[ (1 + i)(1 - \chi) - \frac{(1 - s)i^P e_0^{*2}}{2\Omega} \right] \frac{\theta^P(1 + i^P)}{\Delta \theta(1 + i') + \tau(1 - s)\theta^P i^P} < 0.
$$

**Proof of Proposition 4:** Capital requirements affect the pivotal type according to

$$
\frac{\partial \Omega^*}{\partial k} = - \chi(1 + i') \leq 0, \quad \chi \equiv \frac{1 + r - \theta^G}{1 + r - \theta^P}.
$$

The derivative is zero if $\chi = 0$, that is, no debt bias, $s = 0$. A higher tax rate magnifies and a larger allowance for equity weakens the effect of rising capital requirements on the pivotal type:

$$
\frac{\partial^2 \Omega^*}{\partial k \partial \tau} = \frac{1 + r - \theta^G}{1 + r - \theta^P} \left[ i^P(1 - s)\chi - (1 + i') \frac{\partial \chi}{\partial \tau} \right] > 0,
$$

$$
\frac{\partial^2 \Omega^*}{\partial k \partial s} = - \frac{1 + r - \theta^G}{1 + r - \theta^P} \left[ \tau i^P(1 + i') \frac{\partial \chi}{\partial s} \right] < 0.
$$

The effects are signed taking into account the sensitivities of the tax distortion $\chi$:

$$
\frac{d\chi}{ds} = - \frac{\chi^2 \Delta \theta(1 + i^P)}{\tau(1 - s)^2(1 + r - \theta^P)} < 0, \quad \frac{d\chi}{d\tau} = \frac{\chi^2 \Delta \theta(1 + i^P)}{\tau^2(1 - s)(1 + r - \theta^P)} > 0.
$$

**Proof of Proposition 5:** We first differentiate $V^P(\delta^*) = V^G(\delta^*)$ and substitute the sensitivities of minimum equity, $de_0$, using (49). Rearranging and collecting terms gives
equation (50) with the coefficients defined according to:

\[
\begin{align*}
\sigma_s &= \frac{\Delta \theta V}{(1 - \delta \theta^P)^2} \left[ 1 - \delta \theta^P + \frac{\tau (1 - s) \theta^P \zeta}{1 - \delta \theta^G} \right] > 0, \\
\sigma_s &= \frac{\tau (1 + r - \theta^P)e_0}{1 - \delta \theta^P} \frac{1 + r}{1 + r - \tau (1 - s)(1 + r - \theta^P)(1 + \tilde{\delta} \theta^P)} > 0, \\
\sigma_s &= \frac{(1 - s)(1 + r - \theta^P)e_0}{1 - \delta \theta^P} \frac{1 + r}{1 + r - \tau (1 - s)(1 + r - \theta^P)(1 + \tilde{\delta} \theta^P)} > 0.
\end{align*}
\] (A.5)

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