TI 2026-016/V
Tinbergen Institute Discussion Paper

The bank leverage response to tax shield changes

Felix Ward[1]
Casper de Vries[2]

1 Erasmus University Rotterdam, Tinbergen Institute

2 Erasmus University Rotterdam, Tinbergen Institute

The bank leverage response to tax shield changes [⋆]

Casper de Vries [†]   Felix Ward [‡]

March 2026

Abstract

Does the preferential tax treatment of debt over equity cause banks to increase their leverage? We construct a novel dataset tracing the evolution of the debt tax shield for banks in advanced economies from 1870 to 2020. Exploiting variation from nearly all changes in banking-sector tax shields since the nineteenth century, we show that a 1 percentage point increase in the tax shield reduces bank capital ratios by 0.25–0.8 percentage points. Our estimates suggest that the tax advantage of debt was an important driver of the rise in bank leverage during the twentieth century.

Keywords: corporate income taxation, debt bias, interest deductibility, financial stability

JEL Codes: E44, G21, G32, H25, N20

[⋆] We wish to thank Jeffrey Campbell, Yao Chen, Gernot Peter Doppelhofer, Rui Esteves, Riitta Hjerppe, Tuomas Kosonen, Antti Kujala, Dmitry Kuvshinov, Jochen Mankart, Eric Monnet, Lorenzo Pozzi, Dirk Schindler, Elizaveta Sizova, Leo Stevens, Bert S. van Stiphout-Kramer, Henk Vording, Johannes Wieland, and Donghai Zhang for helpful discussions and suggestions, and for providing guidance in our data collection. We are especially thankful to Björn Richter, Per Svensson, and Kaspar Zimmermann for sharing data with us. Jose Castillo provided excellent research assistance. This publication is part of the project "Dangerous bank leverage" with file number 406.XS.24.03.130 which is financed by the Dutch Research Council (NWO). Any remaining errors are our own.

[†] Erasmus School of Economics, Erasmus University Rotterdam; Tinbergen Institute; WRR; (cde-vries@ese.eur.nl)

[‡] Erasmus School of Economics, Erasmus University Rotterdam; Tinbergen Institute; (ward@ese.eur.nl)

1. INTRODUCTION

Over the course of the past one-and-a-half centuries, banking sector capital ratios in advanced economies have declined dramatically, from an average of one fourth in the late 19th century to around one twentieth in recent decades (Jordà et al., 2021). In this paper we analyzee the role of the concomitant rise in the preferential tax treatment of debt vis-à-vis equity for this secular trend. We empirically assess how changes in the tax advantage of debt affect bank leverage based on a novel dataset that spans nearly the entirety of tax advantage changes in advanced economies over the past one and a half centuries. The novel dataset incorporates key regulatory details, such as limitations on interest expense deductibility and bank-specific corporate tax rules, that allows us to calculate a comprehensive measure of the tax advantage of bank debt. The resulting measure describes the evolution of the tax advantage of bank debt back to its origins in the late nineteenth century.

When combined with long-run bank balance sheet data (Jordà, Richter, Schularick, and Taylor, 2021), the new tax shield measure's copious amount of variation affords novel empirical insights into several long-standing questions: How does bank leverage respond to changes in the debt tax shield (de Mooij, Keen, and Orihara, 2014; Schepens, 2016)? Is the response symmetric for tax shield increases and decreases (Gu, de Mooij, and Poghosyan, 2015; Schandlbauer, 2017)? To what extent do capital requirements limit banks' ability to raise leverage in response to tax shield increases (de Mooij and Keen, 2016)? The dataset's broad historical coverage furthermore enables us to explore factors that are time-invariant in shorter samples. For example, how do capital controls – by restricting international tax arbitrage – shape the relationship between the debt tax shield and bank leverage (Gu, de Mooij, and Poghosyan, 2015; Reiter, Langenmayr, and Holtmann, 2021)?

We begin our analysis by deriving a comprehensive measure for the tax advantage of bank debt and a closed-form optimality condition that links this tax advantage to bank leverage. We do so based on a stylized banking model that accounts for the multiple sources of the tax advantage of debt over equity: corporate tax rates, nominal interest rates, taxes on bank debt (i.e. *bank levies*), limitations on interest expense deductibility (e.g. *thin capitalization rules*, TCR), and extensions of tax-deductibility to dividend payments (i.e. *allowances for corporate equity*, ACE). We then collect annual time series for each of these six variables for 17 advanced economies from 1870 to 2020 and calculate the model-conform tax advantage of debt. This allows us, for the first time, to quantitatively study the full tax advantage of debt in the financial sector all the way back to its origins in the late nineteenth century.

Over the past one and a half centuries, the tax advantage of debt among advanced economies tends to follow an inverse U-shaped pattern. Up to the mid-twentieth century, rising corporate tax rates and the abolition of interest expense non-deductibility from early income tax codes were the main drivers of the rising tax advantage of debt. Rising inflation rates from the late 1960s onwards translated into rising nominal interest rates, which further boosted tax-deductible interest expenses up to the 1980s. After that, a combination of disinflation, corporate tax rate cuts, declining real interest rates, and the proliferation of ACE and bank levies led to a marked decline in the tax advantage of bank debt back to the very low levels last seen in the early twentieth century. At the same time, the rapid growth of the shadow banking system (e.g. Bakk-Simon et al., 2012; Adrian and Ashcraft, 2012; FSB, 2023) – including money market funds, hedge funds, and private equity firms – has given rise to a distinct segment of the financial system that is characterized by a different debt tax shield than that prevailing in traditional commercial banking. Owing to the absence of bank levies and higher borrowing rates, the debt tax shield in the shadow banking sector can be substantially larger. Thus, sizable shadow banking tax shields persisted into the low-interest rate environment that characterized the aftermath of the 2008 financial crisis.

Behind this aggregate description of the long-run evolution of the debt tax shield in advanced economies stands a copious amount of country-specific variation that allows us to study the effects of changes in the tax advantage of debt on bank leverage in various settings. The dataset comprises 596 tax rate changes, of which 327 are tax rate increases and 269 tax rate decreases. Additional tax shield variation stems from 38 changes to allowances for corporate equity, the introduction of seven bank levies, and ten interest expense deductibility changes. We exploit this variation to estimate the adjustment path of bank capital ratios in the aftermath of a change in the tax shield of debt through local projection (LP) estimators.

We find that in response to a +1 percentage point (ppt) change in the tax shield banks reduce their capital ratios between 0.25 and 0.8 ppts within five years. Importantly, we find that the adjustment is driven by a reduction in bank equity, whereas the total amount of bank assets stays on trend. This assuages concerns that policies that are aimed at decreasing the tax shield of debt may generate collateral damage through a reduction in overall bank intermediation. Instrumental variable- (IV) and inverse probability weight- (IPW) estimators, as well as a battery of diagnostic statistics and sensitivity analyses underscore the robustness of the adjustment path estimates.

Do banks only adjust their capital ratios in response to tax shield hikes, but not to cuts? Theoretical work on the *leverage ratchet effect* suggests so (Black and Scholes, 1973; Admati et al., 2018), because the increase in retained earnings that accompanies deleveraging means fewer dividends for bank owners, whereas the benefits of deleveraging accrue primarily to debt-holders, in the form of an increased probability of bond repayment. If the ratchet effect hypothesis is empirically relevant, it would imply that policies that reduce the tax advantage of debt are ineffective at raising bank capitalization rates. By contrast, we find that banks increase their capitalization rate in response to tax shield increases, which suggests that such policies can be effective.

Furthermore, our effect size estimates exhibit significant state-dependencies. First, we find that banks in weakly capitalized banking systems do not further reduce their capital ratios in response to a tax shield increase. This is consistent with the notion that asymmetrically binding capital constraints prevent banks from exploiting the tax advantage of debt beyond a certain point. The results for weakly capitalized banking systems further run counter to the asymmetry prediction made by leverage ratchet effect theory, in that tax shield cuts elicit capitalization rate increases, whereas tax shield hikes do not elicit capitalization rate decreases. Second, we find that in response to a tax shield increase, it is exclusively banks in economies with an open capital account that expand their balance sheets by issuing more debt. This is consistent with the notion that capital account openness amplifies the bank capital ratio response to tax shield changes through international debt shifting, where multinational banks minimize their tax burden by shifting debt towards countries with higher debt tax shields.

After establishing a plausible effect size range, we can quantitatively assess how the evolution of the debt tax shield affected bank leverage over the past one and a half centuries through a historical accounting exercise. We find that tax shield increases can plausibly account for between 19% and 60% of the 20th century decline in bank capital ratios in advanced economies up to the 1980s. Subsequent tax shield decreases have been effective at bolstering bank capital ratios by up to 6 ppts. In light of this estimate, the actual 2.5 ppt increase in the bank capital ratio between the 1980s and 2020 is small. As we find no evidence that tax shield decreases are less effective at increasing capital ratios than tax shield increases are at lowering them, we conclude that the lackluster increase in actual bank capital ratios is indicative of countervailing forces that have offset the decreasing tax advantage of debt since 1980.[1]

The literature our findings speak to reaches back to the seminal contribution of Modigliani and Miller (1958), which establishes the irrelevance of capital structure in a tax-free environment. Subsequent contributions have explored how the debt tax shield

---

[1] A prominent candidate in this regard is the rising banking sector concentration that began around the same time, and that led to the emergence of implicit government guarantees associated with the crystallization of "too-big-to-fail" expectations (Stern and Feldman, 2004; Fohlin and Jaremski, 2020; Baron et al., 2024).

affects companies' financing decision (Stiglitz, 1973; King, 1974). Recent theoretical work has extended the analysis to cover the role of TCR, ACE, and bank levies in a banking context (Boot and de Vries, forthcoming). Our paper complements this literature with a novel empirical leg.

Existing empirical studies confirm that corporate income taxation indeed affects firms' capital structure (MacKie-Mason, 1990; Auerbach, 2002; Graham, 2006; de Mooij, 2011; Feld et al., 2013; Fliers et al., 2024). More recently, the evidence for the responsiveness of firms' capital structure to tax shield changes has been extended to cover the case of ACEs (Hebous and Ruf, 2017; Branzoli and Caiumi, 2020). Closer to our study, regarding the focus on bank leverage, several empirical banking studies document that corporate tax rate changes affect bank leverage (de Mooij et al., 2014; Hemmelgarn and Teichmann, 2014; de Mooij and Keen, 2016; Schandlbauer, 2017; Milonas, 2018; Luca and Tieman, 2019). Schepens (2016) and Martin-Flores and Moussu (2019) have extended this literature by showing that bank leverage is also responsive to the introduction of an ACE. Finally, Devereux et al. (2019) and Celerier et al. (2020) show that bank leverage is also responsive to the introduction of bank levies.

This paper contributes to the literature on the debt tax shield and bank leverage in four ways: First, the tax data provided with this paper will enable researchers to make new inroads into the quantitative study of the linkages between macro-finance and taxation. The new dataset summarizes the available information on the debt tax shield of banks and its components – the corporate tax rate for banks, the bank interest rats, bank levies, limitations on interest expense deductibility, and allowances for corporate equity. The collected time series cover 17 advanced economies and run from 1870 to the present. This coverage conforms to the Jordà-Schularick-Taylor Macrohistory Database (Jordà, Schularick, and Taylor, 2017) and therefore allows for easy adaptability with existing long-run data on the macroeconomy and financial systems.

Second, we derive a comprehensive measure of the tax advantage of debt that nests and interacts its multiple determinants as suggested by theory – including corporate tax rates, the interest rate level, ACE, deductibility limits, and bank levies. By contrast, most of the existing literature focuses exclusively on corporate tax rate changes without accounting for its interaction with the interest rate level, deductibility limits, bank levies, and the presence of ACEs. This is quantitatively important, however, as a corporate tax rate increase in a 4% interest rate environment increases tax deductible interest expenses by twice as much as the same corporate tax rate increase does in a 2% interest rate environment. As a consequence, existing findings, which are exclusively based on post-1990 datasets, are likely to be specific to the low-interest rate environment of the late 20th and early 21st century. By focusing on changes in the overall tax shield, rather than only on corporate tax rate changes, our analysis yields effect size estimates that are robust to variation in the various components of the overall debt tax shield.

Third, we provide macro-estimates that describe the effect of tax shield changes on bank leverage at the aggregate banking sector level. By contrast, most existing studies are based on bank-level datasets that fail to fully reflect the low responsiveness of large banks to changing tax incentives, either because observations are not weighted according to balance sheet size, or because large banks are treated as outliers that are excluded from the analysis. Large banks, however are responsible for a substantial share of total banking system assets. Thus, while most existing micro-estimates accurately reflect the responsiveness of a typical non-large bank, they overestimate the effectiveness of tax shield changes at the macro-level up to four-fold. Our macro-estimates therefore should be of particular interest to macroeconomists and policymakers with an eye on the macro-level, such as macro-prudential regulators.

Fourth, by taking a long-run perspective, we are able to analyze the role of factors that are time-invariant in shorter samples. In particular, our analysis reveals that banks adjust their balance sheets such as to exploit international tax arbitrage opportunities in environments where an open capital account allows them to do so. By contrast, the existing literature is exclusively based on post-1990 datasets within which relatively open capital accounts are a given. The long-run perspective also allows us to conduct a historical accounting exercise that quantitatively addresses the question of how much of the 20th century increase in bank leverage can plausibly be attributed to the concomitant rise in the debt tax shield.

The remainder of this paper is structured as follows: The first part of the paper (section 2) begins with the theoretical derivation of an optimality condition that links bank leverage to the tax advantage of debt based on a banking model (2.1). The derived tax advantage equation guides our data collection, which is described in section (2.2). Based on the collected data we calculate the tax advantage of debt and discuss its historical evolution in Section 2.3. The second part of the paper (section 3) introduces the econometric framework that we use to assess the reaction of bank leverage to tax shield changes (3.1). Section 3.2 presents our findings. After corroborating the robustness of these findings in section 3.3, we juxtapose them with related findings from the literature (3.4). Section 3.5 uses our estimates in a historical accounting exercise that explores the role of the tax advantage of debt in the long-run evolution of bank capital ratios. Section 4 concludes.

2. THE DEBT TAX SHIELD, ITS COMPONENTS, AND BANK LEVERAGE

2.1. Model framework

We use a simple banking model to derive an optimality condition that relates the debt tax shield to bank leverage. As in Boot and de Vries (forthcoming), the exact tax advantage of debt is shaped by the corporate tax rate, limits to interest expense deductibility, allowances for corporate equity, and bank levies. We begin by introducing a bare bone version of the bank's optimality condition under corporate taxation and interest expense deductibility.

Consider a one-period banking model with a bank that maximizes the value to equity holders. At the beginning of the period, the bank decides how much equity, k, and debt, $1-k$, to use to finance an investment project that returns q.[2] Debt financing incurs an interest expense, $i(1-k)$. The equity-debt tradeoff is rendered pertinent by a quadratic bank leverage cost, $\Gamma(k) = \frac{1}{2}\gamma(k^* - k)^2$, where k^* represents the bank's optimal capital ratio in the absence of taxation (Huizinga et al., 2008; Goldbach et al., 2021).

The quadratic cost curve encapsulates a trade-off between the benefits and costs of leverage. Benefits include i.a. the reduction of information asymmetries between managers and equity holders, and the enforcement of manager discipline (Meckling and Jensen, 1976; Jensen, 1986; Diamond and Rajan, 2001); relevant costs encompass i.a. bankruptcy costs, regulatory penalties, market-enforced risk premiums, and costs associated with creative accounting (Kraus and Litzenberger, 1973; de Walque et al., 2010; Gerali et al., 2010). The literature on target capital structures that arise from the presence of various costs and benefits associated with equity and debt financing is discussed by Hovakimian et al. (2004) and Aggarwal and Kyaw (2010). Van Binsbergen et al. (2010) and Korteweg (2010) underscore the empirical relevance of the trade-off theory of capital structure.

At the end of the period, the bank liquidates, and the proceeds are distributed among its financiers – equity holders and depositors. The bank's corporate income is subject to income taxation at rate τ, while interest expenses are tax-deductible:

$$\max_{k} \left\{ \Big[(1-\tau)[q - i(1-k) - \Gamma(k)] + k \Big] \frac{1}{1+i} - k \right\}. \tag{1}$$

The after-tax proceeds that accrue at the end of the period are discounted. The bank's net present value is obtained by subtracting the initial capital outlay, k, from the discounted

---

[2] The normalization of the bank's balance sheet to 1 precludes an adjustment of the bank capital ratio through a change in total bank assets. This assumption will be born out by the empirical analysis, which indicates that, in respond to tax shield changes, banks adjust their liability structure through changes in bank capital rather than through changes in overall balance sheet size.

after-tax proceeds. A model with endogenous return premium ρ, where equity holders discount end of period proceeds using $r = i + \rho$, and where the return premium ρ depends on bank leverage k and the interest rate i, yields qualitatively identical results (Appendix C).

The first-order condition equates the (after-tax) marginal cost of an increase in bank leverage, $(1-\tau)\gamma(k^* - k)$, with the marginal tax benefit that springs from the existence of corporate income taxation in conjunction with interest expense deductibility.

$$(1-\tau)\gamma(k^* - k) = \tau i.$$

The second order condition for a maximum, $-\gamma(1-\tau) < 0$, holds.

Rearranging the first order condition yields an expression for the bank's optimal capital ratio that is linear in the effective debt tax shield, s

$$k = k^* - \frac{1}{\gamma} s, \tag{2}$$

where

$$s \equiv \tau i/(1-\tau). \tag{3}$$

For $\tau = 30\%$ and $i = 5\%$, for example, the effective debt tax shield is around 2% ($= \frac{0.3 \cdot 0.05}{1-0.3}$), which indicates that the return on the marginally issued unit of equity would have to be 2% higher than the return on the marginally issued unit of debt to fully offset debt's preferential tax treatment.[3] The tax advantage of debt is increasing in the interest rate, $\frac{ds}{di} = \frac{(1-\tau)\tau}{(1-\tau)^2} > 0$, and the corporate income tax rate, $\frac{ds}{d\tau} = \frac{i}{(1-\tau)^2} > 0$.[4] According to the optimality condition (2), a 1 ppt increase in s elicits a $\frac{1}{\gamma}$ ppt reduction in the bank capital ratio, k, below its optimum without taxation, k^*.

The response of bank capitalization to tax shield changes is thus characterized by the following claim:

Claim 1.

$$\frac{dk}{ds} = -\frac{1}{\gamma} < 0$$

---

[3] Alternatively, the cost of issuing the marginal unit of equity (e.g. investment bank fees) would have to be 2% lower to compensate for the tax advantage of debt.

[4] The conjunction of $\frac{dk}{ds} < 0$ and $\frac{ds}{di} > 0$ can also be read to signify room for moral hazard: as a rising interest rate increases the debt tax shield the bank takes on a riskier liability structure.

The bank capital ratio is decreasing in the debt tax shield if $\gamma > 0$.

Section 3 will evaluate this effect empirically.[5]

Allowance for corporate equity, limits on interest expense deductibility, and bank levies: The tax shield s can be readily extended to incorporate more regulatory detail. Bank levies, allowances for corporate equity (ACE), and deductibility limits such as thin capitalization rules (TCR) all aim at countering the tax advantage of debt, and their recent spread among advanced economies has rendered them increasingly relevant.

A typical ACE counters the tax advantage of debt by introducing a notional return on equity, $\eta \geq 0$, that is tax deductible. A typical TCR caps the amount of interest expenses that can be deducted to a fraction, $\delta < 1$, of the total. Relatedly, interest expenses have not always been treated as tax deductible. Thus, in the late 19th and early 20th centuries several countries' (corporate) income tax codes effectively capped the amount of deductible interest expenses at zero. Finally, bank levies, that were introduced after the 2008 financial crisis, tax the amount of debt by superimposing a tax rate, $\lambda \geq 0$, on the interest rate, i.

Incorporating these regulatory features into the bank's profit maximization problem yields the extended maximand

$$\max_k \left\{ \Big[(1-\tau)[q-\Gamma(k)] - (i+\lambda)(1-k) + \tau\delta i(1-k) + \tau\eta k + k\Big]\frac{1}{1+i} - k \right\}. \tag{4}$$

Here, $(i+\lambda)(1-k)$ captures the interest expense augmented by the bank levy λ. The $\tau\delta i(1-k)$ reflects the fraction δ of interest expenses that are tax-deductible in light of existing limits on interest deductibility, and $\tau\eta k$ captures the notional equity return η that is rendered tax deductible by an ACE. The bank's optimal capital ratio is again characterized by equation (2), but featuring an extended tax advantage term, s, that constitutes our comprehensive debt tax shield measure.

Claim 2. *The full tax advantage of debt over equity is determined by the following interaction of the corporate tax rate, interest rate, allowance for corporate equity, interest*

---

[5] The existence of regulatory capital requirements can lead to a breakdown in the optimality relation 2. In practice, bank capital can fall short of the regulatory requirement for some time during which the bank incurs a cost – either owing to regulatory penalties, or to market-enforced premiums associated with the need for rapid recapitalization and the shortfall in capital. The existence of a regulatory capital requirement can thus be reframed as part of the intermediation cost $\Gamma(\cdot)$. The fact that many banks hold more equity than what is regulatorily required (Flannery and Rangan, 2008) further suggests that the optimality relation 2 is unlikely to fully break down at the aggregate level. Findings by de Mooij and Keen (2016) even suggest that banks' capital structure is as responsive to tax incentive changes as the capital structure of non-financial firms, that are not subject to regulatory capital requirements. Section 3.2 explores banking systems that have low capitalization rates, and thus are most likely to be affected by binding capital constraints, in greater detail.

deduction limit, and bank levy:

$$s \equiv \frac{\tau(\delta i - \eta) - \lambda}{1 - \tau}. \tag{5}$$

How do capital ratios react to changes in the tax shield's various components? The following are the (partial) capital ratio effects that the model predicts (see Appendix A for derivations):

Claim 3. *We have the following partial effects:*

$$\frac{dk}{di} = -\frac{\tau\delta}{\gamma(1-\tau)} \leq 0 \tag{6}$$

$$\frac{dk}{d\eta} = \frac{\tau}{\gamma(1-\tau)} > 0 \tag{7}$$

$$\frac{dk}{d\delta} = -\frac{\tau i}{\gamma(1-\tau)} < 0 \tag{8}$$

$$\frac{dk}{d\lambda} = \frac{1}{\gamma(1-\tau)} > 0 \tag{9}$$

$$\frac{dk}{d\tau} = -\frac{\delta i - \eta - \lambda}{\gamma(1-\tau)^2} < 0 \quad \textit{for} \quad \delta i - \eta - \lambda > 0 \tag{10}$$

Proof: combine the claim 1 result, $\frac{dk}{ds} < 0$, with the claim 2 definition of how variables i, η, δ, λ, and τ enter s.

Thus, an increase in the bank capital ratio can be elicited by a decrease in the interest rate, an increase in the deductible equity return, a decrease in the interest expense deductibility limit, and an increase in the bank levy.[6] For most practically relevant cases, where interest expense deductibility limits, ACE, and bank levies combined do not fully offset the tax advantage of debt $0 \ngeq \delta i - \eta - \lambda$, an increase in the corporate tax rate elicits a decrease in the capital ratio.

---

[6] Note that an increase in the interest rate i raises the required return on equity, which is implicit in the discount factor $1/(1+i)$, by the same amount as it raises the cost of debt. Consequently, here, an increase in the interest rate does not render debt more expensive than equity and thereby incentivize less debt financing. A model that breaks the link between the interest rate on debt and the required return on equity in a realistic fashion yields the same sign predictions for all partial derivatives but amplifies their size (Appendix C). Only in environments in which the required return on equity does not sufficiently co-move with the interest rate on debt, e.g. in models with a fixed discount factor, would the sign prediction for $\frac{dk}{di}$ reverse.

The model thus provides straightforward sign predictions with respect to each policy change, and stakes out the scope of the data required to assess the full tax advantage of debt.

2.2. Data

We compile long-run time series for all the components of the tax shield variable s, i.e. corporate tax rates, τ, interest rates, i, bank levy rates, λ, ACE rules, η, and interest deductibility limits, δ. The final dataset runs from 1870 to 2020 and covers 17 advanced economies: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the U.K. and the U.S. As there does not exist a single source that provides the required time series for the entire time period we construct new time series based on the information provided in historical law texts, government publications, and academic publications on national tax histories (Data Appendix B).

Corporate income tax rates: For the period after 1950 we can build on existing datasets that compile corporate tax rate series for many countries, such as the OECD Tax Database and the University of Michigan's World Tax Database.[7] To make use of these series we have to adjust them for bank-specific tax regulations. In Italy, for example, a 1954 tax law (*legge 6 agosto 1954 n. 603*) granted credit and savings institutions a 25% discount on the usual corporate income tax obligation.[8]

At the beginning of our sample, the share of non-incorporated banks which were exempt from corporate income taxation, was still sizable in some countries. For example, until the early 20th century, important Dutch banks remained (limited) partnerships (de Vicq, 2022), which were subject to a separate tax on their distributed profits according to the Business Tax Act from 1893 (*Wet op de Bedrijfsbelasting*) and the Dividend and Bonus Tax from 1917 (*Dividend en- tantième belasting*). By contrast, incorporated banks were only subjected to income taxation from 1942 onwards. Thus, shifts in business structure could have a substantial effect on the average tax rate that a banking system faced. Where this is the case, we use weighted averages of the tax rates for incorporated

---

[7] Where different income tax brackets exist, we select the tax rate for the top income bracket. For our sample, the bank-level data by Baron et al. (2024) shows that the five largest banks within a country typically account for 50% of assets under management, and the top 100 largest banks account for 70% to 90% of total assets. Thus, large banks, subject to the top income tax rate, account for the majority of aggregate fluctuations. In several instances tax rates depend on firm profitability (e.g. Sweden until 1938). In this case we use the bank profitability data from Jordà et al. (2021) to select the tax rate that corresponds to the banking sector's aggregate profitability. Remaining measurement error concerns in this regard are addressed through an instrumental variable approach in Section 3.3.

[8] Likewise, under Germany's *Körperschaftssteuergesetz*, many credit institutions faced a reduced tax rate between 1949 and 1980.

and non-incorporated banks, with weights reflecting the banking system's contemporary business structure.

The tax advantage of debt financing was also affected by excess profit- and war-taxes, which were sizable around WW1 and WW2 (Hebous et al., 2022). Although they were originally envisaged as temporary measures, in many cases the abolition of an excess profit tax was accompanied by other tax law changes that effectively perpetuated higher income tax rates. We separately account for this occasionally important source of variation in the effective income tax rate, by accompanying the main corporate tax rate series with a time series on excess profit- and war-tax rates.[9]

ACE: For recent instances of ACE we draw on the summary by Hebous and Ruf (2017), which we update to the current end of our dataset. We also extend the corresponding time series back to 1870. Some countries had experimented with ACEs already in the early 20th century. The 1903 income tax act in Denmark, for example, rendered a 4% return on equity tax-deductible. Likewise, the Dutch excess income tax between 1916 to 1918 allowed for the deduction of a notional return of 5%.

Most ACE rules can be characterized by a notional return on equity that is set by the regulatory authority, and that can be deducted from corporate income. In some cases this notional return is rendered only partially deductible. In 1997, for example, Italy introduced the partial deductibility of a notional equity return of 7% – a value that regulators have periodically updated since then. This notional return was taxed at a reduced rate of 19% instead of the usual 37%. In general, ACE rules can be easily translated into times series for η, that indicate the extent to which the tax advantage of debt is annulled.

Interest expense deductibility limits: At the current end of our sample the majority of countries features a TCR (Ernst & Young LLP, 2008, PWC Worldwide Tax Summaries). While financial institutions are largely exempt from these, some exceptions exist. In Australia, for example, interest expense deductibility is also capped for banks.[10] We assess the extent to which TCRs are binding at the aggregate level by calculating the aggregate banking sector's percentage-deviation from the interest expense cap measure. For example, if the aggregate banking system's capital ratio equals 5%, and interest expense deductibility is capped for capital ratios below 6%, then the aggregate distance measure is $(6\% - 5\%)/6\% = 16\%$. Such a positive value suggests that at least parts of

---

[9] In some cases, war taxes were imposed retroactively. When compiling the tax rate series we treat the year during which a new tax law was enacted as the year of the tax rate change. By thus ignoring tax retroactivity, the resulting tax rate series reflects the information available to contemporary bankers, for whom retroactive tax obligations constituted sunk costs with no bearing on their banks' optimal liability structure. Note, however, that in periods of repeated retroactive taxation (e.g. during prolonged wars), banks may have anticipated such measures.

[10] Interest expense deductibility was also capped in the U.S. between 1909 and 1917 (Bank, 2014).

the banking system operate beyond the limit set by the TCR cap and thus additional interest expenses are no longer deductible. Negative values, on the other hand indicate non-binding TCRs. We restrict the so obtained distance measure to the 0–1 range, by setting all negative values (non-binding TCR caps) to zero, and by normalizing the positive values (binding TCR caps) to the 0–1 range. The resulting indicator is our measure for $(1-\delta)$.[11]

In addition, there exist several countries whose tax codes did not treat interest expenses as tax deductible until the mid 20th century. For example, interest expenses were not tax deductible under France's business turnover tax and early business-profit tax schemes. Within the context of equation (5) this amounts to a TCR that caps the fraction of deductible interest expenses at zero, i.e. $\delta = 0$.

Bank levies: A recently proliferating policy measure that is directed at moderating the tax advantage of debt are bank levies, which many countries have introduced in the aftermath of the 2008 financial crisis. Our main source in this regard is Devereux et al. (2019), who summarize the current state for European Union countries. The only non-EU country with a bank levy in our sample is Australia, which since 2017 superimposes a 0.06% tax on interest expenses. Within our sample, bank levy rates range from 0.035% (Belgium) to 0.088% (U.K.), and they increase the average interest expense by around 5%.[12]

Interest rate: Calculating the tax advantage of debt according to definition 5 also demands a time series for the interest rate, i. We use long-run time series on bank deposit rates from Zimmermann (2019) to calculate the magnitude of the debt-related interest expense.[13] In particular, we use a centered 11-year moving average of this variable. This conforms with the notion that deliberate decisions about a bank's funding mix are based on expected future interest rates rather than exact current values. While a centered 11-

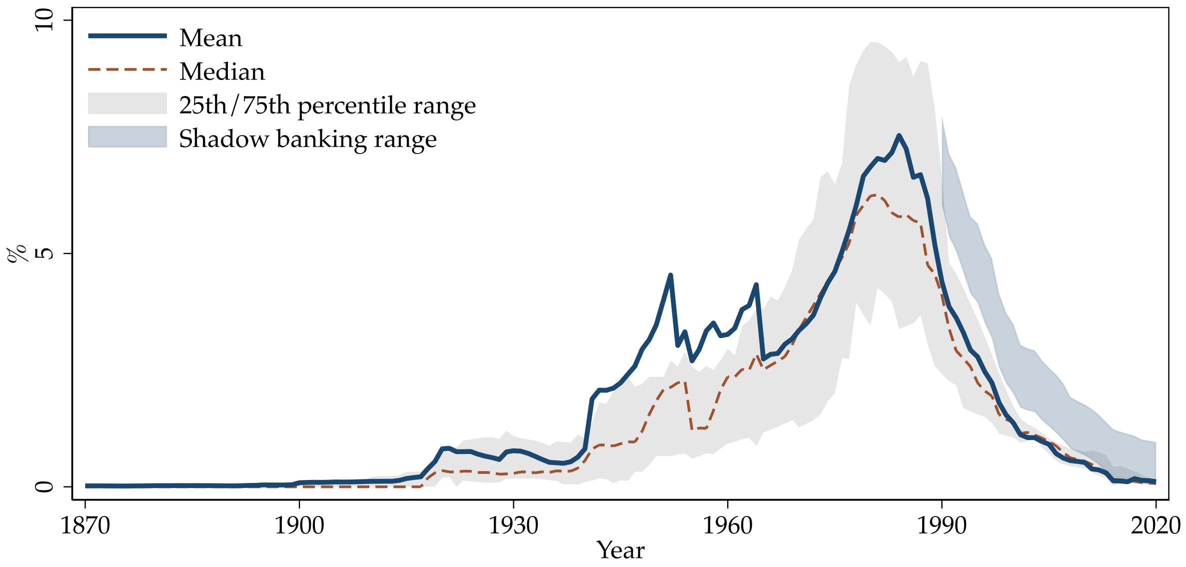
---

[11] Section 3.3 uses an instrumental variable (IV) approach that addresses the potential measurement error problem that can arise by proxying for a banking sector's aggregate interest expense deductibility limit in this way.

[12] We neglect the U.K.'s 1981 bank levy because, as a one-off windfall tax, it has little bearing on banks' capital structure. In Belgium and Germany, bank levies do not apply to insured deposits. Our construction of the tax shield measure for these two countries assumes that the bank levy applies. The potential measurement error resulting from this is addressed in Section 3.3. Finally, in Germany bank levy rates range from 0% to 0.06% depending on the amount of bank debt. Our tax shield measure applies the top rate of 0.06%, which accords with high banking sector concentration: according to Baron et al. (2024) the top-5 banks' asset share stood at around 50% in Germany since the 1990s, implying that large banks' balance sheets dominate fluctuations in the aggregate data we analyze.

[13] We update these series up to 2020, using the deposit rate data compiled by the IMF, and the banking statistics provided by national central banks. The deposit rate series reflect the interest rate on mostly 3-month term deposits. They typically fall short of deposit rates on longer-term deposits and exceed the money market rates at which banks can obtain short-term funding on overnight money markets, but they serve to measure banks' average cost of debt at a plausible average level. Minor differences between the movements of different types of interest rates are of little consequence, given that we use moving averages and our main analysis uses first differences, rather than levels, of the tax advantage term, s.

Figure 1: Tax advantage of debt



Notes: This figure displays the mean, median, and interquartile range of the tax advantage of debt for the banking systems of 17 advanced economies from 1870 to 2020, together with a post-1990 range of mean debt tax shields for the shadow banking system, corresponding to interest rate spreads between 10 and 300 basis points over prevailing money market rates. The tax advantage is defined according to equation (5) and accounts for corporate tax rates, interest rates, allowances for equity, limits on interest expense deductibility, and bank levies. Tax rates pertaining to temporary war taxes and excess profit taxes are excluded from the calculation of the tax advantage of debt.

year moving average reflects interest rate expectations by incorporating a backward- and a forward-looking component into the interest rate measure, one-sided moving averages that reflect purely forward- and backward-looking expectations yield similar results.[14]

2.3. Historical overview

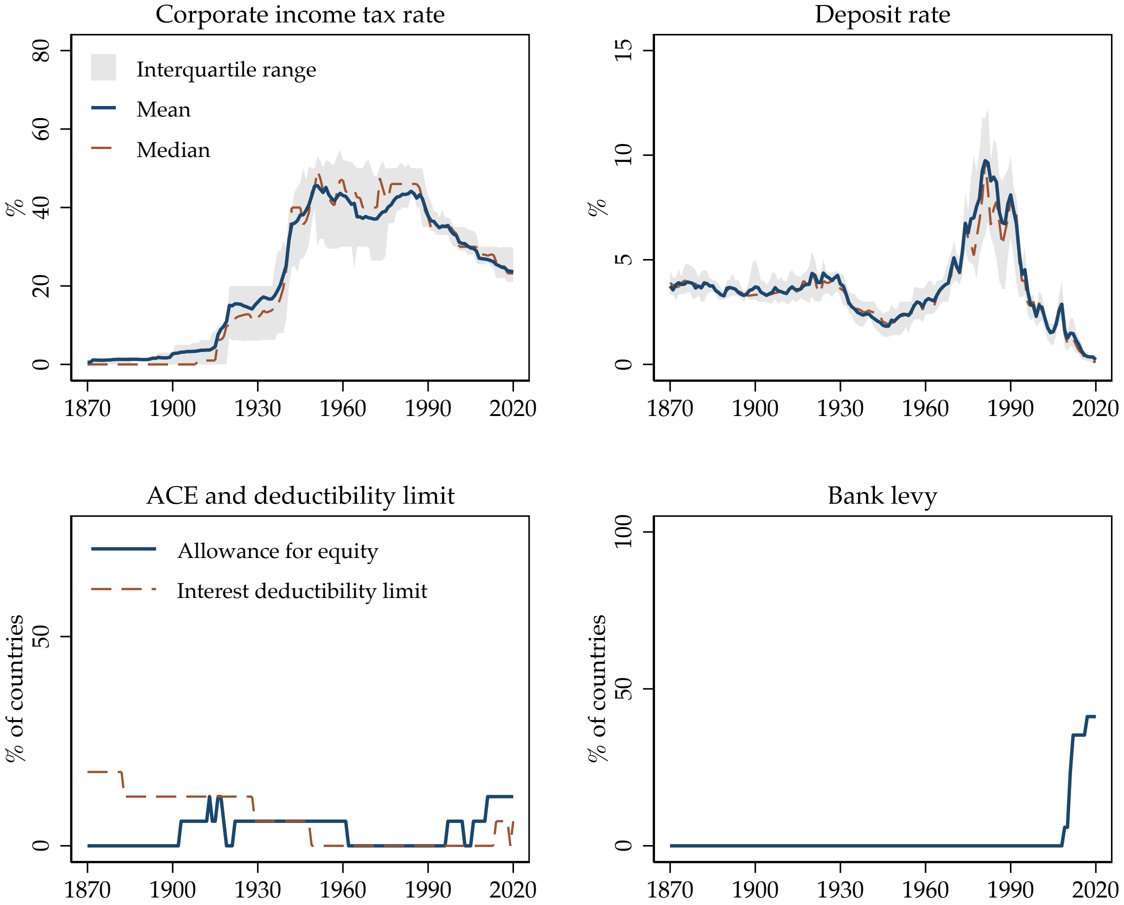
Figure 1 summarizes the data on the tax shield for bank debt, s, from 1870 to 2020. The figure displays the mean, median, and the interquartile range of the debt tax advantage for the 17 countries in our sample. The evolution of the tax shield results from the evolution of its various components, which are summarized in Figure 2. Beginning in the late 19th century, few countries had developed income tax systems. Those that did, initially started out with low tax rates. As a consequence, the average income tax rate in our sample stayed below 5% until World War I. Furthermore, several countries that had introduced income taxes prior to World War I did not treat interest payments as tax deductible expenses until the early 20th century. The upshot was that tax advantages for debt financing were rare prior to World War I.[15]

---

[14] Figures D.1 and D.2 in the Appendix.

[15] Some early country-specific variation in the debt tax shield, however, hides behind the relatively flat pre-1913 averages depicted in Figure 1.

Figure 2: Components of the tax advantage of debt



Notes: This graph summarizes the evolution of the five components of the tax advantage of debt (equation (5)) for 17 advanced economies from 1870 to 2020. Tax rates pertaining to temporary war taxes and excess profit taxes are excluded from the corporate income tax rate series.

World War I was a catalyst for the comprehensive reform of existing income tax systems and the introduction of new ones, owing to the collapse of trade-related tariff revenues and rising military spending. The taxation of (corporate) income became pervasive, with many countries' corporate tax rates settling in the 10% to 20% range during the 1920s and 1930s. For the first time, debt financing enjoyed a non-negligible tax advantage vis-à-vis equity across developed economies. World War II triggered another increase in income tax rates, which raised the median tax advantage of debt to around 2.5 ppts. The average corporate tax rate faced by banks in our sample continued to hover around 40% for several decades after World War II.

Starting in the 1960s rising inflation rates began to exert upward pressure on nominal interest rates. This had a direct impact on the nominal amount of interest expenses that were tax deductible. In conjunction with the high corporate income tax rates that had cemented themselves in the aftermath of World War II, the average tax advantage of debt thus rose above 5 ppts in the late 1970s.

In the 1980s, several factors combined to reverse the upward trend in the tax advantage of debt. First, corporate tax rates embarked upon a sustained downward trend, reaching an average of 30% at the current end of our sample. Second, disinflation implied a reduction in nominal interest rates. Third, the introduction of ACE and TCR rules targeted at eliminating the tax advantage of debt vis-à-vis equity gained steam in the 1990s and the 2000s. Fourth, real interest rates across advanced economies kept trending downward and remained close to 0% for more than a decade in the aftermath of the 2008 financial crisis. Finally, the 2008 financial crisis also triggered the introduction of bank levies in more than a third of countries in our sample.

Owing to the absence bank levies and higher borrowing rates, the debt tax shield in the shadow banking sector can be substantially larger. For the shadow banking sector, relevant funding costs in the repo market and prime brokers' lending rates are better approximated by short-term risk-free money market rates (e.g. LIBOR or SOFR) plus a spread, which in practice varies widely across shadow-banking entities (Ang et al., 2011). Our short-term money market rate indicator is taken from the Jordà-Schularick-Taylor Macrohistory Database (Jordà et al., 2017) and, as before, we use a centered 11-year moving average. We consider a spread ranging from 10 to 300 basis points, where the lower bound reflects secured short-term funding at near risk-free rates, while the upper bound captures riskier and unsecured forms of credit. On this basis, we compute a range of tax shield estimates for the shadow banking system from 1990 onwards. The blue shaded area in 1 shows the sample-mean range of tax shields corresponding to the 10-300 basis point spread used to construct the shadow-banking borrowing rate (i.e. the money market rate plus a spread). This range indicates that the shadow banking system's debt tax shield exceeds that of the traditional banking sector throughout the sample, with potentially sizable tax shields persisting in the aftermath of the 2008 financial crisis up to the end of the sample period. The subsequent increase in inflation and real interest rates has further led to a rebound in the debt tax shield, even for the traditional banking system.[16]

How does the debt tax shield comove with bank capital ratios? Figure 3 explores this comovement on the basis of the newly compiled debt tax shield series and the bank capital ratio series from Jordà et al. (2021).[17] In this capital ratio series, bank capital is defined

---

[16] Note that a significant share of the total assets held in the shadow banking sector are held by pension funds and insurance companies, which issue relatively little debt, and which are subject to additional regulations. The depicted shadow banking tax shield range thus pertains to other non-bank financial institutions – broker-dealers, hedge funds, finance companies etc., which are not subject to additional regulation, but which are responsible for the vast majority of shadow banking sector debt (FSB, 2023).

[17] We apply the traditional banking sector debt tax shield for the comovement analysis. Note that,

as the sum of common stock, reserves, and retained earnings, which aligns with the Basel III definition of Common Equity Tier 1 capital. Bank assets are non-risk-weighted, so the resulting capital ratio is akin to the inverse of the "leverage ratio" in Basel III.[18] The left panel of Figure 3 depicts the comovement in the five-year changes of the tax shield and the capital ratio across the entire sample. Many capital ratio changes occur against the backdrop of a stable debt tax shield, giving rise to a vertical cluster. The remaining observations depict a negative linear relationship between tax shield changes and capital ratio changes, with a 1 ppt tax shield increase being associated with a capital ratio decrease of around 0.25 ppt.

The center panel of Figure 3 highlights the temporal covariation, based on global cross-sectional averages. Similar vertical and downward sloping covariance clusters are discernible. Marker labels further indicate four sub-periods: (i) the pre-1913 period during which the first debt tax shields emerge, (ii) the 30-year crisis between 1914 and 1945 during which debt tax shields establish themselves, (iii) the period of continued debt tax shield rises between 1946 and 1980, (iv) the post-1980 period during which the debt tax shield declines. Much of the vertical cluster is made up of pre-WW2 observations that feature sizable capital ratio changes but comparatively few tax shield changes. The downward sloping cluster consists of post-WW2 observations, that produce the roughly -0.25 ppt change for every 1 ppt change of the tax shield.

The right panel of Figure 3 highlights the cross-sectional covariation contained in the data, based on period-specific time-averages for each of the 17 countries in the sample.[19] Again, similar vertical and downward sloping covariance clusters emerge. The pre-WW2 vertical cluster as well as the post-WW2 downward sloping cluster are substantiated by the cross-sectional variation. The latter is again characterized by a slope in the vicinity of -0.25.

Overall, the negative comovement pattern between tax shield changes and capital ratio changes presents prima facie evidence for the negative relationship between these two variables described by claim 1. While the role of the tax shield in accounting for capital ratio changes prior to 1945 seems comparatively small and thus leaves much room

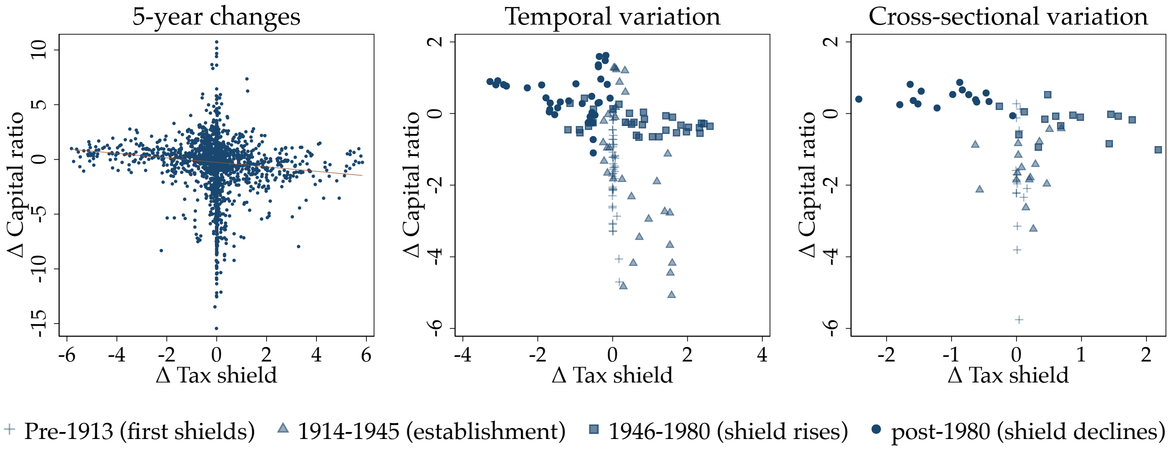
---

despite the level-difference in the debt tax shield between the traditional and shadow banking sectors, changes in the two debt tax shield measures remain highly correlated up to 2008 ($\rho \approx 0.95$), owing to high comovement in the 11-year moving averages of money market rates and deposit rates. After 2008, with the introduction of bank levies, the correlation is somewhat lower ($\rho \approx 0.85$).

[18] The banks covered by this series include monetary financial institutions such as savings banks, postal banks, credit unions, mortgage associations, and building societies. Financial institutions, such as brokerage houses, finance companies, pension funds, and insurance firms are excluded (Schularick and Taylor, 2012).

[19] Time averages over the entire sample period from 1870 to 2020 hardly feature any interesting tax shield variation, because most countries' tax shields start at 0 in 1870 and end at close to 0 in 2020. Hence, the cross-sectional covariation between tax shields and bank capital is better illustrated by time averages within sub-periods which broadly delineate episodes of rising and declining tax shields.

Figure 3: Covariation between the debt tax shield and bank capital ratios (5-year changes)



Notes: The left graph depicts the comovement in the five-year changes of the tax shield and the capital ratio across the entire sample. The center panel shows the temporal covariation, based on global cross-sectional averages. The right panel shows the cross-sectional covariation contained in the data, based on period-specific time-averages for each country.

for other factors (e.g. institutional changes, business norms, etc.) the post-WW2 data describes a reliably negative relationship between the two variables.

3. How does bank leverage react to tax shield changes?

3.1. Econometric strategy

This section presents estimates that hone in on the causal question of how a 1 ppt change in the debt tax shield affects the bank capital ratio. We empirically assess this effect through an impulse response function (IRF) analysis using local projections (Jordà, 2005). In particular, we estimate the following sequence of linear regression models over a 5-year horizon, $h = 0, ..., 5$:

$$\Delta^h k_{t+h,i} = \beta_0^{h,i} + \sum_{l=0}^{L} \beta_1^{h,l} \Delta s_{t-l,i} + \sum_{l} \beta_2^{h,l} X_{t-l,i} + u_{t+h,i} \tag{11}$$

where $\Delta^h k_{t+h,i}$ is the cumulative change in the bank capital ratio between years $t-1$ and $t+h$ in country i, and $\beta_0^{h,i}$ are country-specific constants for each horizon. $\Delta s_{t-l,i}$ denotes the change in the tax advantage of debt, where l denotes the lag. Thus, $\beta_1^{2,0}$, for example describes the cumulative effect of a 1 ppt increase in s on the bank capital ratio after two years. $X_{t-l,i}$ is a vector of control variables and $u_{t+h,i}$ are horizon-specific error terms. The estimated $\{\beta_1^{h,0}\}_{h=0}^{5}$ describe the cumulative response of the bank capital ratio to a 1 ppt increase in the tax shield s. Our IRF estimates indicate that by year five ($h = 5$) the transition dynamics have completed, and $\beta_1^{5,0}$ can thus be interpreted as an estimate of $-\frac{1}{\gamma}$ (Claim 1).[20] To account for our dataset's cross-sectional and temporal dependencies we use Driscoll-Kraay standard errors (Driscoll and Kraay, 1998) to calculate confidence intervals.[21]

Dependent variables: Our main dependent variable is the bank capital ratio provided by Jordà et al. (2021). This series defines bank capital as the sum of common stock, reserves, and retained earnings, which aligns with the Basel III definition of Common Equity Tier 1 capital. Assets are non-risk-weighted, so the resulting capital ratio is akin to the inverse of the "leverage ratio" in Basel III. The banks covered by this series include monetary financial institutions such as savings banks, postal banks, credit unions, mortgage associations, and building societies. Financial institutions, such as brokerage houses, finance companies, pension funds, and insurance firms are excluded (Schularick and Taylor, 2012). We use the capital ratio's component series – bank capital and total bank assets – as dependent variables to disentangle numerator and denominator responses. We deflate both series using the CPI index by Jordà et al. (2017). Finally, we also use the the tax shield as a dependent variable to estimate the tax shield's own-response. This allows us to assess the persistence of a tax shield shock over the projection horizon.

Control variables: We saturate the control vector $X_{t,i}$ with variables that are commonly included in empirical analyses of capital structure (e.g. Hemmelgarn and Teichmann, 2014; Gu et al., 2015; de Mooij and Keen, 2016). We use real GDP growth and consumer price inflation based on the the Jordà-Schularick-Taylor Macrohistory Database to account for the effect of business cycle fluctuations (Jordà et al., 2017, `http://www.macrohistory.net/data/`). The financial crisis dummy from the same source accounts for systematic bank leverage dynamics around crisis dates.[22] The time series for banks' return on equity by Jordà et al. (2021) allows us to account for lags of bank profitability – an important source of fluctuation in bank leverage to the extent that banks retain profits (de Mooij and Keen, 2016).

To account for the influence of regulatory capital requirements, we interact the change in the tax shield with the difference between the regulatorily required capital ratio and the actual capital ratio from the World Bank's Banking Regulation and Supervision Survey

---

[20] Our analysis focuses on the responsiveness of bank capital ratios to tax shield changes, while remaining silent on why the leverage level of banks exceeds that of non-financial firms. Explanations for the latter include liquidity provision in the form of deposit creation as core part of banks' business model (DeAngelo and Stulz, 2013; McLeay et al., 2014), differences in the liability rules between financial and non-financial firms (Koudijs et al., 2021; Aldunate et al., 2021), or the greater diversification of banks' asset portfolios compared to non-financial firms (Berg and Gider, 2017).

[21] While the baseline specification gives equal weight to all countries in our sample, the application of real purchasing power parity adjusted GDP weights yields very similar findings (Figure D.3 in the Appendix).

[22] An additional global financial crisis dummy accounts for the global financial crises of 1931 and 2008.

(Barth et al., 2001, and subsequent updates).[23] We also use controls for the introduction of deposit insurance schemes, lender of last resort institutions, and major changes to liability regulations (unlimited, double, limited) to account for the effect that such institutional changes can have on banks' need for loss absorbing capital. To this end we compile simple (binary) indicators that highlight the relevant dates, either from existing datasets (Bordo et al., 2001) or from the wider extant literature on a country's financial history.[24]

We include global GDP growth and CPI inflation among the regressors to account for global business cycle conditions (Jordà et al., 2020). The international spillovers that spring from debt shifting (Gu et al., 2015; Martin-Flores and Moussu, 2019) are picked up by a term that interacts country i's capital account openness (Quinn et al., 2011), which ranges from 0 to 1, and its tax advantage differential vis-à-vis other countries, $KAOPEN_{i,t} \cdot (s_{i,t} - \sum_{j \neq i} s_{j,t})$. The equity return premium is included among the controls to account for changes in the relative cost of debt and equity (Jordà et al., 2019).[25] Changes in the tax shield that spring from temporary excess profit- and war-taxes are included as a separate control variable. Finally, we capture the own-dynamics of banks' balance sheets by controlling for total loan growth and lagged changes of the capital ratio.[26]

We include five lags, $L = 5$, as well as the contemporaneous values of all endogenous regressors.[27] Thus, we take a conservative stance with respect to the contemporaneous response of bank leverage to changes in the tax advantage of debt, effectively attributing as much as possible of that response to contemporaneous variation in the control variables rather than tax shield changes. We do not include the contemporaneous values of the balance sheet controls – return on equity and total loan growth – to avoid definitional overlap with the balance sheet variables we are interested in as outcomes (e.g. equity in the denominators of the return on equity and capital ratio variables). For the exogenous

---

[23] The data from this source runs from 2000 to 2016. We impute missing values of actual risk-based capital ratio series from 1993 (Basel I implementation) to 2020 based on country-specific predictive regressions that use the non-risk-based capital ratio from Jordà et al. (2021) to predict the risk-based capital ratio. The R^2's of the predictive regressions are high, typically exceeding 0.4. Prior to 1993 we set the resulting capital ratio tightness series to its sample minimum, indicating the slackness of regulatory capital constraints prior to Basel I.

[24] The main purpose of including rare institutional changes among the controls is to increase estimator precision. The lack of systematic correlation between such rare institutional changes and variation in the tax shield assuages concerns about omitted variable bias more generally.

[25] Analogously to our treatment of the bank deposit rate i, we calculate the centered 11-year average of the return on equity, r. Results for one-sided moving averages that reflect purely forward- and backward-looking expectations about these variables produce results that are very similar to our baseline findings (Figures D.1 and D.2 in the Appendix).

[26] When we analyze bank capital or total bank assets as dependent variables, we replace the capital ratio changes in $X_{t,i}$ with the bank capital- or total bank asset growth rates, respectively.

[27] Controls on bank capital structure and profitability, business cycle controls, the regulatory capital requirement term, the debt shifting control, equity return premium changes, and excess profit- and war-tax rate changes.

regressors – the binary variables on the introduction of a lender of last resort, deposit insurance, and changes in liability regulation – we also include leads up to the estimation horizon h, which serves to mop up variation in the dependent variable and thereby increase the precision of the coefficient estimates of interest (Stock and Watson, 2018).

Identification challenges: Can the resulting coefficient estimates be given a causal interpretation? We use various robustness checks and diagnostic statistics to dispel the most relevant threats to causal identification that spring from correlated impulses, reverse causality, anticipation effects, functional form mis-specification, and measurement error. Our findings in this regard are summarized in Section 3.3, to which we will turn immediately after the presentation of the baseline results in Section 3.2.

3.2. Results

How do changes in the tax advantage of debt affect banks' capital ratios? Figure 4 shows the answer provided by our estimation results. The upper left panel describes the own-response of the tax shield. It shows that changes in the tax shield are highly persistent, i.e. they do not significantly reverse within a 5-year horizon. The upper right panel depicts the response of the bank capital ratio. It declines by around 0.3 percentage points in the five years after a 1 ppt shield increase.

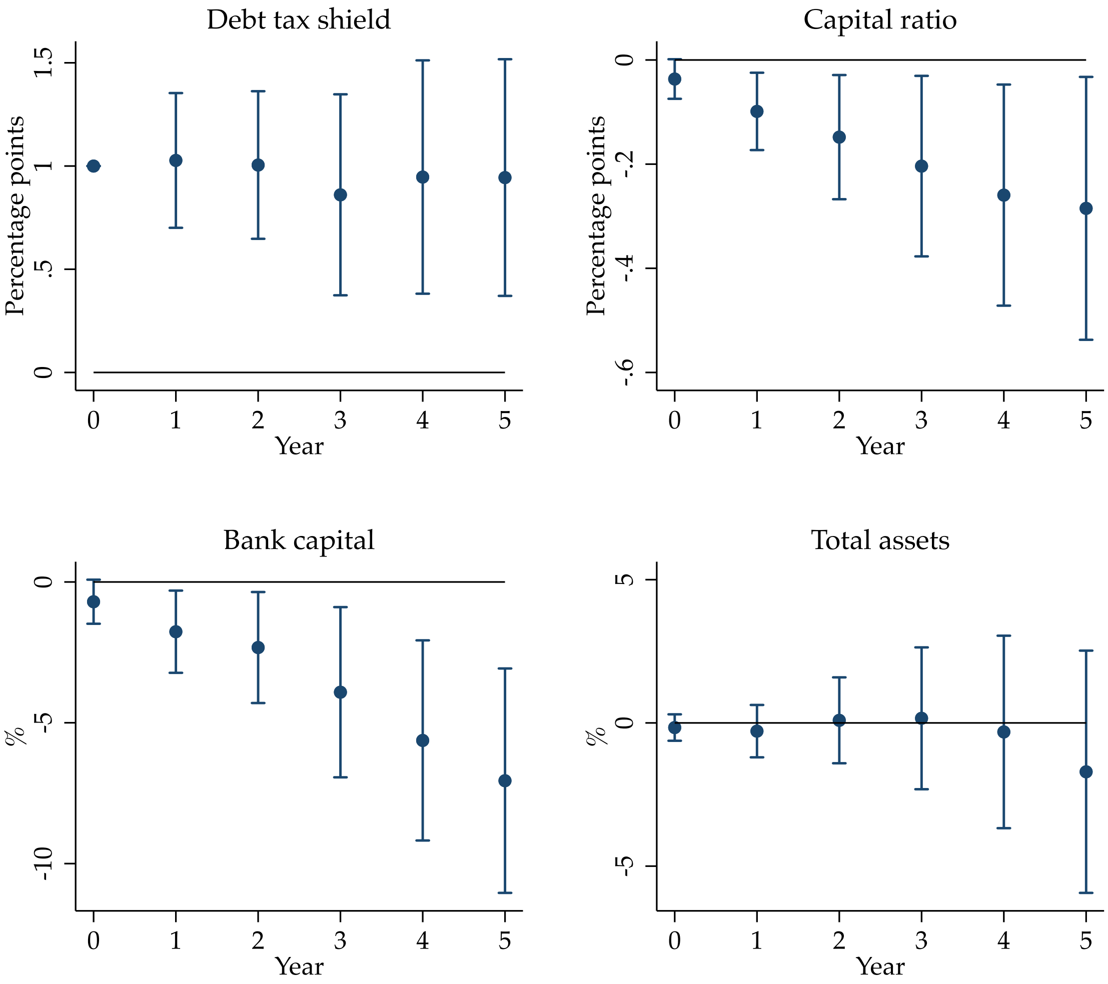
Do banks reduce their capital ratio through a reduction in capital, or through an extension of their balance sheets? The bottom panels in Figure 4 show that the former is the case – bank equity decreases markedly, whereas banks' assets do not deviate significantly from their trend level. This substantiates similar findings by Schepens (2016) and Célérier et al. (2017), and thus moderates concerns that tax shield decreases could develop a negative side-effect through a reduction in overall bank intermediation.

Tax shield component effects: We conduct an assessment of the five components of the tax advantage of debt. In particular, we assess the model's sign predictions (6) to (10) through a local projection specification that captures the conditional historical average path of a banking system's capital ratio in the aftermath of a change in the corporate tax rate, the interest rate, the ACE, the interest deductibility limit, and the bank levy:

$$\begin{aligned}\Delta^h k_{t+h,i} = \beta_0^{h,i} \quad &+ \quad \sum_{l=0}^{L} \beta_1^{h,l} \Delta\tau_{t-l,i} + \sum_{l=0}^{L} \beta_2^{h,l} \Delta i_{t-l,i} + \sum_{l=0}^{L} \beta_3^{h,l} \Delta\eta_{t-l,i} \\ &+ \quad \sum_{l=0}^{L} \beta_4^{h,l} \Delta\delta_{t-l,i} + \sum_{l=0}^{L} \beta_5^{h,l} \Delta\lambda_{t-l,i} + \sum_{l} \beta_6^{h,l} X_{t-l,i} + u_{t+h,i}\end{aligned}$$

$\{\beta_v^{h,0}\}_{h=0}^{5}$ for $v = 1, ..., 5$ describe the adjustment paths we are interested in. The set of

Figure 4: Bank balance sheet responses to tax advantage changes



Notes: This graph describes the bank balance sheet response to a change in the tax advantage of debt vis-à-vis equity of 1 percentage point. The bars delineate 90% confidence intervals.

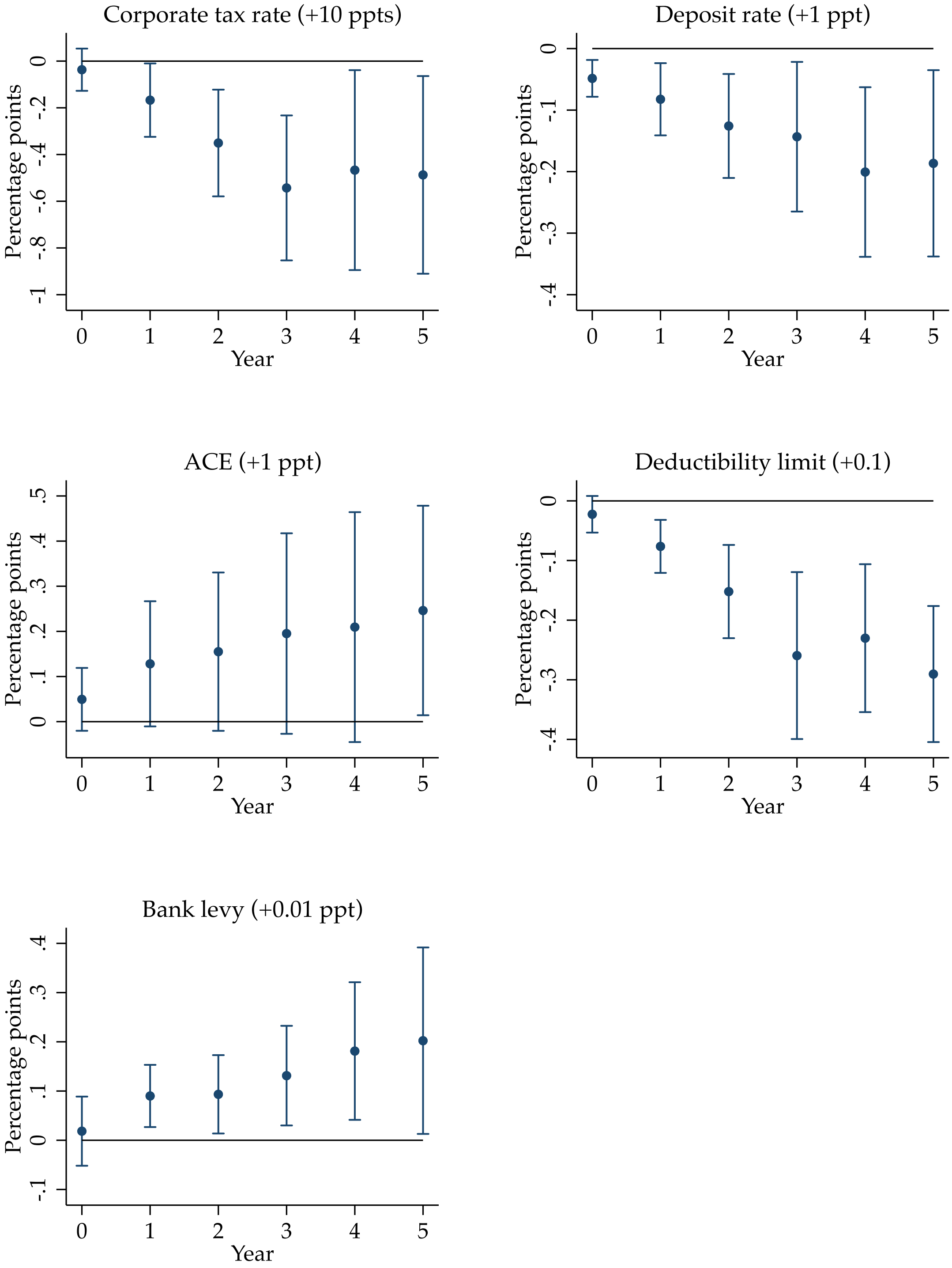
controls, X_t, is the same as in the baseline specification (11).[28]

Figure 5 shows the results. The model's sign predictions are generally born out by the empirical results. Bank capital ratios decrease in the aftermath of corporate tax rate hikes, interest rate increases and a loosening of interest deductibility limits, whereas bank capital ratios increase in the aftermath of ACE and bank levy increases. The estimated

---

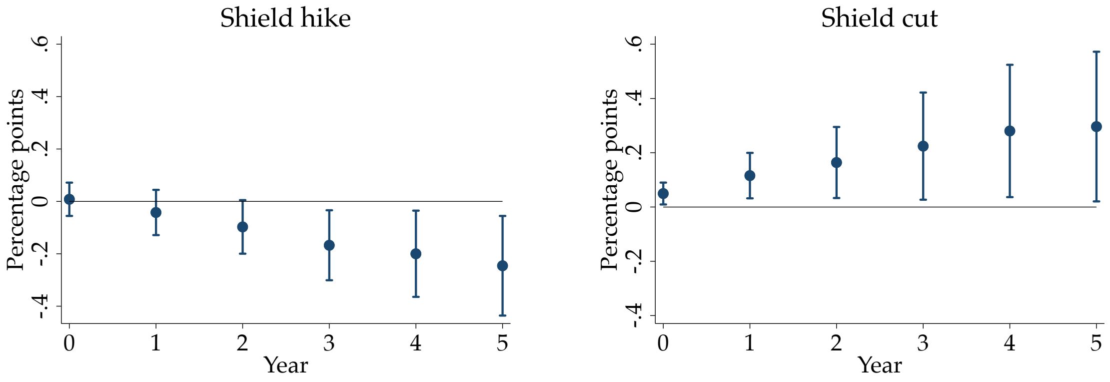
[28] As we are interested in the capital ratio effect of a year-on-year interest rate change, $\{\beta_2^{h,0}\}_{h=0}^{5}$, we use annual interest rate changes Δi_t, rather than the 11-year moving average of the interest rate that enters the tax advantage of debt s. This gives rise to additional endogeneity concerns, as an (anticipated) economic boom over the projection horizon might act as the omitted driver of an interest rate increase and a subsequent bank leverage increase. We therefore conduct a robustness check that includes proxies for anticipated business cycle dynamics, in particular horizon-specific lead cumulative real GDP growth ($\frac{GDP_{t+h}-GDP_t}{GDP_t}$) and lead cumulative price level growth ($\frac{CPI_{t+h}-CPI_t}{CPI_t}$). The results are almost identical.

Figure 5: Tax shield component effects



Notes: This graph describes the capital ratio response to changes in each of the five components of the tax advantage of debt. The bars delineate 90% confidence intervals.

Figure 6: Leverage ratchet effect: symmetry of the bank capital ratio response



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Difference	0.06	0.07	0.07	0.06	0.08	0.05
Hike=cut (p-value)	0.07	0.06	0.24	0.50	0.48	0.69

Notes: The graph analyzes the symmetry of the capital ratio response to tax shield hikes and cuts. Bars delineate 90% confidence intervals. The table displays the difference between the absolute shield hike and cut responses, $\beta_{1+}^{h,0}$, and the p-value of the Wald test for equality, $H_0 : \beta_1^{h,0} = \beta_1^{h,0} + \beta_{1+}^{h,0}$.

paths present statistically significant trend deviations and accord well with the theoretical predictions.[29]

Leverage ratchet effect: Does bank leverage react differently to shield increases compared to shield decreases? Theoretical work by Admati et al. (2018) on the leverage ratchet effect suggests so. This is because in a limited liability environment the benefits of deleveraging accrue primarily to debt-holders, whereas the increase in retained earnings that accompanies the deleveraging implies lower shareholder dividends.

To analyze this question we extend our baseline specification to separately include tax shield increases among the regressors:

$$\Delta^h k_{t+h,i} = \beta_0^{h,i} + \sum_{l=0}^{L} \beta_1^{h,l} \Delta s_{t-l,i} + \sum_{l=0}^{L} \beta_{1+}^{h,l} \Delta s_{t-l,i}^{+} + \sum_{l} \beta_3^{h,l} X_{t-l,i} + u_{t+h,i}$$

$\Delta s_{t,i}^{+}$ equals tax shield increases if $\Delta s_{t,i} > 0$ and zero otherwise. The $\{\beta_1^{h,0}\}_{h=0}^{5}$ coefficients trace out the effect of a 1 ppt decrease in the tax shield, whereas the summed coefficients $\{\beta_1^{h,0} + \beta_{1+}^{h,0}\}_{h=0}^{5}$ describe the effect of a 1 ppt increase in the tax shield.

The left panel in Figure 6 depicts the effect of a 1 ppt increase in the tax shield. Bank

---

[29] Figure D.5 in the Appendix shows that the policy shocks exhibit strong persistence. This indicates that the results shown here reflect banks' capital ratio adjustment in the aftermath of a persistent change in the policy environment.

capital ratios decline by around 0.25 ppts within five years. This effect is not significantly different from the effect we estimate based on the symmetric baseline specification. The effect of a decrease in the marginal shield is only somewhat larger – 0.3 ppts. Beyond year 1, Wald tests cannot reject the hypothesis of an equal absolute effect size for shield hikes and cuts. This contrasts with findings by Schandlbauer (2017), which indicate a leverage ratchet effect being operative in the U.S. between 1998 and 2011. By contrast, our results corroborate the findings by Gu et al. (2015) (for a sample of 91 multinational banks), Martin-Flores and Moussu (2019) (Italy), and Bond et al. (2016) (Italy) that indicate a symmetric reaction of banks to increases and decreases in the debt tax shield.[30] Thus, our results suggest that a symmetric response to tax shield hikes and cuts is the more representative outcome.[31] An exception are weakly capitalized banking systems, to which we turn next.

Asymmetrically binding capital constraint: Do banking systems with high capital ratios respond differently to changing tax incentives than banking systems with low capital ratios? In the latter case, capital ratios may prove less responsive to tax shield increases because banks face binding capital constraints. Several empirical studies' findings suggest that low capitalization rates go hand in hand with a lower responsiveness of banks' capital ratios to tax shield changes (Bond et al., 2016; de Mooij and Keen, 2016).

We address this question by separately analyzing strong and weak capitalization groups through the following specification:

$$\begin{aligned}\Delta^h k_{t+h,i} = \beta_0^{h,i} &+ \sum_{l=0}^{L} \beta_1^{h,l} \Delta s_{t-l,i} + \sum_{l=0}^{L} \beta_2^{h,l} \Delta s_{t-l,i} \omega_{i,t}^{weak} + \sum_{l=0}^{L} \beta_3^{h,l} \Delta s_{t-l,i} \omega_{i,t}^{strong} \\ &+ \sum_{l=0}^{L} \beta_{1+}^{h,l} \Delta s_{t-l,i}^{+} + \sum_{l=0}^{L} \beta_{2+}^{h,l} \Delta s_{t-l,i}^{+} \omega_{i,t}^{weak} + \sum_{l=0}^{L} \beta_{3+}^{h,l} \Delta s_{t-l,i}^{+} \omega_{i,t}^{strong} \\ &+ \sum_{l} \beta_4^{h,l} X_{t-l,i} + u_{t+h,i}\end{aligned}$$

$\omega_{i,t}^{weak}$ is a binary indicator that equals 1 when a country-year observation's capital ratio lies below the 25th percentile in year t. Analogously, $\omega_{i,t}^{strong}$ indicates capital ratios above the 75th percentile.[32] All other variables and parameters are defined as before. $\{\beta_1^{h,0} + \beta_3^{h,0}\}_{h=0}^{5}$

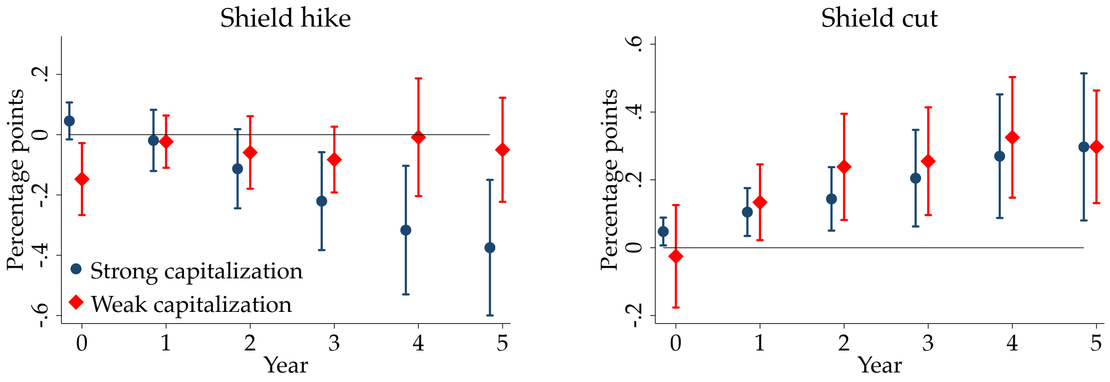
---

[30] Figure D.4 in the Appendix shows that it is bank capital that does the adjusting – in response to tax shield hikes as well as cuts. Total assets remain stable in both cases.

[31] Results for a post-Bretton Woods sample, 1973–2020, indicate some asymmetry, but with the absolute effect size being around one third smaller for shield hikes than cuts – the opposite from that predicted by leverage ratchet effect theory (Figure D.6 in the Appendix).

[32] This period-specific definition of weakly and strongly capitalized banking systems is necessitated by long-term structural changes (e.g. in risk management techniques, institutional contexts, and business

Figure 7: Asymmetric bank capital response under weak capitalization



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Shield hike difference	0.19	0.00	-0.05	-0.14	-0.31	-0.32
Strong=weak (p-value)	0.01	0.95	0.54	0.20	0.08	0.05
Shield cut difference	-0.07	0.03	0.09	0.05	0.05	-0.00
Strong=weak (p-value)	0.40	0.67	0.31	0.67	0.65	0.99

Notes: The graph analyzes the symmetry of the capital ratio response to tax shield hikes and cuts in strongly and weakly capitalized banking systems. Bars delineate 90% confidence intervals. The table displays the difference between strongly and weakly capitalized banking systems, and the p-values correspond to Wald tests for equality.

describes the response of a strongly capitalized banking system to a tax shield decrease, and $\{\beta_1^{h,0}+\beta_2^{h,0}\}_{h=0}^5$ the response of a weakly capitalized one. $\{\beta_1^{h,0}+\beta_{1+}^{h,0}+\beta_3^{h,0}+\beta_{3+}^{h,0}\}_{h=0}^5$ describes the response of a strongly capitalized banking system to a tax shield increase, and $\{\beta_1^{h,0}+\beta_{1+}^{h,0}+\beta_2^{h,0}+\beta_{2+}^{h,0}\}_{h=0}^5$ the response of a weakly capitalized one.[33]

Figure 7 displays the findings.[34] The results reveal a clear asymmetry between the responses to shield hikes and cuts among weakly capitalized banking systems. Consistent with the notion that capital constraints are asymmetrically binding, weakly capitalized banking systems increase their capital ratio in response to a shield cut, but do not decrease the capital ratio in response to a shield hike. This contrasts with the symmetric capital response in strongly capitalized banking systems, where in response to a shield hike capital ratios decline by as much as they increase in response to a shield cut. The (pointwise) Wald

---

norms) that have altered what is considered a weakly capitalized banking system (Grossman, 2010).

[33] The use of real purchasing power parity adjusted GDP weights yields results that are very similar to the non-weighted specification (Figure D.8 in the Appendix).

[34] The tax shield's own-response is stronger in the weak capitalization group. We therefore rescale the weak capitalization IRF estimates by the ratio of the strong capitalization shield response to the weak capitalization shield response. The rescaling is done separately for each horizon, $h = 1, ..., 5$. This ensures that we compare the balance sheet behavior of strongly and weakly capitalized banking systems after equally sized and equally persistent tax shield increases.

tests confirm that the capital response difference between strongly and weakly capitalized banking systems to a shield hike is statistically significant at the 10% level from year 4 onwards. A joint cross-horizon test rejects the null of equal IRFs among strongly and weakly capitalized banking systems for shield hikes at the 1% level. The result further is at odds with leverage ratchet effect theory, because it qualifies the effectiveness of tax shield hikes in increasing bank leverage, rather than the effectiveness of tax shield cuts in lowering bank leverage.

Openness and debt shifting: When a country's capital account is open, the local tax advantage of debt begins to interact with the tax advantage of debt abroad. This is because international tax shield differentials render debt shifting profitable (Edgar, 1987; Mintz and Smart, 2004; Desai et al., 2004; Schindler and Schjelderup, 2012). Thus, a shield increase causes a larger increase in bank leverage in an open economy than in a closed one, to the extent that the local shield increase incentivizes multinational banks to borrow locally on behalf of their foreign affiliates. Analogously, if a shield increase abroad is exploited through debt shifting, then local bank leverage should decrease. Several empirical studies confirm that such debt shifting is indeed common among multinational banks (Gu et al., 2015; Martin-Flores and Moussu, 2019; Reiter et al., 2021).[35]

We analyze the role of capital account openness in modulating the bank leverage response of tax shield changes through a specification that distinguishes between the response of open and closed economies

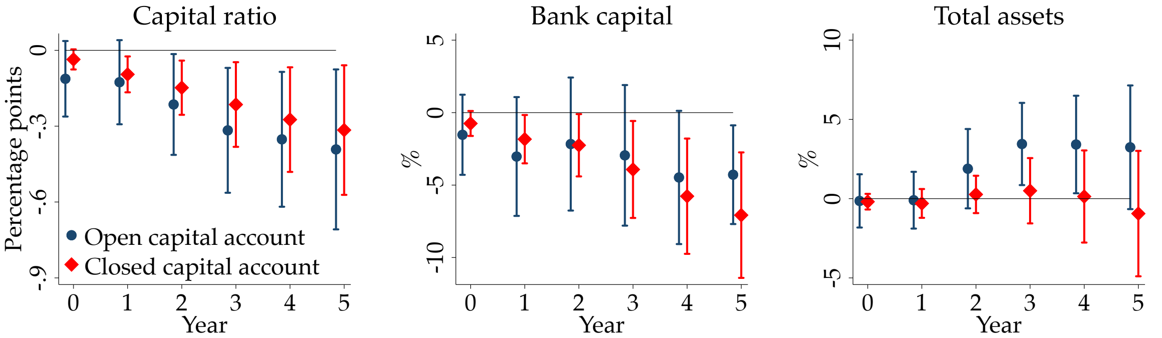
$$\begin{aligned}\Delta^h k_{t+h,i} = \beta_0^{h,i} &+ \sum_{l=0}^{L} \beta_1^{h,l} \Delta s_{t-l,i} + \sum_{l=0}^{L} \beta_2^{h,l} \Delta s_{t-l,i} \omega_{i,t}^{closed} + \sum_{l=0}^{L} \beta_3^{h,l} \Delta s_{t-l,i} \omega_{i,t}^{open} \\ &+ \sum_{l} \beta_4^{h,l} X_{t-l,i} + u_{t+h,i}\end{aligned}$$

$\omega_{i,t}^{closed}$ and $\omega_{i,t}^{open}$ are dummy variables that equal 1 when the capital account is closed and open, respectively. More concretely, we code country-year observation as "open" for capital account openness values in the top quartile of the openness index, and as "closed" for values in the bottom quartile. By separating closed from open economies in this way we obtain a sharp contrast along the openness dimension. The consequent three-part grouping of economies according to their capital account openness – open, closed, and a middle group – also reflects the insight by Klein and Shambaugh (2015) that capital

---

[35] Scott (2022) documents the spread of international tax avoidance in interwar Britain. Similarly, the Netherlands became an important tax haven for German business faced with high post-WW1 tax rates (Farquet, 2016). This evidences that the beginnings of international tax avoidance reach all the way back to the emergence of a significant tax shield for debt during WW1. Relatedly, U.S. government officials were endorsing capital flow bans in the run-up to the Bretton Woods conference with the intention of countering similar international tax avoidance after WW2 (Steil, 2013, p.134).

Figure 8: Bank balance sheet responses – open versus closed capital account



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital ratio difference	0.08	0.03	0.07	0.10	0.08	0.08
Open=closed (p-value)	0.34	0.72	0.49	0.36	0.51	0.54
Bank capital difference	0.78	1.20	-0.08	-0.98	-1.29	-2.79
Open=closed (p-value)	0.59	0.57	0.97	0.66	0.58	0.25
Total assets difference	-0.05	-0.20	-1.62	-2.95	-3.28	-4.18
Open=closed (p-value)	0.96	0.80	0.16	0.02	0.02	0.03

Notes: The graph analyzes the capital ratio response in open and closed economies. Bars delineate 90% confidence intervals. The table displays the difference between open- and closed-economy responses, and the p-values correspond to Wald tests for equality.

account openness follows a trimodal distribution, in which only strict capital controls are effective at segmenting global capital markets.[36]

Figure 8 displays our findings.[37] We find that the effect size of a 1 ppt tax shield increase on the capital ratio is consistently 0.1 ppt larger in open economies (left panel). However, neither pointwise Wald tests nor a joint cross-horizon test reject the null of equal IRFs. The bank capital and total asset responses reveal that the difference in the mean capital ratio IRFs stems from a substantial increase in total bank assets among open economies. Wald tests confirms that the response difference between open and closed economies in this regard is statistically significant from year three onwards. Likewise, a joint cross-horizon test rejects the null of equal total asset IRFs. The overall picture is thus a mixed one, with some indication of debt shifting, whereby multinational banks minimize their tax burden by shifting debt away from countries with a decreasing tax shield and towards countries with an increasing tax shield.[38]

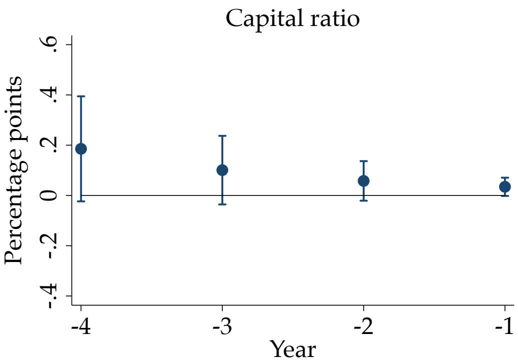
---

[36] The use of real purchasing power parity adjusted GDP weights again yields results that are very similar to those of the non-weighted specification (Figure D.9 in the Appendix).

[37] The tax shield's own-response is consistently larger among open economies. As before, we rescale the open capital account IRFs of all other variables according to the ratio of the own-responses, thereby ensuring IRF comparability across groups.

[38] While since the 1970s an increasing number of countries has introduced TCRs to counter debt shifting

Figure 9: Pre-event analysis



Notes: Cumulative growth rate prior to a +1 ppt change in the tax advantage of debt. The results are based on an LP specification that is equivalent to (11), except that the left-hand side variable substitutes $\Delta^h k_{t-h,i}$ for $\Delta^h k_{t+h,i}$ ($h = 1, ..., 4$), and X_t does not contain lags of the capital ratio change, which now is the pre-trend variable of interest. The bars delineate 90% confidence intervals. The confidence intervals are calculated based on Driscoll-Kraay standard errors.

In sum, the estimates from Figures 4 to 8 suggest that a bank capital ratios decrease in response to a tax shield increase. Estimates vary with the banking system's capitalization rate in interaction with the sign of the tax shield change, and, to a certain extent, the economy's capital account openness.

3.3. Identification challenges and robustness

This section addresses concerns about anticipation effects, correlated impulses, measurement error, simultaneity and functional form. Various robustness checks and diagnostic statistics address the most relevant endogeneity concerns, while subsample analyses investigate regional and temporal heterogeneities.

Anticipation effects: When banks face capital adjustment costs, it can become optimal to adjust the capital ratio gradually over time rather than in one go – equity becomes "sticky" (Boyarchenko and Mueller, 2019).[39] In such an environment, banks may want to adjust their capital ratios already in anticipation of future tax shield changes.[40] A simple

---

for tax avoidance purposes, financial institutions are typically exempt (Ruf and Schindler, 2015; de Mooij and Hebous, 2018).

[39] While in recent decades the gradual phase-in and phase-out of tax law changes has become more common, in the past, implementation lags for corporate tax rate changes rarely exceeded one year. Moreover, exact tax rates typically were not pinned down until shortly before the tax law was adopted. Beyond such considerations of short-term predictability, tax law changes may be "in the air" for a long time, before political opportunity allows for their implementation. Electoral cycles, for example, may allow for longer-term predictions, to the extent that promised tax reforms are rolled out once a particular party gains power. However, capital adjustment costs would need to be large to warrant anticipatory adjustments in capital structure based on such longer-term assessments of where political winds are blowing.

[40] For the U.S. between 1998 and 2011, Schandlbauer (2017) finds that banks' capital ratios react one

way to explore whether this is the case in our sample is through a pre-event analysis, that reveals the behavior of capital ratios prior to changes in the tax shield of debt. Figure 9 displays the average cumulative change in banks' capital ratios in the four years prior to a 1 ppt tax shield change.[41] The mean estimates decrease slightly, by around 0.15 ppts, but they remain statistically insignificant at the 10% level. Thus, bank capital ratios do not significantly change in anticipation of tax shield change within our sample. Rather than adjusting balance sheets in anticipation, our findings suggest that banks adjust their balance sheet only after a tax shield change has materialized, and even then only gradually so.[42]

Correlated impulses: Causal identification requires that our independent variable of interest is not correlated with other determinants of bank leverage. Our baseline specification addresses this omitted variables concern by saturating the control vector with a rich set of relevant control variables,[43] but we also conduct two instrumental variable local projection (IV-LP) analyses.

The first one uses *peer pressure* for fiscal reform as an instrument for local tax shield changes (Furceri and Loungani, 2018). The peer pressure IV is a leave-one-out instrument, based on the notion that a country is more likely to implement fiscal reforms that change its debt tax shield when other countries have recently done so. In particular, we define the reform pressure IV as the average (cumulated) global tax shield change of the preceding two years: $\Delta^c s_{i,t}^{glo} = \sum_{j \neq i} \Delta^c s_{j,t}$, $c = 1, 2$. The first stage produces highly significant coefficient estimates and an F-statistic of 10.10 (Table D.3 in the Appendix).[44] Table 1,

---

year ahead of the enactment of a tax rate change. By contrast, Bond et al. (2016) (Italy) and Hemmelgarn and Teichmann (2014) (for a multinational sample) find that banks' capital structure reacts to tax rate changes only with a lag. Our findings suggest that the latter is the more representative case across advanced economies.

[41] The application of real purchasing power parity adjusted GDP weights generates a very similar result (Figure D.10 in the Appendix).

[42] As an additional robustness check we consider a local projection specification with inverse probability weighing (IPW-LP) (Jordà and Taylor, 2016; Angrist et al., 2018). The IPW-LP estimator addresses anticipation effects through a first-stage logit regression that predicts tax shield changes on the basis of relevant regressors, such as the state of public finances, recent financial crisis experience, and the business cycle. The resulting probability weights are then used in weighted local projections that give large weight to unpredictable tax shield changes and low weight to predictable ones. Row *IPW-LP* of Table 1 shows that the resulting IRF estimate is qualitatively similar to the baseline response. The absolute effect size exceeds the baseline estimate, reaching 0.55 ppts after five years. The exact set of predictors used to assess the probability of a tax shield increase comprises the first lags of the following: financial crisis dummy, public debt to GDP ratio, short-term interest rate, openness, detrended (HP-trend, $\lambda = 1600$) public debt to GDP ratio, detrended short-term interest rate, detrended capital ratio, detrended real GDP, detrended real bank loans, tax shield increase dummy, country-dummies, decadal dummies.

[43] We analyze the role of the control vector $X_{t,i}$ by re-estimating equation (11) without it. The resulting IRF estimates are qualitatively similar, but about one third the size (Figure D.12 in the Appendix), indicating that the control vector plays a notable role in safeguarding our coefficient estimates from correlated impulses.

[44] The Kleibergen-Paap test statistic for weak instrumental variables exceeds 40, indicating a strong instrument.

row *IV-LP*, shows that the IV-LP estimator yields post-transition coefficient estimates of around -0.36.

A limitation of the *peer pressure* IV is that the exogeneity assumption is violated to the extent that tax shield changes in other countries generate spillover effects, e.g. through debt shifting (see section 3.2). This will bias the (absolute) effect size estimates of the IV-LP estimator in a downward direction to the extent that foreign tax shield increases (decreases) lead to less (more) local debt issuance (e.g. Graham and Tucker, 2006). This suggests an interpretation of the ≈ -0.36 coefficient estimate as a lower bound effect size estimate.

The second IV-LP analysis uses a Romer and Romer (2010)-type narrative tax shock series for the U.S. to instrument tax shield changes. The narrative tax shock series is provided by Mertens and Ravn (2013), with subsequent updates by Liu and Williams (2019). It identifies exogenous and unanticipated *corporate* tax changes between 1950 and 2018, based on various government publications – congressional records, the Economic Report of the President, CBO reports etc. The series excludes endogenous tax changes that were motivated by the current state of the business cycle, as well as announced tax changes with an implementation lag of more than one quarter.[45] Our first stage includes the level and the first difference of this narrative corporate tax shock series (Table D.4 in the Appendix). The resulting F-statistic is 16.37; both regressors are highly significant.[46] The resulting IV-LP estimate equals -0.69 after five years (Table 1, row *Narrative IV-LP*).[47] Overall, the IV-LP estimates thus exceed the baseline estimate in (absolute) size.

Measurement error: Another potential endogeneity concern is measurement error in the tax shield variable. While in principle the measurement of balance sheet variables and tax shield determinants is comparatively straightforward[48], some measurement error is likely to creep in as a consequence of idiosyncratic tax exemptions[49], unobserved re-

---

[45] The tax shock series by Adler et al. (2024), which covers most countries in our sample from 1978 onwards, does not provide relevant first stage results – possibly because most of its variation pertains to changes in taxes other than the corporate income tax.

[46] The Kleibergen-Paap test statistics for LP horizon estimates $h = 0, ..., 5$, however, are around 5, indicating a somewhat weak instrument.

[47] The lower number of observations in the U.S.-only sample ($N = 68$) requires a pruning of the regressor list compared to the baseline specification. We therefore apply a parsimonious specification that only includes instrumented changes in the debt tax shield.

[48] Bank balance sheet data are typically readily available owing to financial regulation or external accounting requirements, and statutory tax rates are published by governments. By comparison, the measurement of many other macro-aggregates, such as GDP, is more involved. An exception is the aggregate interest expense deductibility limit series (see Section 2.2), which proxies for the degree to which the tax-deductibility of a banking system's interest expenses is curtailed by regulatory measures (δ).

[49] Portugal's 1872 tax law, for example, exempted two banks – *Comhania do Crédito Predial Português* and *Economica do Montepio Geral*. While the latter accounted only for 2% to 3% of all deposits in the 1870s, its share rose to more than 10% in the 1880s (Lains, 2021, pp.17ff.).

Table 1: Robustness

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Baseline	-0.04	-0.10*	-0.15*	-0.20*	-0.26*	-0.28*
	(0.02)	(0.05)	(0.07)	(0.11)	(0.13)	(0.15)
Peer IV-LP	-0.20*	-0.27*	-0.32*	-0.37*	-0.37*	-0.36*
	(0.06)	(0.07)	(0.10)	(0.14)	(0.15)	(0.17)
Narrative IV-LP	-0.04	-0.15	-0.24	-0.53*	-0.65*	-0.69*
	(0.34)	(0.22)	(0.32)	(0.18)	(0.15)	(0.11)
IPW-LP	-0.09	-0.16	-0.33*	-0.41*	-0.61*	-0.55*
	(0.06)	(0.13)	(0.15)	(0.18)	(0.20)	(0.21)
w/o regional τ	-0.03	-0.07*	-0.11*	-0.17*	-0.20*	-0.23*
	(0.03)	(0.04)	(0.06)	(0.09)	(0.11)	(0.13)
w/o η, δ, λ, i change	-0.03	-0.09*	-0.13*	-0.19*	-0.23*	-0.27*
	(0.02)	(0.04)	(0.06)	(0.09)	(0.12)	(0.14)
Nonlinearity	-0.04*	-0.11*	-0.17*	-0.24*	-0.29*	-0.32*
	(0.02)	(0.05)	(0.08)	(0.12)	(0.15)	(0.17)
Winsorizing	0.01	-0.07	-0.20*	-0.33*	-0.42*	-0.48*
	(0.06)	(0.08)	(0.11)	(0.14)	(0.15)	(0.20)
Post-1980	-0.08	-0.21*	-0.38*	-0.55*	-0.70*	-0.79*
	(0.05)	(0.09)	(0.14)	(0.19)	(0.22)	(0.25)
1946-1980	-0.03	-0.09*	-0.15*	-0.22*	-0.26*	-0.30*
	(0.02)	(0.04)	(0.07)	(0.10)	(0.13)	(0.15)
Pre-1945	0.02	-0.07	-0.14	-0.26	-0.15	-0.29
	(0.06)	(0.10)	(0.14)	(0.19)	(0.22)	(0.28)
High inflation	-0.03	-0.10*	-0.15*	-0.24*	-0.29*	-0.34*
	(0.04)	(0.05)	(0.07)	(0.09)	(0.11)	(0.14)
Lowflation	-0.14*	-0.28*	-0.33*	-0.51*	-0.61*	-0.63*
	(0.04)	(0.07)	(0.10)	(0.13)	(0.16)	(0.18)
Northwestern Europe	-0.04*	-0.10*	-0.14*	-0.20*	-0.25*	-0.28*
	(0.02)	(0.04)	(0.06)	(0.09)	(0.11)	(0.14)
Scandinavia	-0.03	-0.08	-0.17*	-0.28*	-0.40*	-0.45*
	(0.05)	(0.07)	(0.09)	(0.12)	(0.15)	(0.19)
Southern Europe	0.01	-0.06	-0.18	-0.34*	-0.46*	-0.50*
	(0.06)	(0.09)	(0.12)	(0.16)	(0.17)	(0.19)
Asia-Pacific	-0.13	-0.22	-0.35	-0.64	-0.78	-0.86
	(0.09)	(0.16)	(0.27)	(0.40)	(0.50)	(0.59)

Notes: The table displays local projection estimates. Standard errors in brackets. * denotes significance at the 90% level. High inflation: $>$ 5% CPI-inflation; Lowflation: $<$ 1% CPI-inflation; Northwestern Europe: Belgium, France, Germany, Netherlands, Switzerland, U.K.; Scandinavia: Denmark, Finland, Norway, Sweden; Southern Europe: Italy, Portugal, Spain; Asia-Pacific: Australia, Canada, Japan, U.S.

gional heterogeneity in corporate tax rates within countries[50], and discrepancies between marginal and top tax rate changes (MacKie-Mason, 1990).[51] To the extent that the resulting measurement error is of a classical nature the baseline coefficient estimates will be afflicted by attenuation bias,[52] which presents one reason for why the IV-LP effect size estimate exceeds the baseline estimate (in absolute terms).

Reverse causality: Bank levies, ACEs, and limits on interest deductibility are targeted at levelling the playing field between debt and equity financing. Often such policy measures are motivated by the perception of high leverage and associated concerns about financial stability.[53] Thus, our coefficient estimates may conflate the causal effect that runs from tax shield changes to capital ratios with the causal effect that runs from capital ratio changes to tax shields. In this case, our baseline estimate would underestimate the absolute effect size. Related concerns surround interest rate changes, which are possibly affected by bank leverage as well as endogenous to the business cycle. As a first pass at addressing reverse causality, panel Granger-causality tests (Dumitrescu and Hurlin, 2012) on the direction of causality indicate that tax shield changes Granger-cause bank capital ratio changes, but not the other way round in the post-WW2 data (Table D.1 in the Appendix). For the full sample, no significant Granger-causality relationship is indicated.[54]

---

[50] While we aim at compiling top tax rate series that cover central government taxes *and* regional taxes, for some countries we do not have the local income tax rates all the way back to 1870 (e.g. Switzerland). Where we have long-run local corporate income tax rates, we either add an average of local tax rates to the central government tax rate (e.g. Sweden), or, where bank headquarters are clearly concentrated in particular regions, we only average the local tax rates of those particular regions (e.g. for Canada: Nova Scotia, Ontario, and Quebec). To the extent that the banks behind our balance sheet aggregates are located in regions with tax rate changes that are not represented by these cross-region averages of top tax rates our tax shield changes may harbor a measurement error.

[51] For our sample, the bank-level data by shows that the five largest banks within a country typically account for 50% of all bank assets in the national aggregate, and the top-100 banks account for 70% to 90% of assets. Thus, while large banks, subject to the top income tax rate as well as highest bank levy rates, account for the majority of aggregate fluctuations, our tax shield measure may deviate from the marginal tax shield changes that smaller banks face. The same line of reasoning applies to bank levy rates that can differ according to the amount of bank debt.

[52] A non-classical measurement error could result from banks concentrating their headquarters in regions that are less (more) inclined to raise (lower) tax rates than the average region. In this case, our coefficient estimates would systematically underestimate (in absolute terms) the true responsiveness of bank capital ratios to tax shield changes. A direct way to assess the relevance of this measurement challenge is to focus on a subsample within which corporate income taxation is predominantly the prerogative of the central government. We find that such a subsample produces a result that is very similar to the baseline result (Table 1, row *w/o regional* τ).

[53] Note, however, that the reverse causal force from bank leverage to changing ACE, interest deductibility, and bank levy rules can be expected to operate at a lower frequency than what regression equations (11) pick up. This is because the implementation of bank levies, ACE, and interest deductibility regulation is unlikely to be driven by current annual changes in bank leverage.

[54] Country-by-country Granger-causality tests generally indicate no Granger-causality with the exception of three countries: in one the tax shield Granger causes capital ratios, in another the reverse relationship holds, while in a third Granger-causality is bidirectional (Table D.2 in the Appendix).

A more thorough robustness check is to re-estimate equation (11) with separate controls for ACE-, interest deductibility-, bank levy-, and interest rate-changes,

$$\begin{aligned}\Delta^h k_{t+h,i} = \beta_0^{h,i} + \sum_{l=0}^{L} \beta_1^{h,l} \Delta s_{t-l,i} + \sum_{l=0}^{L} \beta_2^{h,l} \Delta \eta_{t-l,i} + \sum_{l=0}^{L} \beta_3^{h,l} \Delta \delta_{t-l,i} \\ + \sum_{l=0}^{L} \beta_4^{h,l} \Delta \lambda_{t-l,i} + \sum_{l=0}^{L} \beta_5^{h,l} \Delta i_{t-l,i} + \sum_{l} \beta_6^{h,l} X_{t-l,i} + u_{t+h,i}.\end{aligned}$$

The thus estimated $\{\beta_1^{h,0}\}_{h=0}^{5}$ are purged of the reverse causal force that might run from capital ratio changes to interest rates, ACE, interest deductibility, and bank levies. Instead, the $\{\beta_1^{h,0}\}_{h=0}^{5}$ now isolate the effect of tax shield changes that stem from the variable that poses no serious reverse causality concern – the corporate tax rate. The result based on this specification is very similar to the baseline result (Table 1, row *w/o* η, δ, λ *change*).[55]

Functional form: The linear projection setup (11) is theoretically grounded in the linearity of the optimality condition (2), which in turn hinges on the assumption of a quadratic intermediation cost function, $\Gamma(1-k) = \frac{1}{2}\gamma(1-k)^2$. For different intermediation cost functions, the optimality condition can become non-linear. We therefore conduct a robustness check that controls for the non-linearity associated with non-quadratic intermediation costs by interacting tax shield changes with the tax shield level, $\Delta s \cdot s$, and its square, $\Delta s \cdot s^2$. The similar results we obtain for this setup assuage concerns about the relevance of nonlinearities in the bank's optimality condition (Table 1, row *Nonlinearity*).

Winsorizing: Our sample contains several very high values for the debt tax shield, $\frac{\tau(\delta i-\eta)-\lambda}{1-\tau}$. This results from high corporate income tax rates producing a small denominator. For example, in the 1940s and 1950s the U.K.'s corporate income tax rate exceeded 90%, giving rise to tax shield values in the 20 to 60 range. We assess the robustness of our findings to such outliers by removing the top 1% of tax shield values (i.e. $s > 20$) from the sample. The results are robust to thus winsorizing the sample. (Table 1, row *Winsorizing*).

Regional and temporal subsamples: We assess the temporal and regional heterogeneity of the coefficient estimates by conducting various temporal and regional subsample analyses. The Year 5 coefficient estimates for the temporal subsamples indicate that the responsiveness of bank capital to tax shield changes has grown stronger over time, from a statistically insignificant -0.29 prior to 1945 to -0.79 after 1980 (Table 1, rows *Post-*

---

[55] The IPW-LP result provides additional assurance in this regard, because the first-stage logit regression also predicts tax shield changes based on capital ratio fluctuations. As a consequence, the IPW estimator down-weighs those observations where tax shield changes result from policymakers' reaction to lagged capital ratio movements.

1980, 1946–1980, Pre-1945). The (statistically significant) effect sizes on the regional subsamples range from -0.28 (Northwestern Europe) to -0.5 (Southern Europe). The Asia-Pacific economies (Australia, Canada, Japan, U.S.) exhibit a larger but statistically insignificant response of -0.86. We also find that bank capital responds more strongly to tax shield changes in a low-inflation environment ($< 1\%$ CPI-inflation) than in a high-inflation environment ($> 5\%$ CPI-inflation). A Wald-test for equality of the high- and low-inflation IRF estimates rejects the null at the 5% level for horizons $h \geq 3$. This is consistent with the notion that banks are less responsive to tax shield changes that are rooted in inflation-driven nominal interest rate changes.

In sum, the Year 5 estimates in Table 1 shows that across a variety of subsamples and methodologies our estimates for the responsiveness of bank capital ratios to a 1 ppt tax shield increase concentrate in the -0.25 to -0.8 ppt range.

3.4. Quantitative discussion

How do our findings compare to those reported in the extant literature? Rather than analyzing the effect of tax shield changes, existing empirical studies mostly analyze the effect of corporate tax rate changes on bank capital ratios. Accordingly, reported coefficient estimates represent the reaction of bank capital ratios to a 1 ppt increase in the corporate tax rate. To render such coefficient estimates comparable to ours we need to rescale them by $dS/d\tau = (\delta i - \eta - \lambda)/(1-\tau)^2$. In each case, we select values for τ, δ, i, and η that correspond to the sample averages of the dataset upon which a study was based.[56] A few studies report findings in a different format (Schepens, 2016; Schandlbauer, 2017; Martin-Flores and Moussu, 2019), but in each case it is possible to translate reported effect sizes into the effect size associated with a 1 ppt tax shield change.[57]

Table 2 lists effect size estimates from the literature, ranked from smallest to largest (in absolute terms).[58] At first sight, our finding that a +1 ppt tax shield change reduces the capital ratio somewhere in the 0.25 to 0.8 ppt range (see Year 5 estimates in Table 1) places our estimates at at the lower end of the effect size range that can be found in the literature. By more clearly situating our findings in this literature, however, this

---

[56] In particular, we use an interest rate of $i = 5.5\%$ for global samples containing advanced and developing economies. This corresponds to post-1990 global averages of 3.5% for consumer price inflation and 2% for the real interest rate (IMF IFS). We take the sample average for τ from each publications' summary statistics table. The resulting scaling factors, $dS/d\tau$, range from 6.5 to 9.5.

[57] Schepens (2016), for example, presents leverage effects associated with the 2006 introduction of an ACE in Belgium, i.e. a change in η that aims to offset the tax advantage of debt. Accordingly, we normalize the reported effect size by $\tau\Delta\eta/(1-\tau)$, where τ corresponds to the Belgian corporate income tax rate at the eve of the ACE reform.

[58] Bond et al. (2016) and Gambacorta et al. (2017) are not listed, because they focus on a subset of small Italian banks that account for less than 6% of Italy's total bank assets.

Table 2: Effect of a 1ppt tax shield increase on bank capital ratios

Publication	Data		Δ capital ratio
	Years	Countries	(in ppts)
Martin-Flores and Moussu (2019)	1993–2000	Italy	-.09
This study (low)	1870–2020	AE	-.25
de Mooij et al. (2014) (country-level)	2001–2011	82 AE & DE	-.4
Schepens (2016)	2003–2007	Belgium	-.4
Schandlbauer (2017)	1998–2011	U.S. state-level	-.48
de Mooij et al. (2014) (asset-weighted)	2001–2011	82 AE & DE	-.69
Horvath (2013)	1997–2011	71 AE & DE	-.76
This study (high)	1870–2020	AE	-.8
Hemmelgarn and Teichmann (2014)	1997–2011	87 AE & DE	-1.15
Gu et al. (2015)	1997–2011	90 AE & DE	-1.4
Milonas (2018)	1994–2012	U.S. state-level	-1.41
Luca and Tieman (2019)	2001–2017	131 AE & DE	-1.64
de Mooij et al. (2014) (bank-level)	2001–2011	82 AE & DE	-1.64
de Mooij and Keen (2016)	2001–2009	82 AE & DE	-1.7

Notes: AE – advanced economies; DE – developing economies.

section shows that our estimates are representative of long-run effect size estimates at the aggregate banking sector level.

Bank size and aggregation: An important dimension along which reported effect sizes vary is bank size. Small banks' capital ratios have been shown to respond more strongly to tax rate changes than large banks' capital ratios (e.g. de Mooij et al., 2014; Milonas, 2018; Luca and Tieman, 2019).[59] At the same time, large banks account for a substantial fraction of a banking system's aggregate capital and total assets. As a consequence, macro-level analyses better reflect large banks' influence at the aggregate level than bank-level analyses that treat each bank equally, regardless of its size. This aggregation effect is evidenced by de Mooij et al. (2014) who show that an (unweighted) bank-level analysis yields an effect size that is four times as large as the the effect size yielded by a country-level analysis based on the same data in aggregated form – 1.64 ppts versus 0.4 ppts (Table 2, "bank-level" versus "country-level").[60]

In addition, many bank-level studies exclude large banks from the sample, typically by winsorizing the bank size variable and thereby dropping the top and bottom 1% of observations.[61] While the purpose of this is to remove outliers from the sample, it also

---

[59] One possible economic rationale for this is that large banks that are "too-big-to-fail" enjoy implicit government guarantees that effectively eliminate many of the private risks associated with high leverage ratios. As a consequence, large banks are more likely to lever up to the regulatory maximum at which point leverage becomes less sensitive to marginal changes in tax incentives.

[60] When the same bank-level analysis applies asset-weights according to crude bank size bins, the effect size is -0.69 ppts (Table 2, "asset-weighted").

[61] Horvath (2013) also winsorizes at the 1% and 99% levels, but his analysis is based on banks' risk-weighted assets, rather than total assets. The comparatively small effect size of 0.76 ppts thus needs to be augmented by an additional 2% to 7% reduction in the average risk-weight of bank assets. This

discards many of the least responsive banks that happen to account for a substantial share of total banking system assets. de Mooij et al. (2014) illustrate the point: in their 82-country sample from 2001 to 2011, the top 2.5 percentile of banks account for 65% of all banking assets. At the same time, the top 2.5 percentile of banks exhibits no capital ratio reaction to corporate tax rate changes. Accordingly, studies that are based on winsorized datasets are responsible for many of the highest effect size estimates in Table 2 (de Mooij and Keen, 2016; Milonas, 2018; Luca and Tieman, 2019).[62]

Short-run versus long-run: The focus in our study has been on long-run effect size estimates. Table 2 lists long-run effects where available. Several papers, however, only estimate short-run effects (Schepens, 2016; Schandlbauer, 2017; Martin-Flores and Moussu, 2019). Studies that estimate short-run as well as long-run effects suggest that the latter exceeds the former by a factor in the two to five range (de Mooij et al., 2014; Horvath, 2013; Hemmelgarn and Teichmann, 2014; de Mooij and Keen, 2016).[63] Not surprisingly then, the smallest effect size listed in Table 2 comes from an ACE study that assesses a short-run effect (Martin-Flores and Moussu, 2019).

Similarly, Schepens (2016), based on a winsorized dataset that excludes the top two size-percentiles of the Belgian bank distribution, evaluates the short-run effect of an ACE-induced 1 ppt cut in the tax shield at -0.4 ppts. Multiplying this short-run estimate by a factor in the two to five range, produces a long-run estimate which is reminiscent of the high long-run effect estimates produced by comparable (unweighted) bank-level analyses that use winsorized datasets (e.g. de Mooij and Keen, 2016; Milonas, 2018; Luca and Tieman, 2019). The -0.48 ppt estimate by Schandlbauer (2017) can be similarly situated in the literature.

Thus, the time horizon of an estimate, as well as bank size and aggregation effects, can account for much of the effect size variation in Table 2. The "country-level" and "asset-weighted" estimates by de Mooij et al. (2014) emerge as the most relevant comparison group for our estimates. This is because they assess long-run effects that capture the influence of large and unresponsive banks at the aggregate level. At -0.4 ppts and -0.69 ppts, the estimates by de Mooij et al. (2014) are broadly corroborated by our estimate range of -0.25 to -0.8 ppts.[64]

---

implies an effect size for non-risk weighted bank leverage that exceeds 1 and therefore falls into the range of comparable studies.

[62] Consistent with this line of reasoning, Hemmelgarn and Teichmann (2014), who do not winsorize bank size, present an effect size estimate that lies at the lower end of available micro-estimates (in absolute terms). Their estimate of -1.15 ppts is roughly 0.5 ppts smaller ($\approx 1/3$) than comparable estimates based on winsorized datasets.

[63] The time-profile of our own IRF estimates indicates that long-run responses exceeds short-run responses ($h = 0$ and $h = 1$) by a factor in the three to seven range (Table 1).

[64] Note that de Mooij et al. (2014) uses a post-Bretton Woods sample that is dominated by relatively open capital accounts. For such a sub-sample our findings also indicate a somewhat stronger capital ratio

In sum, based on two dimensions – micro / macro, short run / long run – it is possible to account for much of the effect size variation in Table 2. After having thus situated our estimates in the wider literature, we use them to assess the extent to which the tax advantage of debt can account for the evolution of bank leverage over the past one and a half centuries.[65]

3.5. For how much bank leverage is the tax advantage of debt responsible?

How much of the 20th century decline in bank capital ratios can be attributed to the increase in the tax advantage of debt? Our macro-estimates of the effect size of a 1 ppt tax shield increase allow us to make a back-of-the envelope calculation. The average tax shield rose from approximately 0 ppts at the eve of WW1 to an average of 7.5 ppts in the late 1980s. According to our lower bound effect size estimate of -0.25 ppts this can account for a 1.875 ppt ($= -0.25 \cdot 7.5$ ppts) decline in bank capital ratios. Given that advanced economy bank capital ratios declined by about 10 ppts during this time period, from 15% to 5%, the rise in the debt tax shield can account for 18.75% of the concomitant increase in bank leverage.

For an effect size of -0.8 ppts, which is in line with the highest effect size estimates, the same 7.5 ppt tax shield increase accounts for a 6 ppt decline in bank capital ratios, or 60% of the overall capital ratio decline. Thus, the rise of the tax advantage of debt plausibly accounts for 19% to 60% of the 20th century bank leverage increase (Table 3, 2nd column). While this is a relatively wide range, it identifies the tax advantage of debt as an important determinant of bank leverage.

Bank capital ratios had already declined from around 25% in 1870 to around 15% prior to WW1. This occurred at a time before the tax advantage of debt became noticeable in many countries. When considering the entire 20 ppt decline in bank capital ratios from 25% in 1870 to around 5% in the 1980s, the emergence of the tax shield of debt can plausibly account for between 9% and 30% of that (Table 3, 1st column).

According to our back-of-the-envelope calculation, the dwindling tax advantage of

---

response (Table 1). This can plausibly account for some of the remaining difference in the effect size estimates reported in de Mooij et al. (2014) and here.

[65] How do these effect size estimates for banks compare to effect size estimates for non-financial firms? The meta-study by Feld et al. (2013) reports a marginal tax effect on the capital ratio of non-financial firms of -0.27 ppts. This translates into a -1.7 ppt tax shield effect, which locates the non-financial firm effect size among the largest effect sizes in Table 2. The meta study by Feld et al. (2013) distills micro-estimates of long-run effects based on mostly late C20th early C21st datasets of open economies. This is precisely the context within which similarly sized effect estimates are reported for banks. The capital ratio responses of banks and non-financial firms to tax shield changes thus appear to be similarly sized (also see Gropp and Heider, 2010; de Mooij and Keen, 2016). However, given that banks operate with substantially lower capital ratios than non-financial firms, the percentage change in the capital ratio after a tax shield change is actually larger among banks than among non-financial firms.

Table 3: Contribution of the tax advantage of debt to bank capital ratio changes

	Tax shield increase		*Tax shield decrease*
	1870–1980s	1913–1980s	1980s–2020
Actual Δk (ppts)	-20	-10	2.5
Predicted Δk (ppts)	-1.875 to -6	-1.875 to -6	1.875 to 6
	9% to 30%	19% to 60%	75% to 240%

Notes: The table displays the actual mean of bank capital ratio change for 17 advanced economies from 1870 to 2020 (Jordà, Richter, Schularick, and Taylor, 2021, and updates) together with predicted bank capital ratio changes based on our coefficient estimates.

debt after the 1980s should have given rise to a 1.875 ppt to 6 ppt increase in bank capital ratios. The actually observed increase amounts to 2.5 ppts. The decline in the tax advantage of debt thus runs the risk of over-explaining the post-1980 increase in bank capital ratios (Table 3, 3rd column). One prominent explanation for this is the leverage ratchet effect (Admati et al., 2018) according to which capital ratios are less responsive to tax shield cuts than hikes. However, our finding that bank capital reacts symmetrically to tax shield hikes and cuts points towards the different explanation that countervailing forces have (partly) offset the capital ratio increasing effect of tax shield decreases. What are plausible candidate forces in this regard? The timing is consistent with a role for rising banking sector concentration (Stern and Feldman, 2004; Fohlin and Jaremski, 2020; Baron et al., 2024) giving rise to "too-big-to-fail" expectations and the emergence of implicit government guarantees.

In sum, our findings highlight the importance of the tax advantage of debt as a contributor to the evolution of bank leverage over the past 150 years. Up to the 1980s, the rising tax advantage of debt can account for 19% to 60% of the 20th century decline in bank capital ratios. After that, our findings indicate that tax shield reductions have been effective at bolstering bank capital ratios. However, the overall only modest increase in bank capital ratios since the 1980s is indicative of countervailing forces that have encouraged banks to maintain high leverage ratios despite the dwindling tax advantage of debt.

4. Conclusion

This paper introduces a new dataset on the banking sector debt tax shield and its determinants – corporate tax rates, the existence of interest expense deductibility, interest rates, bank levies, as well as ACE and TCR rules – for 17 advanced economies from 1870 to 2020. The analysis of this dataset reveals that the debt tax shield follows an inverse

U-shape pattern over the past 150 years. The tax shield's initial emergence was a side-effect of the spread of income taxation in conjunction with the establishment of interest expense deductibility during the late nineteenth and early twentieth centuries. Its decline since the 1980s was driven by a combination of falling corporate tax rates, falling interest rates, and policy measures aimed at levelling the playing field between debt and equity.

Our findings underscore that banks' financing decisions are influenced by changes in the tax advantage of debt. In the aftermath of a +1 ppt change in the tax shield the banking system lowers its capital ratio by somewhere between 0.25 to 0.8 ppts. While the capital ratio response to tax shield hikes and cuts is generally symmetric, weakly capitalized banking systems cease to decrease their capital ratio in response of tax shield hikes, which is consistent with the presence of asymmetrically binding capital constraints. Banking systems located in open economies show some signs of an amplified capital ratio response that is driven by increased debt issuance in countries with rising debt tax shields – a pattern that is indicative of international debt shifting.

Our estimates imply that changes to the tax advantage of debt have been an important determinant of the long-run evolution of bank leverage, accounting for up to 60% of the upwards march in bank leverage in the 20th century. Our findings also suggest that the lacklustre increase of bank capital ratios between the 1980s and 2020, a time during which the debt tax shield was dwindling, should not be interpreted as evidence for the ineffectiveness of tax shield decreases in eliciting higher bank capitalization rates. Rather, our results point towards countervailing forces that have encouraged banks to maintain relatively high leverage ratios since the 1980s. For macro-prudential policy makers interested in raising capitalization rates this implies that policies directed at countering the tax advantage of debt can be an effective tool.

References

Adler, Gustavo, Cian Allen, Giovanni Ganelli, and Daniel Leigh. 2024. *An updated action-based dataset of fiscal consolidation.* International Monetary Fund.

Admati, Anat R., Peter M. DeMarzo, Martin F. Hellwig, and Paul Pfleiderer. 2018. The leverage ratchet effect. *The Journal of Finance* 73(1): 145–198.

Adrian, Tobias, and Adam B. Ashcraft. 2012. *Shadow banking: a review of the literature.* Springer.

Aggarwal, Raj, and NyoNyo Aung Kyaw. 2010. Capital structure, dividend policy, and multinationality: theory versus empirical evidence. *International Review of Financial Analysis* 19(2): 140–150.

Aldunate, Felipe, Dirk Jenter, Arthur Korteweg, and Peter Koudijs. 2021. Shareholder liability and bank failure. CEPR Discussion Paper No. DP16309.

Ang, Andrew, Sergiy Gorovyy, and Gregory B. van Inwegen. 2011. Hedge fund leverage. *Journal of Financial Economics* 102(1): 102–126.

Angrist, Joshua D., Òscar Jordà, and Guido M. Kuersteiner. 2018. Semiparametric estimates of monetary policy effects: string theory revisited. *Journal of Business & Economic Statistics* 36(3): 371–387.

Auerbach, Alan J. 2002. Taxation and corporate financial policy. *Handbook of Public Economics* 3: 1251–1292.

Bakk-Simon, Klára, Stefano Borgioli, Celestino Giron, Hannah Sabine Hempell, Angela Maddaloni, Fabio Recine, and Simonetta Rosati. 2012. Shadow banking in the euro area: an overview. ECB Occasional Paper Series No. 133.

Bank, Steven A. 2014. Historical perspective on the corporate interest deduction. *Chapman Law Review* 18: 29.

Baron, Matthew, Moritz Schularick, and Kaspar Zimmermann. 2024. Survival of the biggest: large banks and financial crises. Available at SSRN 4189014.

Barth, James R., Gerard Caprio, and Ross Levine. 2001. The regulation and supervision of banks around the world: a new database. World Bank Policy Research Working Paper No. 2588.

Berg, Tobias, and Jasmin Gider. 2017. What explains the difference in leverage between banks and nonbanks? *Journal of Financial and Quantitative Analysis* 52(6): 2677–2702.

Black, Fischer, and Myron Scholes. 1973. The pricing of options and corporate liabilities. *Journal of Political Economy* 81(3): 637–654.

Bond, Steve, Kiung Yeon Han, Giorgia Maffini, Andrea Nobili, and Giacomo Ricotti. 2016. Regulation, tax and capital structure: evidence from administrative data on Italian banks. Bank of Italy Occasional Papers Number 361.

Boot, Arnoud W. A., and Casper G. de Vries. forthcoming. The intricacies of taxing banks. *Journal of Money, Credit and Banking* .

Bordo, M., B. Eichengreen, D. Klingebiel, and M.S. Martinez-Peria. 2001. Is the crisis problem growing more severe? *Economic policy* 16(32): 51–82.

Boyarchenko, Nina, and Philippe Mueller. 2019. Corporate credit provision. FRB of New York Staff Report 895.

Branzoli, Nicola, and Antonella Caiumi. 2020. How effective is an incremental ACE in addressing the debt bias? Evidence from corporate tax returns. *International Tax and Public Finance* 27: 1485–1519.

Celerier, Claire, Thomas Kick, and Steven Ongena. 2020. Taxing bank leverage: the effects on bank capital structure, credit supply and risk-taking. Available at SSRN: https://ssrn.com/abstract=2829326 or http://dx.doi.org/10.2139/ssrn.2829326.

Célérier, Claire, Thomas K. Kick, and Steven Ongena. 2017. Changes in the cost of bank equity and the supply of bank credit. CEPR Discussion Paper No. DP12172.

de Mooij, Ruud, and Shafik Hebous. 2018. Curbing corporate debt bias: do limitations to interest deductibility work? *Journal of Banking & Finance* 96: 368–378.

de Mooij, Ruud A. 2011. *The tax elasticity of corporate debt: a synthesis of size and variations.* IMF Working Paper WP/11/95.

de Mooij, Ruud A., and Michael Keen. 2016. Debt, taxes, and banks. *Journal of Money, Credit and Banking* 48(1): 5–33.

de Mooij, Ruud A., Michael Keen, and Masanori Orihara. 2014. Taxation, bank leverage, and financial crises. In *Taxation and regulation of the financial sector*, edited by De Mooij, Ruud A., and Gaëtan Nicodème. MIT Press.

de Vicq, Amaury. 2022. Exploring the limits of the limited partnership: the case of the Bank of Twente, 1860s–1920s. *Enterprise & Society* 23(4): 1122–1147.

de Walque, Gregory, Olivier Pierrard, and Abdelaziz Rouabah. 2010. Financial (in) stability, supervision and liquidity injections: a dynamic general equilibrium approach. *The Economic Journal* 120(549): 1234–1261.

DeAngelo, Harry, and René M. Stulz. 2013. Why high leverage is optimal for banks. NBER Working Paper 19139.

Desai, Mihir A., C. Fritz Foley, and James R. Hines Jr. 2004. A multinational perspective on capital structure choice and internal capital markets. *The Journal of Finance* 59(6): 2451–2487.

Devereux, Michael, Niels Johannesen, and John Vella. 2019. Can taxes tame the banks? Evidence from the European bank levies. *The Economic Journal* 129(624): 3058–3091.

Diamond, Douglas W., and Raghuram G. Rajan. 2001. Liquidity risk, liquidity creation, and financial fragility: A theory of banking. *Journal of Political Economy* 109(2): 287–327.

Driscoll, John C., and Aart C. Kraay. 1998. Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics* 80(4): 549–560.

Dumitrescu, Elena-Ivona, and Christophe Hurlin. 2012. Testing for Granger non-causality in heterogeneous panels. *Economic modelling* 29(4): 1450–1460.

Edgar, Tim. 1987. The corporate interest deduction and the financing of foreign subsidiaries. *Austalian Tax Forum* 4: 491.

Ernst & Young LLP. 2008. Thin capitalization regimes in selected countries. Report prepared for the Advisory Panel on Canada's System of International Taxation.

ESRB. 2017. EU Shadow Banking Monitor. Technical Report 2, European Systemic Risk Board.

Farquet, Christophe. 2016. *La défense du paradis fiscal suisse avant la Seconde Guerre mondiale: une histoire internationale.* Editions Alphil Presses universitaires suisses.

Feld, Lars P., Jost H. Heckemeyer, and Michael Overesch. 2013. Capital structure choice and company taxation: a meta-study. *Journal of Banking & Finance* 37(8): 2850–2866.

Flannery, Mark J, and Kasturi P. Rangan. 2008. What caused the bank capital build-up of the 1990s? *Review of Finance* 12(2): 391–429.

Fliers, Philip T., Abe de Jong, and Bert S. van Stiphout-Kramer. 2024. Corporate taxes, leverage, and investment: Evidence from Nazi-occupied Netherlands. *The Economic History Review* .

Fohlin, Caroline, and Matthew Jaremski. 2020. US banking concentration, 1820–2019. *Economics Letters* 190: 109104.

FSB. 2023. The financial stability implications of leverage in non-bank financial intermediation. Technical Report, Technical Report, FSB.

Furceri, Davide, and Prakash Loungani. 2018. The distributional effects of capital account liberalization. *Journal of Development Economics* 130: 127–144.

Gambacorta, Leonardo, Giacomo Ricotti, Suresh Sundaresan, and Zhenyu Wang. 2017. The effects of tax on bank liability structure. Banca d'Italia Working Paper Number 1101.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico M. Signoretti. 2010. Credit and banking in a DSGE model of the euro area. *Journal of Money, Credit and Banking* 42(s1): 107–141.

Goldbach, Stefan, Jarle Møen, Dirk Schindler, Guttorm Schjelderup, and Georg Wamser. 2021. The tax-efficient use of debt in multinational corporations. *Journal of Corporate Finance* 71: 102119.

Graham, John R. 2006. A review of taxes and corporate finance. *Foundations and Trends in Finance* 1: 573–691.

Graham, John R., and Alan L. Tucker. 2006. Tax shelters and corporate debt policy. *Journal of Financial Economics* 81(3): 563–594.

Gropp, Reint, and Florian Heider. 2010. The determinants of bank capital structure. *Review of Finance* 14(4): 587–622.

Grossman, Richard S. 2010. *Unsettled account: the evolution of banking in the industrialized world since 1800*. Princeton Univ Press.

Gu, Grace Weishi, Ruud de Mooij, and Tigran Poghosyan. 2015. Taxation and leverage in international banking. *International Tax and Public Finance* 22(2): 177–200.

Hebous, Shafik, Dinar Prihardini, and Nate Vernon. 2022. Excess profit taxes: historical perspective and contemporary relevance. *IMF Working Papers* 2022(187).

Hebous, Shafik, and Martin Ruf. 2017. Evaluating the effects of ACE systems on multinational debt financing and investment. *Journal of Public Economics* 156: 131–149.

Hemmelgarn, Thomas, and Daniel Teichmann. 2014. Tax reforms and the capital structure of banks. *International Tax and Public Finance* 21(4): 645–693.

Horvath, Balint L. 2013. The impact of taxation on bank leverage and asset risk. CentER Discussion Paper; Vol. 2013-076.

Hovakimian, Armen, Gayane Hovakimian, and Hassan Tehranian. 2004. Determinants of target capital structure: the case of dual debt and equity issues. *Journal of Financial Economics* 71(3): 517–540.

Huizinga, Harry, Luc Laeven, and Gaetan Nicodeme. 2008. Capital structure and international debt shifting. *Journal of Financial Economics* 88(1): 80–118.

Jensen, Michael C. 1986. Agency costs of free cash flow, corporate finance, and takeovers. *American Economic Review* 76(2): 323–329.

Jordà, Òscar. 2005. Estimation and inference of impulse responses by local projections. *The American Economic Review* 95(1): 161–182.

Jordà, Òscar, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, and Alan M Taylor. 2019. The rate of return on everything, 1870–2015. *The Quarterly Journal of Economics* 134(3): 1225–1298.

Jordà, Òscar, Björn Richter, Moritz Schularick, and Alan M. Taylor. 2021. Bank capital redux: solvency, liquidity, and crisis. *The Review of Economic Studies* 88(1): 260–286.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor. 2017. Macrofinancial history and the new business cycle facts. *NBER macroeconomics annual* 31(1): 213–263.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor. 2020. The effects of quasi-random monetary experiments. *Journal of Monetary Economics* .

Jordà, Òscar, and Alan M. Taylor. 2016. The time for austerity: estimating the average treatment effect of fiscal policy. *The Economic Journal* 126(590): 219–255.

King, Mervyn A. 1974. Taxation and the cost of capital. *The Review of Economic Studies* 41(1): 21–35.

Klein, Michael W., and Jay C. Shambaugh. 2015. Rounding the corners of the policy trilemma: sources of monetary policy autonomy. *American Economic Journal: Macroeconomics* 7(4): 33–66.

Korteweg, Arthur. 2010. The net benefits to leverage. *The Journal of Finance* 65(6): 2137–2170.

Koudijs, Peter, Laura Salisbury, and Gurpal Sran. 2021. For richer, for poorer: Bankers' liability and bank risk in New England, 1867 to 1880. *The Journal of Finance* 76(3): 1541–1599.

Kraus, Alan, and Robert H. Litzenberger. 1973. A state-preference model of optimal financial leverage. *The Journal of Finance* 28(4): 911–922.

Lains, Pedro. 2021. *A history of public banking in Portugal in the 19th and 20th centuries*, volume 28. Routledge.

Liu, Chang, and Noah Williams. 2019. State-level implications of federal tax policies. *Journal of Monetary Economics* 105: 74–90.

Luca, Oana, and Alexander F. Tieman. 2019. Financial sector debt bias. *Journal of Banking & Finance* 107: 105597.

MacKie-Mason, Jeffrey K. 1990. Do taxes affect corporate financing decisions? *The Journal of Finance* 45(5): 1471–1493.

Martin-Flores, Jose, and Christophe Moussu. 2019. Is bank capital sensitive to a tax allowance on marginal equity? *European Financial Management* 25(2): 325–357.

McLeay, Michael, Amar Radia, and Ryland Thomas. 2014. Money creation in the modern economy. Bank of England Quarterly Bulletin.

Meckling, William H., and Michael C. Jensen. 1976. Theory of the Firm. *Managerial Behavior, Agency Costs and Ownership Structure* .

Mertens, Karel, and Morten O. Ravn. 2013. The dynamic effects of personal and corporate income tax changes in the United States. *American Economic Review* 103(4): 1212–1247.

Milonas, Kristoffer. 2018. Bank taxes, leverage, and risk. *Journal of Financial Services Research* 54: 145–177.

Mintz, Jack, and Michael Smart. 2004. Income shifting, investment, and tax competition: theory and evidence from provincial taxation in Canada. *Journal of Public Economics* 88(6): 1149–1168.

Modigliani, Franco, and Merton H. Miller. 1958. The cost of capital, corporation finance and the theory of investment. *The American Economic Review* 48(3): 261–297.

Quinn, Dennis, Martin Schindler, and A Maria Toyoda. 2011. Assessing measures of financial openness and integration. *IMF Economic Review* 59(3): 488–522.

Reiter, Franz, Dominika Langenmayr, and Svea Holtmann. 2021. Avoiding taxes: banks' use of internal debt. *International Tax and Public Finance* 28(3): 717–745.

Romer, Christina D., and David H. Romer. 2010. The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks. *American Economic Review* 100(3): 763–801.

Ruf, Martin, and Dirk Schindler. 2015. Debt shifting and thin-capitalization rules–German experience and alternative approaches. *Nordic Tax Journal* 2015(1): 17–33.

Schandlbauer, Alexander. 2017. How do financial institutions react to a tax increase? *Journal of Financial Intermediation* 30: 86–106.

Schepens, Glenn. 2016. Taxes and bank capital structure. *Journal of Financial Economics* 120(3): 585–600.

Schindler, Dirk, and Guttorm Schjelderup. 2012. Debt shifting and ownership structure. *European Economic Review* 56(4): 635–647.

Schularick, Moritz, and Alan M. Taylor. 2012. Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870–2008. *American Economic Review* 102(2).

Scott, Peter. 2022. A fiscal constitutional crisis: tax avoidance and evasion in inter-war Britain. *The English Historical Review* 137(584): 170–197.

Steil, Benn. 2013. *The battle of Bretton Woods: John Maynard Keynes, Harry Dexter White, and the making of a new world order.* Princeton University Press.

Stern, Gary H., and Ron J. Feldman. 2004. *Too big to fail: the hazards of bank bailouts.* Brookings Institution Press.

Stiglitz, Joseph E. 1973. Taxation, corporate financial policy, and the cost of capital. *Journal of Public Economics* 2(1): 1–34.

Stock, James H., and Mark W. Watson. 2018. Identification and estimation of dynamic causal effects in macroeconomics using external instruments. *The Economic Journal* 128(610): 917–948.

Van Binsbergen, Jules H., John R. Graham, and Jie Yang. 2010. The cost of debt. *The Journal of Finance* 65(6): 2089–2136.

Zimmermann, Kaspar. 2019. Monetary policy and bank profitability, 1870–2015. Available at SSRN 3322331.

Internet Appendix

to *“The bank leverage response to tax shield changes”*

Casper de Vries[1]   Felix Ward[2]

---

[1] Erasmus School of Economics, Erasmus University Rotterdam; Tinbergen Institute; WRR (cdevries@ese.eur.nl).

[2] Erasmus School of Economics, Erasmus University Rotterdam; Tinbergen Institute (ward@ese.eur.nl).

Contents

A. MODEL DERIVATIONS

Partial effect derivations

The first order condition of the extended banking model is

$$(1-\tau)\gamma(k^*-k)-[\tau(\delta i-\eta)-\lambda]=0 \tag{A.1}$$

The second order condition for a maximum, $-\gamma(1-\tau)<0$, holds. We obtain the responsiveness of the bank capital ratio with respect to corporate tax rate changes by differentiating with respect to τ and k

$$-[\gamma(k^*-k)+(\delta i-\eta)]d\tau-(1-\tau)\gamma dk=0$$

or

$$\frac{dk}{d\tau}=\frac{\eta-[\delta i+\gamma(k^*-k)]}{\gamma(1-\tau)}$$

substituting A.1 for $\gamma(1-k)$ yields

$$\frac{dk}{d\tau}=-\frac{\delta i-\eta-\lambda}{\gamma(1-\tau)^2}<0 \quad \text{for} \quad \delta i-\eta-\lambda>0 \tag{A.2}$$

Thus, corporate tax rate increases imply a lower bank capital ratio in most practically relevant cases where ACEs, interest deductibility limits, and bank levies do not fully annul the tax advantage of debt, i.e. $\delta i-\eta-\lambda>0$.

To characterize the effect of an interest rate change on the optimal bank capital ratio, we differentiate A.1 with respect to i and k

$$-\tau\delta di-(1-\tau)\gamma dk=0$$

which implies

$$\frac{dk}{di}=-\frac{\tau\delta}{\gamma(1-\tau)}\leq 0. \tag{A.3}$$

As long as interest expenses are at least partly tax deductible, i.e. $\delta>0$, a higher interest rate implies a lower bank capital ratio.[3]

Equivalently, differentiating A.1 with respect to k, and η, δ, or λ yields the following three derivatives that characterize the response of bank leverage to ACE-, deductibility limit-, and bank levy changes

$$\frac{dk}{d\eta}=\frac{\tau}{\gamma(1-\tau)}>0 \tag{A.4}$$

---

[3] An extended model that allows ρ to vary and thus to move with changes in i yields qualitatively identical, but quantitatively amplified results (Appendix C).

$$\frac{dk}{d\delta} = -\frac{\tau i}{\gamma(1-\tau)} < 0 \tag{A.5}$$

$$\frac{dk}{d\lambda} = \frac{1}{\gamma(1-\tau)} > 0 \tag{A.6}$$

By levelling the playing field between debt- and equity financing, increases in η, decreases in δ, and increases in λ all bring about a higher bank capital ratio.

B. DATA

Australia: Corporate tax rate: Bank (2014) (1894–1895), Sobeck et al. (2022) (1915–1950), Australian Bureau of Statistics Year Book (1950–1956), University of Michigan's World Tax Database (1956–1975), Australian government budget archive (1976–1999), OECD Tax Database (2000–2017). Excess profit- & war-time tax rates: War Time Profits Tax Assessment Act 1917, 1940 War-time Companies Tax Assessment Act (incl. 1941, 1942, and 1947 amendments), Statue Law Revision 1950, Australian Bureau of Statistics Year Book. Non-deductibility: n.a. ACE: Income Tax Assessment Act 1915, Income Tax Assessment Act 1918. TCR: New business tax system (thin capitalisation) Act 2001 No.162, Tax and superannuation laws amendment (2014 measures No.4) Bill 2014, Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: Major Bank Levy Bill 2017.

Belgium: Corporate tax rate: Genovese et al. (2016) (1920–1962), University of Michigan's World Tax Database (1963–1992), OECD Tax Database (1993–2017). Excess profit- & war-time tax rates: n.a. Non-deductibility: Gesetz- und Verordnungsblatt (1916), Baudhuin (1958, pp.57–59). ACE: Hebous and Ruf (2017). TCR: PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

Canada: Corporate tax rate: Perry (1955) (1916–1946), Perry (1989) (1947–1959), Department of Finance Canada (1960–2000), OECD Tax Database (2001–2017). Excess profit- & war-time tax rates: Stamp (1917), Breadner (1918), Tolmie (1941), Stikeman (1948), Hebous et al. (2022). Non-deductibility: n.a. ACE: n.a. TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

Denmark: Corporate tax rate: Johansen (2007) (1870–1961), Elkær-Hansen et al. (1987) (1962–1969), Danmarks Statistik (1970–2000), OECD Tax Database (2001–2017). Excess profit- & war-time tax rates: Johansen (2007), Hebous et al. (2022). Non-deductibility: n.a. ACE: 1903 Income Tax Act, 1922 Income Tax Act. TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

Finland: Corporate tax rate: Voutilainen (2016) (1870–1885), Suomen Virallinen Tilasto – Varallisuustilastoa, Turkkila (2011) (1920–1938), Linnakangas (2015), Valvanne (1947), Suomen Pankin Taloustieteellinen Selvityksiä (1939–1954), Linnakangas (2015), University of Michigan's World Tax Database, OECD Tax Database (1959–2017). Excess profit- & war-time tax rates: Linnakangas (2015), Suomen Pankin Taloustieteellinen Selvityksiä. Non-deductibility: n.a. ACE: Tulo- ja omaisuusverosta 1920, Linnakangas (2015). TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

France: Corporate tax rate: Haig (1929) (1917–1919), Shoup (1930), Lamothe (1938, p.226) (1920–1939), White et al. (2007), Touchelay (2008) (1940–1944), Boyer (2020, ch.9), University of Michigan's World Tax Database (1949–2000), OECD Tax Database (2001–2017). Excess profit- & war-time tax rates: Douglas (1943), Hautcoeur and Grotard (2001), Hebous et al. (2022). Non-deductibility: Shoup (1930), Lamothe (1938, p.226). ACE: n.a. TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: n.a.

Germany: Corporate tax rate: Körperschaftssteuergesetz (30.3.1920), Steueranpassungsgesetz (16.10.1934), Reichsgesetzblatt (1920–1944), Kontrollratsgesetze Nr. 3 & 12, Gesetzblatt der Verwaltung des Vereinigten Wirtschaftsgebietes (1945–1949), Bundesgesetzblatt/Körperschaftssteuergesetz (1950–2000), OECD Tax Database (2001–2017). Excess profit- & war-time tax rates: FinanzArchiv (1914), Roesler (2017), Buehler (1940), Meimberg (1944), Notopfergesetz (1948–1958). Non-deductibility: n.a. ACE: Wehrbeitragsgesetz 1913. TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

Italy: Corporate tax rate: Legge 6 agosto 1954 n. 603 (1954–1957), Teso Unico delle leggi sulle imposte dirette (1958–1973), IRPEG – imposta sul reddito delle persone giuridiche, TUIR – Testo Unico delle sui redditi, ILOR – imposta locale sui redditi, IRAP – imposta regionale sulle attivita produttive, (1974–2004), Jordà et al. (2019) (1981–1999), OECD Tax Database, with adjustment for banks' and financial intermediaries' tax rate after 2016 (2005–2016). Excess profit- & war-time tax rates: Stamp (1917), Griziotti (1919), Nina (1920), Hebous et al. (2022). Non-deductibility: n.a. ACE: Hebous and Ruf (2017). TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: n.a.

Japan: Corporate tax rate: Shiomi (1935), Nakaoka (2016), Onji and Tang (2017) (1899–1934), Shavell (1948), Shiomi (1957), of Finance (2010) (1935–1951), University of Michigan's World Tax Database (1952–2003), OECD Tax Database (2004–2017). Excess profit- & war-time tax rates: Shiomi (1935), Sakamoto (2014), Shiomi (1957), Sebald (1935). Non-deductibility: n.a. ACE: n.a. TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: n.a.

Netherlands: Corporate tax rate: Wet op de Bedrijfsbelasting 1893, Wet op Dividend- en Tantième Belasting 1917, Considerans Wet Vennootschapsbelasting 1969, Suppl. 647 (2006), Fritschy (1997), de Vicq (2022), Morck (2007) (1893–1941), Besluit op de Vennootschapsbelasting 1942 (1942–1968), Wet op Vennootschapsbelasting 1969 (1969–1980), OECD Tax Database (1981–2017). Excess profit- & war-time tax rates: Wet op de Oorlogswinstbelasting 1916. Non-deductibility: n.a. ACE: Wet op de Oorlogswinstbelasting

1916, P. (1917). TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

Norway: Corporate tax rate: Genovese et al. (2016), Sentralbyrå (1974), Gerdrup (1998) (1870–1920), Sentralbyrå (1968) (1921–1956), University of Michigan's World Tax Database (1957–1999), OECD Tax Database (2000–2017). Excess profit- & war-time tax rates: n.a. Non-deductibility: n.a. ACE: n.a. TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

Portugal: Corporate tax rate: CARTA de lei de 9 de maio de 1872, Regulamento da contribuição industrial approvado por decreto de 28 de junho de 1894, Colecção oficial de legislação portuguesa, Lains (2021) (1870–1922), Palma (2022), Decreto No. 8719, Decreto No. 15295, Decreto No. 16731, Diário do Govêrno I(83), Decreto No. 22541, Lei No. 23592, Decreto-Lei No. 24916, Decreto-Lei No. 27417, Decreto No. 33479, Amaral (2013) (1923–1962), Decreto-Lei No. 45399, Decreto-Lei No. 45103, Decreto-Lei No. 653/70, Lei No. 21-A/79, Decreto-Lei No. 201-A/79 (1863–1980), Jordà et al. (2019) (1981–1988), University of Michigan's World Tax Database (1989–2000), OECD Tax Database (2001–2017). Excess profit- & war-time tax rates: Lei No. 1989, Decreto 32681, Decreto 33582. Non-deductibility: Colecção oficial de legislação portuguesa. ACE: Hebous and Ruf (2017). TCR: PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

Spain: Corporate tax rate: von Eheberg (1936, p.738), Gaceta de Madrid 1900 Núm 92, Gaceta de Madrid 1907 Núm 221 (1870–1919), Portillo Navarro (1997), Linares (2015), Gaceta de Madrid 1920 Núm 297 (1920–1932), Ley de 20 de noviembre de 1932, Ley de 14 de noviembre de 1935, Albiñana (1969), Gaceta de Madrid 1932 Núm 358 (1933–1940), Albiñana (1969, p.350), Genovese et al. (2016) (1941–1954), Ley de 16 de decembre de 1954, Albiñana (1969, pp.54ff) (1955–1963), University of Michigan's World Tax Database (1965–1999), OECD Tax Database (2000–2017). Excess profit- & war-time tax rates: Stamp (1917), Balibrea Gil (1996). Non-deductibility: n.a. ACE: n.a. TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

Sweden: Corporate tax rate: Henrekson and Stenkula (2015) (1870–1999), OECD Tax Database (2000–2017). Excess profit- & war-time tax rates: Henrekson and Stenkula (2015). Non-deductibility: n.a. ACE: n.a. TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

Switzerland: Corporate tax rate: Steuerverwaltung (2010) (1870–1980), OECD Tax Database (1981–2017). Excess profit- & war-time tax rates: Steuerverwaltung (2010).

Non-deductibility: n.a. ACE: n.a. TCR: PWC Worldwide Tax Summaries. Bank levy: n.a.

United Kingdom: Corporate tax rate: Genovese et al. (2016) (1870–1964), Finance Act 1965, HMRC (1965–1977), University of Michigan's World Tax Database (1978–2002), OECD Tax Database (2003–2017). Excess profit- & war-time tax rates: Arnold (2014), Billings and Oats (2014), Hebous et al. (2022), Buehler (1940), Finance Acts 1939, 1940, 1941, 1945, 1946. Non-deductibility: n.a. ACE: n.a. TCR: Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: Devereux et al. (2019).

United States: Corporate tax rate: Revenue Act 1861, Wilson-Gorman Tariff Act 1894 (1870–1908), IRS SOI Tax Stats (1909–1999), OECD Tax Database (2000–2017). Excess profit- & war-time tax rates: Plehn (1920), Revenue Act 1940, 1941, 1942, 1943, 1945, Ratchford (1945), Boulton (1951), Hebous et al. (2022). Non-deductibility: n.a. ACE: n.a. TCR: Bank (2014), Ernst & Young LLP (2008), PWC Worldwide Tax Summaries. Bank levy: n.a.

C. Additional model results

Model with endogenous return premium

Here, we show that an endogenous return premium, ρ, that varies with the safe interest rate, i, and the bank capital ratio, k, tends to act as an amplifier that increases the absolute size of the derivatives reported in the main text.

Consider $\rho = \bar{\rho} + ai + bk$, with $a \geq 0$ and $b \leq 0$. The former accords with empirical findings by Bernanke and Kuttner (2005), Bekaert et al. (2013), Gertler and Karadi (2015), and Bauer et al. (2023) that document an increase in return premiums in the aftermath of a risk-free rate increase. The latter, accords with the notion that lower capital ratios are associated with higher return premiums (Weaver and Herzig-Marx, 1978; Kollmann et al., 2011). The bank's objective function is

$$\max_k \left\{ \Big[(1-\tau)[q-\Gamma(k)] - (i+\lambda)(1-k) + \tau\delta i(1-k) + \tau\eta k + k\Big]\frac{1}{1+r} - k \right\}, \quad \text{(C.1)}$$

where the return premium enters through the discount factor that represents the return required by bank equity holders, $r = i + \rho$. The first order condition of the banking model with endogenous return premium is

$$(1-\tau)\gamma(k^* - k) = \tau(\delta i - \eta) - \lambda + \bar{\rho} + 2bk + ai \quad \text{(C.2)}$$

Solving for k yields

$$k = k^* \frac{\gamma}{\gamma + \frac{2b}{1-\tau}} - \frac{1}{\gamma + \frac{2b}{1-\tau}} \left[\frac{\tau(\delta i - \eta) - \lambda}{1-\tau} + \frac{\bar{\rho} + ai}{1-\tau} \right], \quad \text{(C.3)}$$

and hence

$$\frac{dk}{ds} = -\frac{1}{\gamma + \frac{2b}{1-\tau}} < 0$$

$$\text{for} \quad \gamma + \frac{2b}{1-\tau} > 0$$

where, as before, $s \equiv \frac{\tau(\delta i - \eta) - \lambda}{1-\tau}$. With the endogenous risk premium this derivative contains an additional term in its denominator, $\frac{2b}{1-\tau}$. Quantitatively, b is small. Within our dataset, a fixed effects regression of the lending rate–deposit rate spread on the capital ratio yields a coefficient of -0.08. Similarly sized estimates for the capital ratio sensitivity of bank interest rate spreads are presented by Kollmann et al. (2011, Appendix A). Their log-log specifications yield coefficient estimates in the vicinity of -0.25, which translates into a b-coefficient estimate -0.15 (after taking sample average capital ratios and spreads into account). Together with our empirical estimates for $\frac{dk}{ds} \in [-0.5; -0.25]$, this implies

$0 > -\frac{1}{\gamma} > -\frac{1}{\gamma+\frac{2b}{1-\tau}}$ in most practically relevant settings.[4] The additional $\frac{2b}{1-\tau}$-term thus tends to increase the absolute size of the derivative by lowering its denominator. The economic rationale for this is that any increase in the tax shield that lowers the optimal bank capital ratio now also implies a higher discount rate, r, which dampens the marginal Γ-cost increase associated with the leverage increase. Thus, for any given tax shield increase leverage now needs to be increased even further to equalize its marginal cost with with its increased marginal benefit. Thus, the endogenous return premium amplifies the effect of tax shield changes on the capital ratio.

Next, differentiating C.2 with respect to τ and k yields

$$-[\gamma(k^* - k) + (\delta i - \eta)]d\tau - (1-\tau)\gamma dk - 2b dk = 0$$

or

$$\begin{aligned} \frac{dk}{d\tau} &= \frac{-[(\delta i - \eta) + \gamma(k^* - k)]}{\gamma(1-\tau) + 2b} < 0 \\ \text{for} \quad & -[(\delta i - \eta) + \gamma(k^* - k)] < 0 \\ \text{and} \quad & \gamma(1-\tau) + 2b > 0 \end{aligned}$$

Note that typically $(k^* - k) > 0$, i.e. the optimal bank capital ratio in the presence of a debt tax shield is lower than the optimal bank capital ratio in the absence of taxation (see (C.3)). Thus, the endogenous return premium again amplifies the effect in most practically relevant settings, with $\frac{1}{\gamma(1-\tau)+2b} > \frac{1}{\gamma(1-\tau)}$ and $(\delta i - \eta) > 0$. The same amplification effect also characterizes the other derivatives.

We obtain the effect of an interest rate change on the optimal bank capital ratio, by differentiating C.2 with respect to i and k

$$-\tau\delta di - (1-\tau)\gamma dk - 2b dk - a di = 0$$

which for $\gamma(1-\tau) + 2b > 0$ implies

$$\frac{dk}{di} = -\frac{\tau\delta + a}{\gamma(1-\tau) + 2b} \leq 0. \tag{C.4}$$

Here, $a > 0$ acts as a second amplifying mechanism: the higher interest rate no longer just implies a larger interest expense deduction, but also a higher return premium that further disincentivizes equity financing.

Differentiating C.2 with respect to k, and η, δ, or λ yields derivatives that describe

---

[4] An exception occurs for the very high τ that can be observed for some countries during WW2 and in its aftermath. For example, the U.K.'s main corporate tax rate until the late 1950s exceeded 90%.

amplified responses of bank leverage to ACE-, deductibility limit-, and bank levy changes

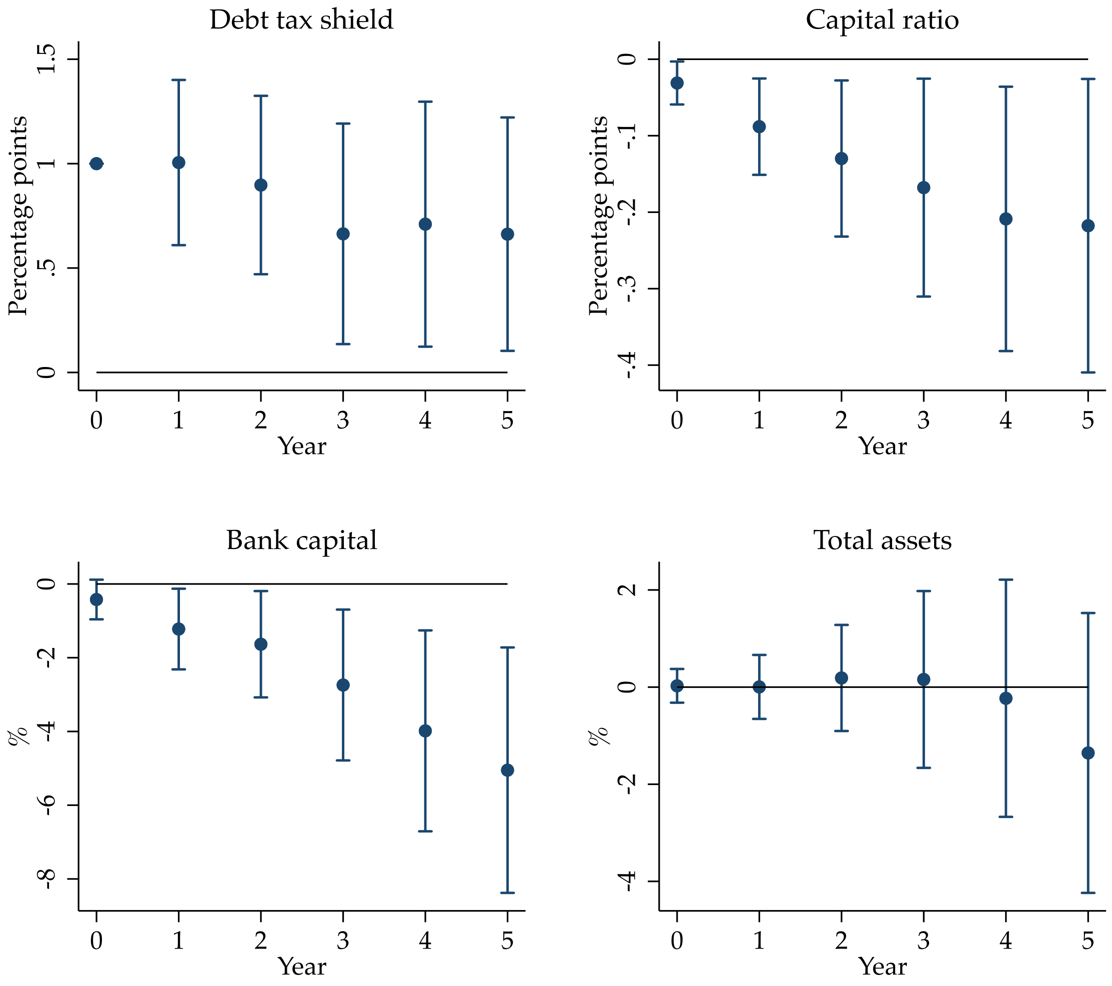
$$\frac{dk}{d\eta} = \frac{\tau}{\gamma(1-\tau)+2b} > 0 \tag{C.5}$$

$$\frac{dk}{d\delta} = -\frac{\tau i}{\gamma(1-\tau)+2b} < 0 \tag{C.6}$$

$$\frac{dk}{d\lambda} = \frac{1}{\gamma(1-\tau)+2b} > 0 \tag{C.7}$$

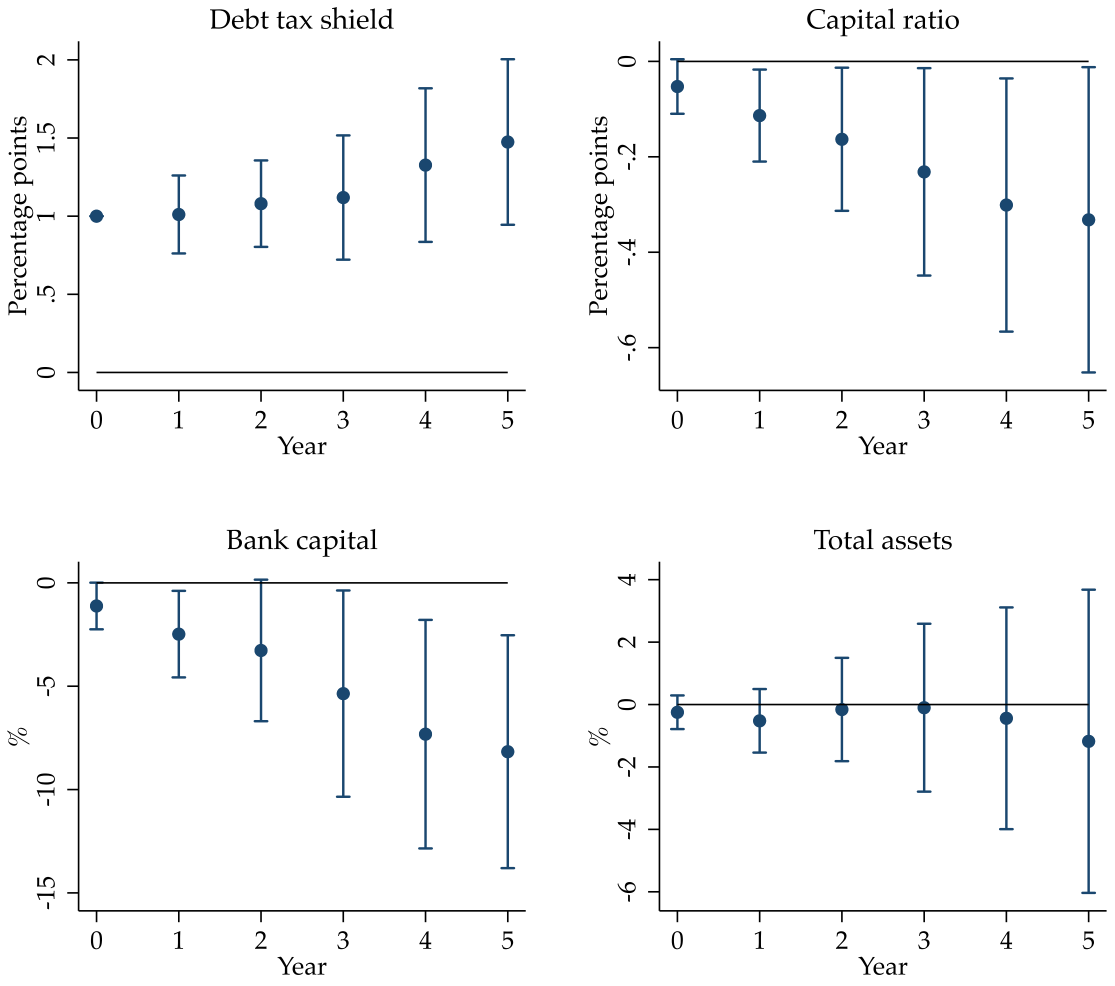
D. Additional empirical results

Figure D.1: Forward looking expectations



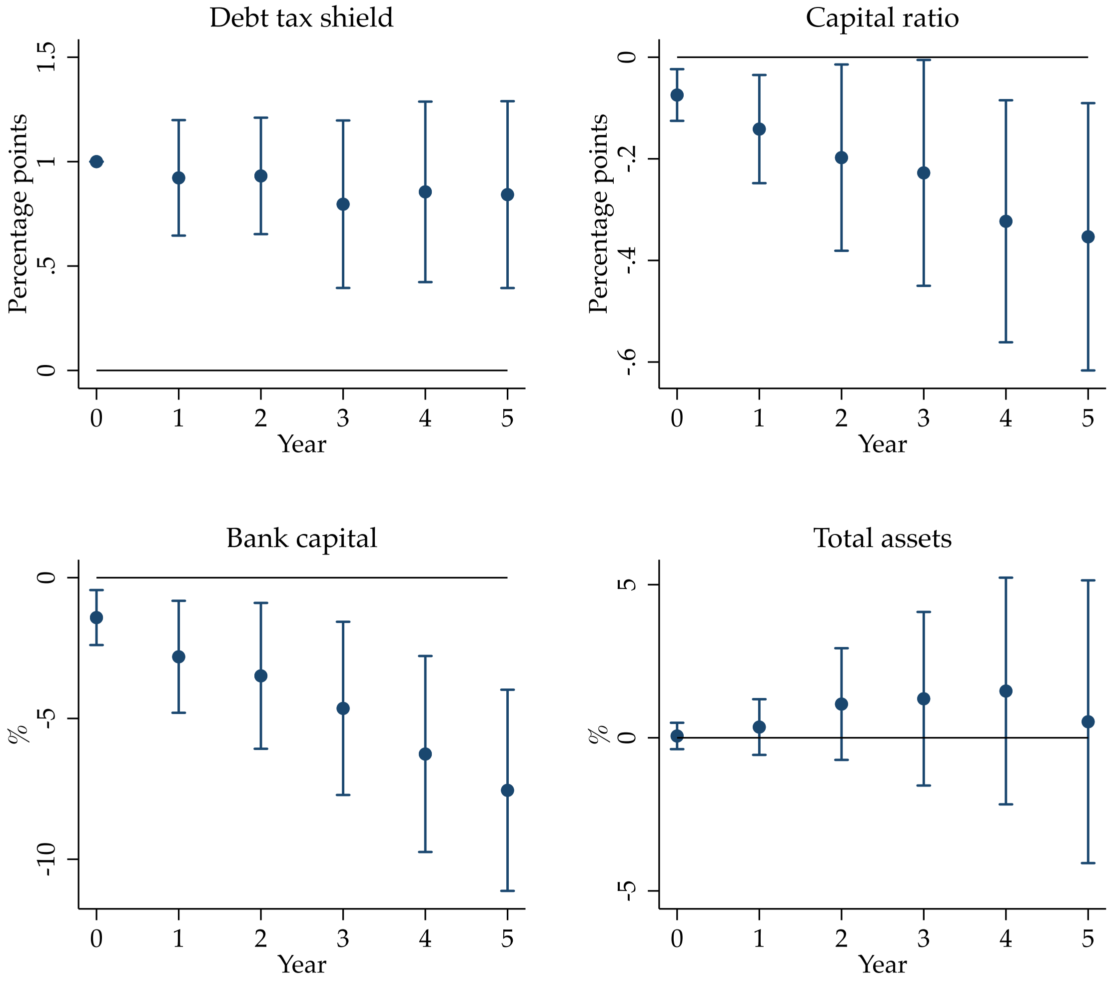
Notes: Results for a specification that uses a forward-looking 6-year moving average (incl. contemporary observation) of the bank deposit rate i and the return premium. The bars delineate 90% confidence intervals.

Figure D.2: Backward looking expectations



Notes: Results for a specification that uses a backward-looking 6-year moving average (incl. contemporary observation) of the bank deposit rate i and the return premium. The bars delineate 90% confidence intervals.

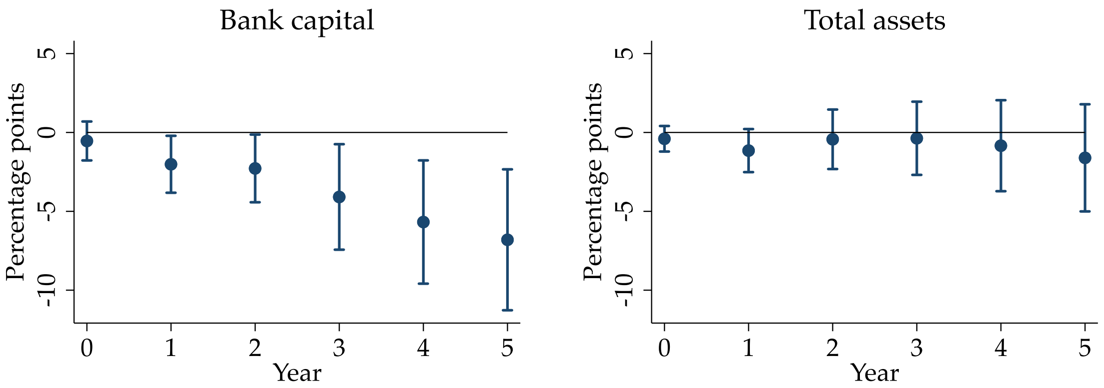
Figure D.3: Real PPP adjusted GDP weights



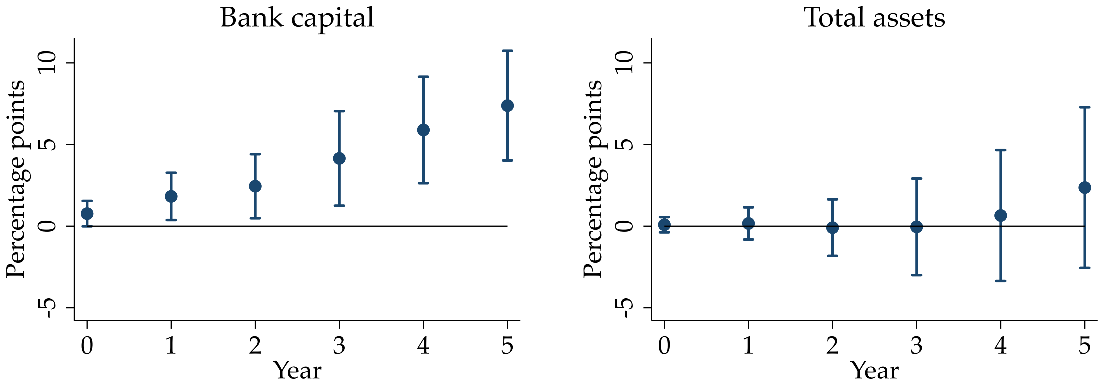
Notes: Results for a specification that accounts for the economic size of countries by applying real purchasing power parity adjusted GDP weights. The bars delineate 90% confidence intervals.

Figure D.4: Bank capital and asset response to a tax advantage cut and hike

Tax advantage hike:

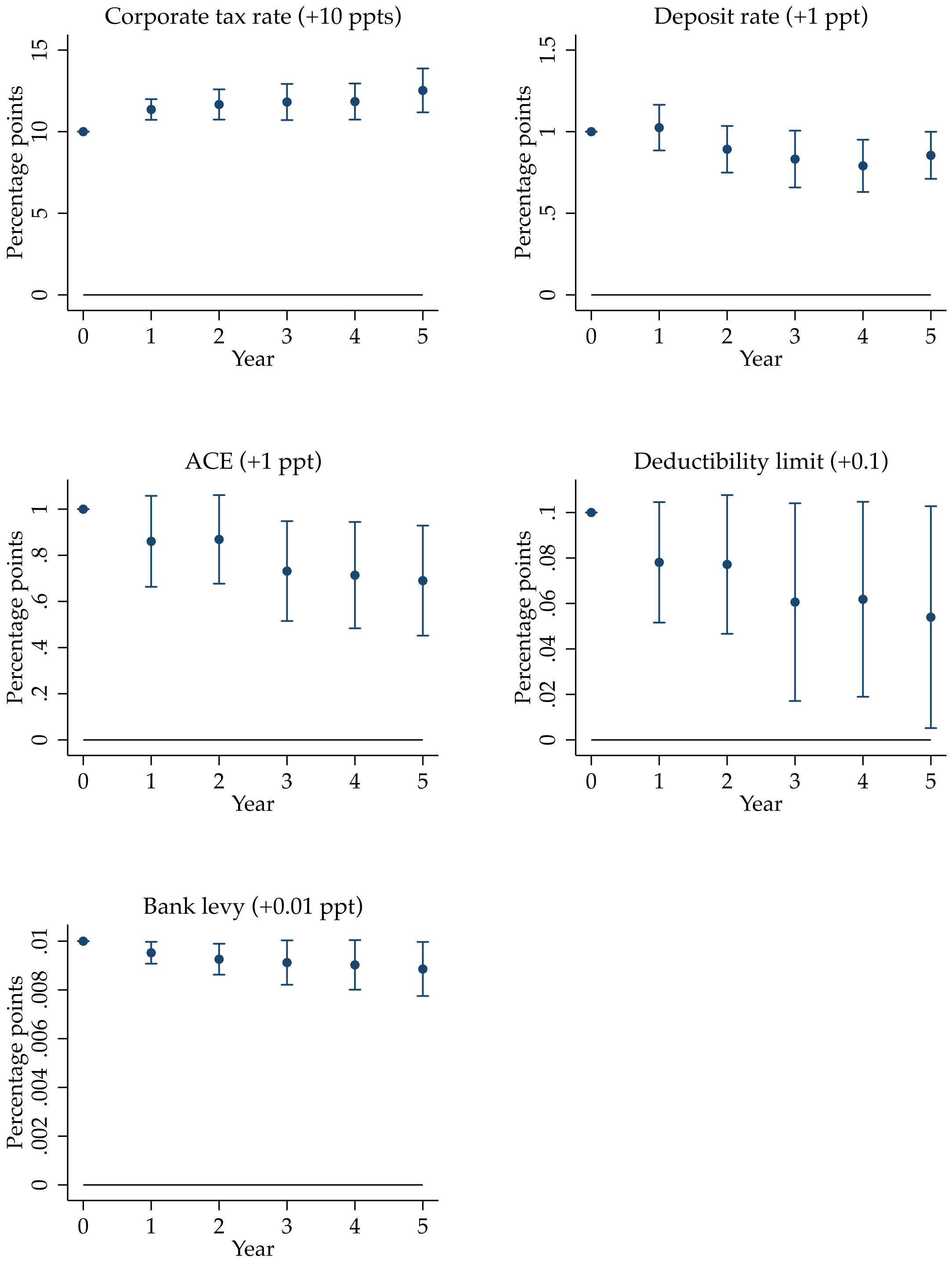


Tax advantage cut:



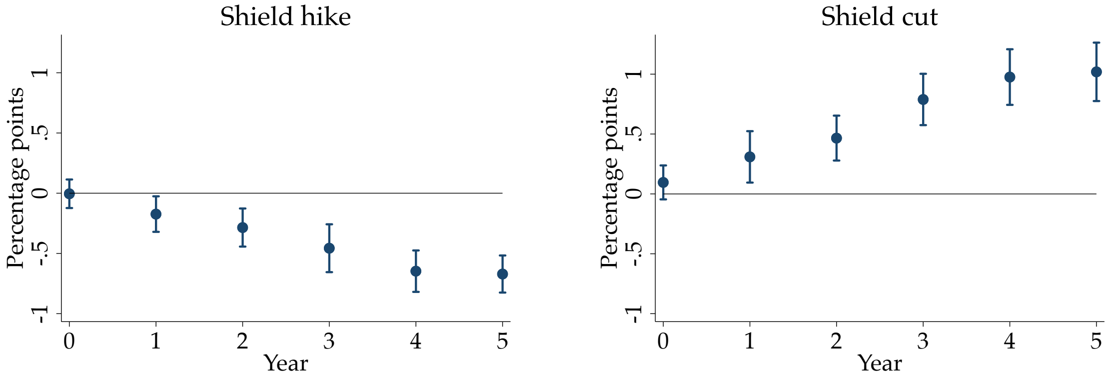
Notes: This graph describes the bank balance sheet response to an increase and decrease in the tax advantage of debt vis-à-vis equity of 1 percentage point. The bars delineate 90% confidence intervals.

Figure D.5: Persistence of impulses



Notes: This graph describes the persistence of the policy changes that yield the capital ratio effects described in Figure 5. The bars delineate 90% confidence intervals. The sharp decrease in estimate variance at horizon 4 of the deductibility limit own-response results from the tightening of the Australian deductibility limit in 2014 – three years before the end of our sample in 2017.

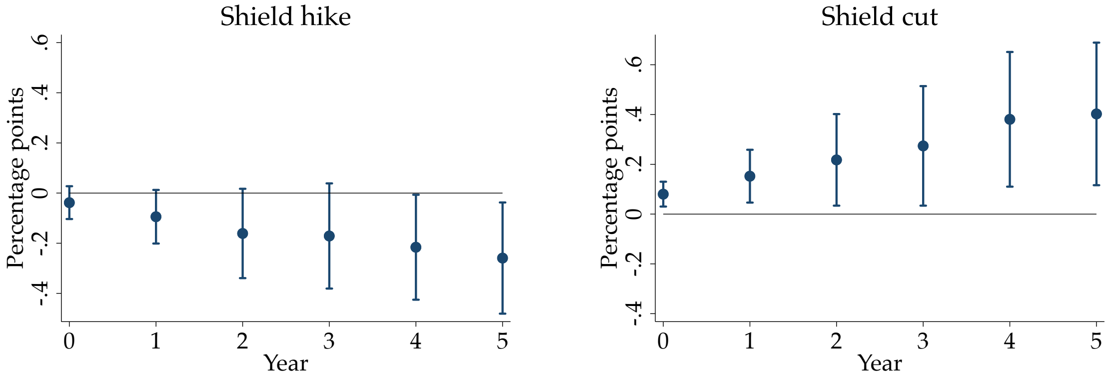
Figure D.6: Post-Bretton Woods – tax shield hikes versus cuts



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Difference	0.09	0.14	0.18	0.33	0.33	0.35
Hike=cut (p-value)	0.10	0.09	0.06	0.00	0.01	0.00

Notes: The graph analyzes the symmetry of the capital ratio response to tax shield hikes and cuts. Bars delineate 90% confidence intervals. The table displays the difference between the absolute shield hike and cut responses, and the p-values correspond to Wald tests for equality.

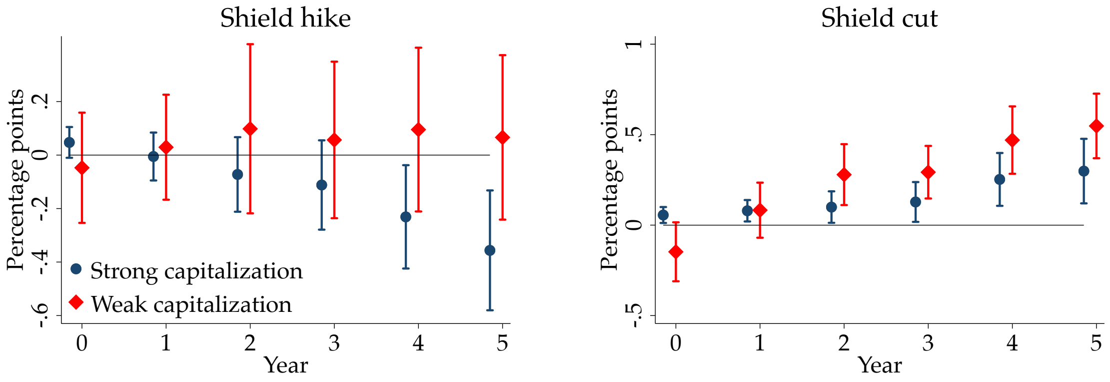
Figure D.7: Real PPP adjusted GDP weights – tax shield hikes versus cuts



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Difference	0.04	0.06	0.06	0.10	0.16	0.14
Hike=cut (p-value)	0.07	0.07	0.20	0.05	0.02	0.10

Notes: The graph analyzes the symmetry of the capital ratio response to tax shield hikes and cuts. Bars delineate 90% confidence intervals. The table displays the difference between the absolute shield hike and cut responses, and the p-values correspond to Wald tests for equality.

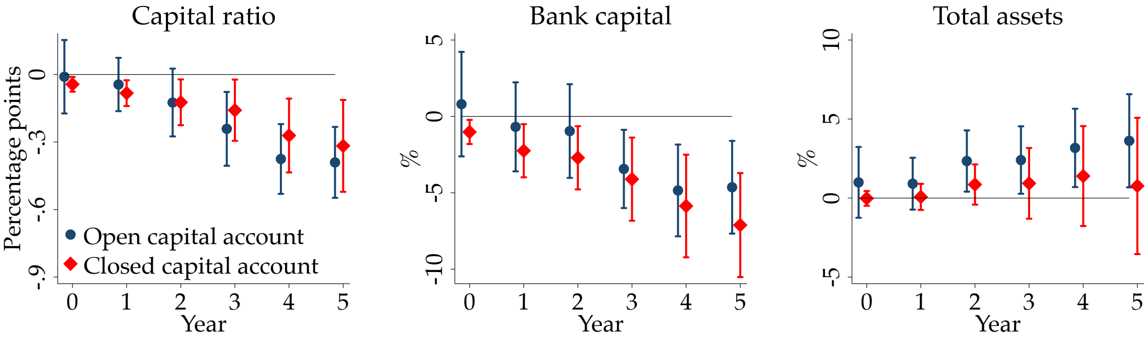
Figure D.8: Real PPP adjusted GDP weights – strong versus weak capitalization



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Shield hike difference	0.19	0.00	-0.05	-0.14	-0.31	-0.32
Strong=weak (p-value)	0.01	0.95	0.54	0.20	0.08	0.05
Shield cut difference	-0.07	0.03	0.09	0.05	0.05	-0.00
Strong=weak (p-value)	0.40	0.67	0.31	0.67	0.65	0.99

Notes: The graph analyzes the symmetry of the capital ratio response to tax shield hikes and cuts in strongly and weakly capitalized banking systems. Bars delineate 90% confidence intervals. The table displays the difference between strongly and weakly capitalized banking systems, and the p-values correspond to Wald tests for equality.

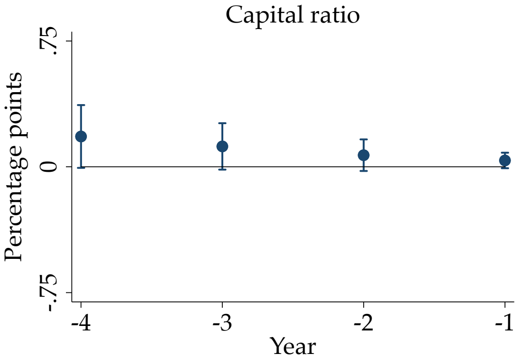
Figure D.9: Real PPP adjusted GDP weights – open versus closed economies



	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capital ratio difference	-0.03	-0.04	0.00	0.08	0.11	0.07
Open=closed (p-value)	0.71	0.50	0.99	0.25	0.15	0.39
Bank capital difference	-1.82	-1.56	-1.75	-0.66	-1.00	-2.46
Open=closed (p-value)	0.36	0.27	0.29	0.61	0.59	0.23
Total assets difference	-1.01	-0.84	-1.49	-1.48	-1.79	-2.87
Open=closed (p-value)	0.42	0.36	0.20	0.29	0.29	0.20

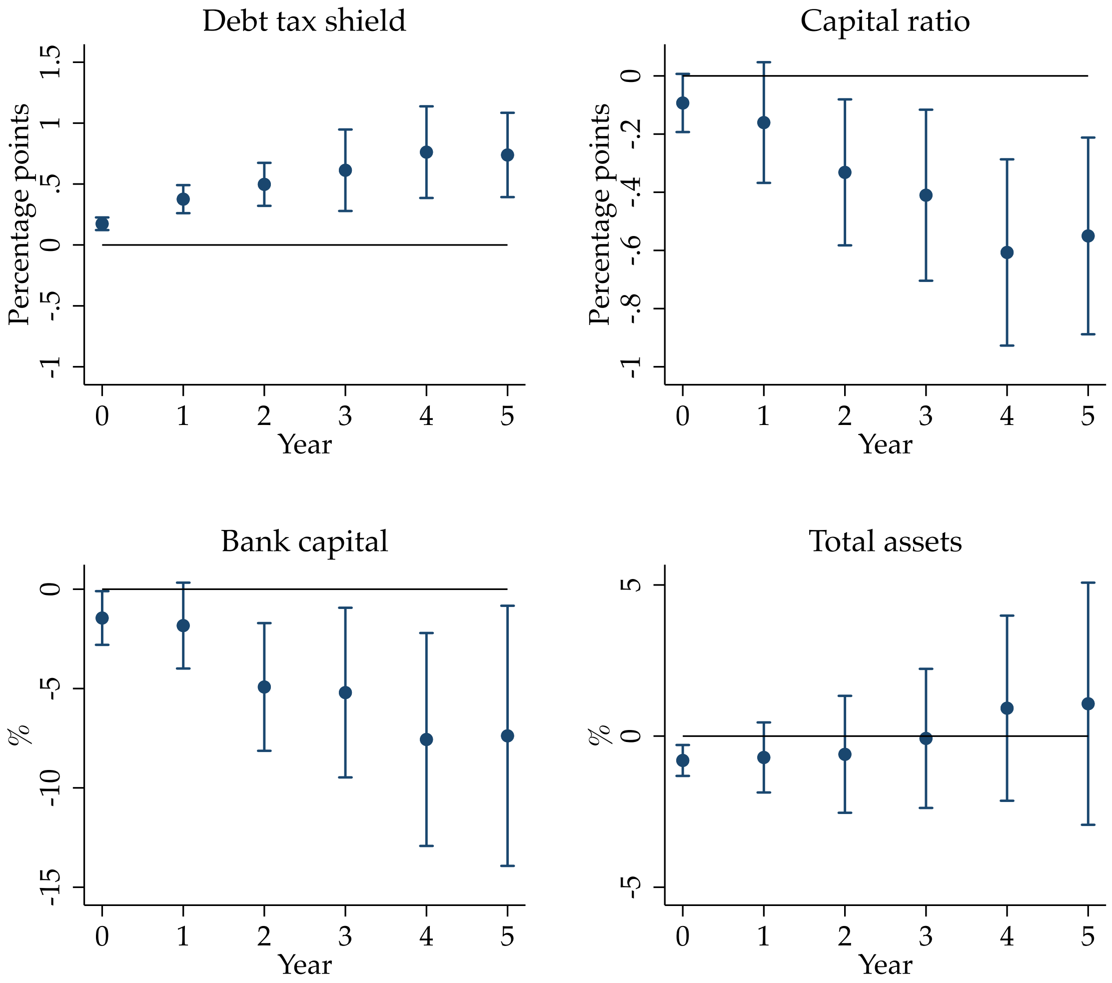
Notes: The graph analyzes the capital ratio response in open and closed economies. Bars delineate 90% confidence intervals. The table displays the difference between open- and closed-economy responses, and the p-values correspond to Wald tests for equality.

Figure D.10: Pre-event analysis with real PPP adjusted GDP weights



Notes: Cumulative growth rate prior to a +1 ppt change in the tax advantage of debt. The results are based on an LP specification that is equivalent to 11 with real purchasing power parity adjusted GDP weights applied, the left-hand side variable substitutes $\Delta^h k_{t-h,i}$ for $\Delta^h k_{t+h,i}$ ($h = 1, ..., 4$), and X_t does not contain lags of the capital ratio change, which now is the pre-trend variable of interest. The bars delineate 95% confidence intervals. The confidence intervals are calculated based on Driscoll-Kraay standard errors.

Figure D.11: Inverse probability weighted local projections (IPW-LP)



Notes: Results for a specification that applies inverse probability weights to a local projection specification. The bars delineate 90% confidence intervals.

Table D.1: Panel granger causality tests

	$\Delta s \rightarrow \Delta k$		$\Delta k \rightarrow \Delta s$	
	$\bar{Z}$	p-val	$\bar{Z}$	p-val
Full sample	-.25	.84	-1.61	.15
Post-WW2 sample	2.18	.07	1.36	.21

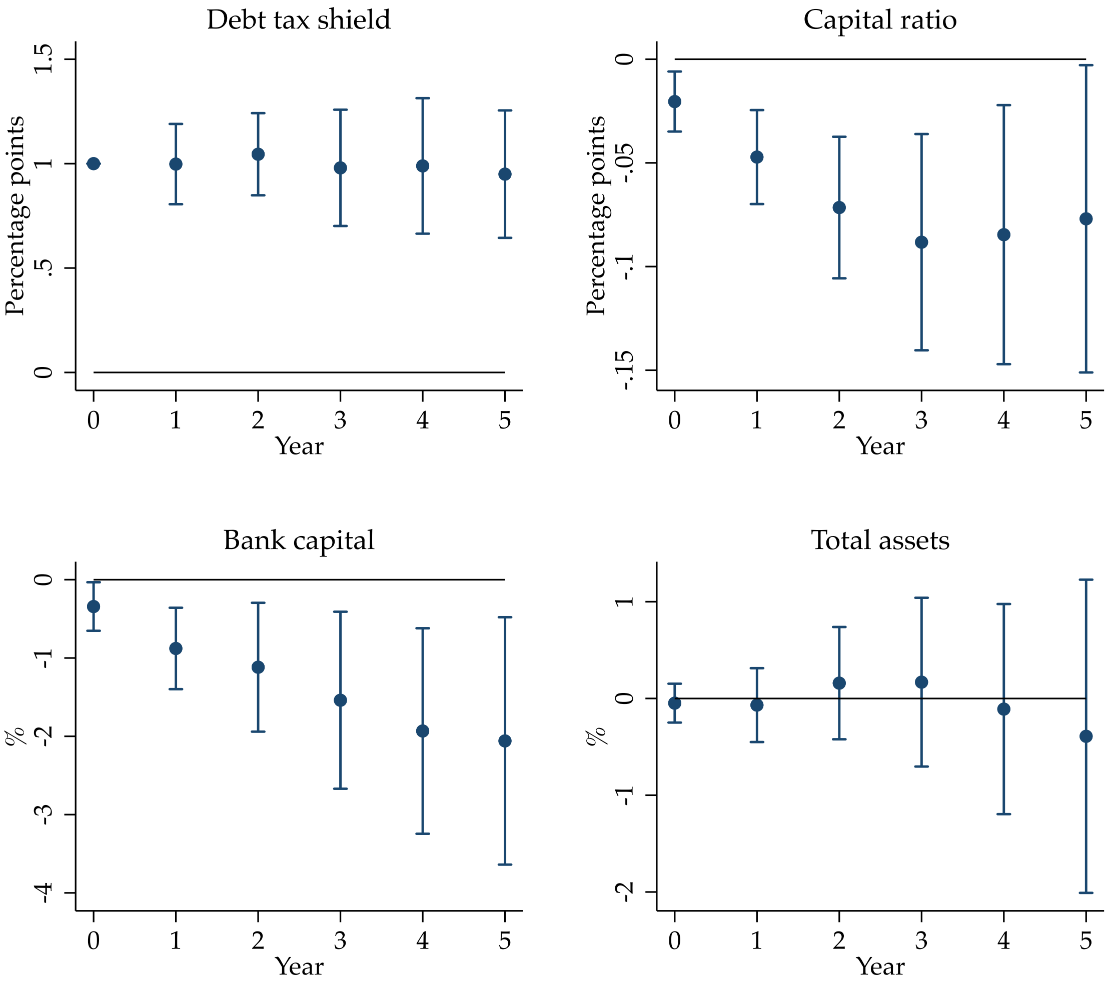
Notes: Granger-causality test for heterogeneous panels by Dumitrescu and Hurlin (2012). Test based on first differenced variables, for which the Pesaran panel unit root test with cross-sectional and first difference mean included cannot reject the null of homogenous stationarity (Pesaran, 2007). Optimal lag order determined by Schwarz's Bayesian information criterion equals 1 in all four cases considered. $\bar{Z}$-statistic H_0: first variable does not Granger-cause the second variable. Breusch-Pagan test indicates cross-sectional dependence (Pesaran, 2015). p-values based on bootstrap procedure that accounts for cross-sectional dependence. 1000 bootstrap runs. s– debt tax shield; k – bank capital ratio.

Table D.2: Granger causality tests: country-by-country

	$\Delta s \rightarrow \Delta k$		$\Delta k \rightarrow \Delta s$	
	χ^2	p-val	χ^2	p-val
Australia	.3	.58	1.09	.3
Belgium	1.22	.27	.08	.78
Canada	.08	.78	.01	.91
Denmark	0	.94	.12	.73
Finland	.17	.68	.06	.81
France	.19	.66	.29	.59
Germany	.66	.42	1.29	.26
Italy	.41	.52	.09	.77
Japan	.2	.65	.12	.73
Netherlands	2.71	.1	11.81	0
Norway	6.87	.01	.02	.89
Portugal	.58	.45	3.84	.05
Spain	.34	.84	.43	.81
Sweden	.22	.64	.6	.44
Switzerland	.1	.75	.03	.86
United Kingdom	1.16	.28	.1	.75
United States	.21	.64	.03	.87

Notes: Granger-causality tests (Granger, 1969). Test based on first differenced variables, for which the Pesaran panel unit root test with cross-sectional and first difference mean included cannot reject the null of homogenous stationarity (Pesaran, 2007). Optimal lag order determined by Schwarz's Bayesian information criterion. Optimal lag lengths range from one to two. χ^2-statistic H_0: first variable does not Granger-cause the second variable. s– debt tax shield; k – bank capital ratio.

Figure D.12: Without control variables



Notes: Results for a specification that excludes the control vector $X_{t,i}$ from the specification. The bars delineate 90% confidence intervals.

Table D.3: First stage

	First stage
$\Delta^1 S^{glo}$	0.40***
	(0.09)
$\Delta^2 S^{glo}$	-0.22***
	(0.07)
F-statistic	10.10
Observations	2500

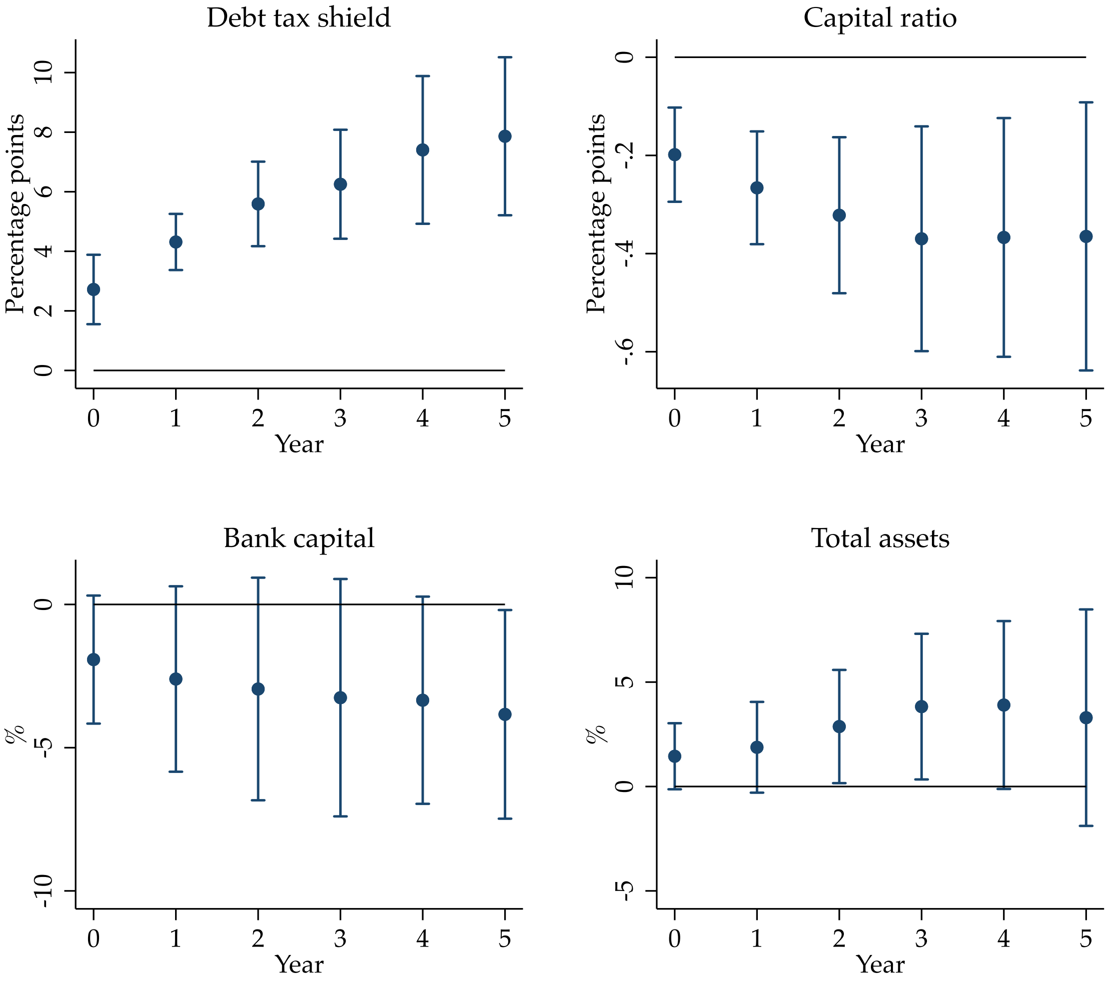
Notes: First stage regression result. Standard errors in parentheses. * (p<0.10), ** (p<0.05), *** (p<0.01).

Table D.4: First stage – narrative corporate tax shock for the U.S.

	First stage
$\Delta\tau$	0.12***
	(0.02)
τ	-0.15***
	(0.03)
F-statistic	16.37
Observations	68

Notes: First stage regression result. Standard errors in parentheses. * (p<0.10), ** (p<0.05), *** (p<0.01). Romer and Romer (2010)-type narrative corporate tax shock by Mertens and Ravn (2013) with updates by Liu and Williams (2019)

Figure D.13: Instrumental variable local projections (IV-LP)



Notes: IV estimate. The bars delineate 90% confidence intervals. For comparability with the baseline results, all IRFs except the shield own-response have been rescaled to reflect the response to a perfectly persistent 1 ppt change in the marginal tax shield.

References

Albiñana, César. 1969. *La Contribución General sobre la Renta en los años 1953-1954*. Instituto de Estudios Políticos.

Amaral, Luciano. 2013. Imperfect but true competition: innovation and profitability in Portuguese banking during the golden age (1950–1973). *Financial History Review* 20(3): 305–333.

Arnold, Anthony J. 2014. 'A paradise for profiteers'? The importance and treatment of profits during the first world war. *Accounting History Review* 24(2-3): 61–81.

Balibrea Gil, María Ángeles. 1996. El gravamen de los beneficios extraordinarios de sociedades y particulares una forma de financiación en épocas de guerra. *Anales de derecho: revista de la Facultad de Derecho* .

Bank, Steven A. 2014. Historical perspective on the corporate interest deduction. *Chapman Law Review* 18: 29.

Baudhuin, Fernand. 1958. *Histoire économique de la Belgique, 1945–1956*. É. Bruylant.

Bauer, Michael D., Ben S. Bernanke, and Eric Milstein. 2023. Risk appetite and the risk-taking channel of monetary policy. *Journal of Economic Perspectives* 37(1): 77–100.

Bekaert, Geert, Marie Hoerova, and Marco Lo Duca. 2013. Risk, uncertainty and monetary policy. *Journal of Monetary Economics* 60(7): 771–788.

Bernanke, Ben S., and Kenneth N. Kuttner. 2005. What explains the stock market's reaction to Federal Reserve policy? *The Journal of Finance* 60(3): 1221–1257.

Billings, Mark, and Lynne Oats. 2014. Innovation and pragmatism in tax design: excess profits duty in the UK during the First World War. *Accounting History Review* 24(2-3): 83–101.

Boulton, Schroeder. 1951. The excess profits tax of 1950. *Financial Analysts Journal* 7(2): 153–157.

Boyer, Alain. 2020. *Introduction au droit fiscal*. Editions Ellipses.

Breadner, R. W. 1918. The business profits and income war tax acts. *The Canadian Chartered Accountant* 8(2): 104–123.

Buehler, Alfred G. 1940. The taxation of corporate excess profits in peace and war times. *Law and Contemporary Problems* 7(2): 291–300.

de Vicq, Amaury. 2022. Exploring the limits of the limited partnership: the case of the Bank of Twente, 1860s–1920s. *Enterprise & Society* 23(4): 1122–1147.

Devereux, Michael, Niels Johannesen, and John Vella. 2019. Can taxes tame the banks? Evidence from the European bank levies. *The Economic Journal* 129(624): 3058–3091.

Douglas, George. 1943. Excess profits taxation and the taxpayer. *Law and Contemporary Problems* 10(1): 140–148.

Dumitrescu, Elena-Ivona, and Christophe Hurlin. 2012. Testing for Granger non-causality in heterogeneous panels. *Economic modelling* 29(4): 1450–1460.

Elkær-Hansen, Tom, Torben Møller Pedersen, and Lars Kirkegaard. 1987. Beskatningen i Danmark: en dokumentation af Danmarks Statistiks skatte- og afgiftsmodul og generelle skattestatistik. Danmarks Statistik Arbejdsnotat Nr. 20.

Ernst & Young LLP. 2008. Thin capitalization regimes in selected countries. Report prepared for the Advisory Panel on Canada's System of International Taxation.

FinanzArchiv. 1914. Gesetz über einen einmaligen ausserordentlichen Wehrbeitrag vom 3. Juli 1913. FinanzArchiv, 1914, 31. Jahrg., H. 1 (1914), pp.320-332.

Fritschy, Wantje. 1997. A history of the income tax in the Netherlands. *Revue Belge de Philologie et d'histoire* 75(4): 1045–1061.

Genovese, Federica, Kenneth Scheve, and David Stasavage. 2016. Comparative income taxation database. [Computer file]. Stanford, CA: Stanford University Libraries. http://data. stanford. edu/citd.

Gerdrup, Karsten R. 1998. *Skattesystem og skattestatistikk i et historisk perspektiv*. Statistisk sentralbyrå.

Gertler, Mark, and Peter Karadi. 2015. Monetary Policy Surprises, Credit Costs, and Economic Activity. *American Economic Journal: Macroeconomics* 7(1): 44–76.

Gesetz- und Verordnungsblatt. 1916. Gesetz- und Verordnungsblatt für die okkupierten Gebiete Belgiens. No. 289, 18. Dezember 1916.

Granger, Clive W. J. 1969. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica* 424–438.

Griziotti, Benvenuto. 1919. L'imposte sulla ricchezza dopo la guerra. *Giornale degli economisti e Rivista di statistica* 93–137.

Haig, Robert Murray. 1929. *The public finances of post-war France.* Columbia University Press.

Hautcoeur, Pierre-Cyrille, and Sandrine Grotard. 2001. Taxation of corporate profits, inflation and income distribution in France, 1914-1926. Communication au congrès d'Oxford de l'European historical economics society.

Hebous, Shafik, Dinar Prihardini, and Nate Vernon. 2022. Excess profit taxes: historical perspective and contemporary relevance. *IMF Working Papers* 2022(187).

Hebous, Shafik, and Martin Ruf. 2017. Evaluating the effects of ACE systems on multinational debt financing and investment. *Journal of Public Economics* 156: 131–149.

Henrekson, Magnus, and Mikael Stenkula. 2015. Swedish taxation since 1862: an overview. IFN Working Paper No. 1052.

Johansen, Hans Chr. 2007. *Indkomstskatter og offentlig vækst 1903-2005: Dansk skattehistorie.* Told-og Skattehistorisk Selskab.

Jordà, Òscar, Katharina Knoll, Dmitry Kuvshinov, Moritz Schularick, and Alan M Taylor. 2019. The rate of return on everything, 1870–2015. *The Quarterly Journal of Economics* 134(3): 1225–1298.

Kollmann, Robert, Zeno Enders, and Gernot J Müller. 2011. Global banking and international business cycles. *European Economic Review* 55(3): 407–426.

Lains, Pedro. 2021. *A history of public banking in Portugal in the 19th and 20th centuries*, volume 28. Routledge.

Lamothe, Roger. 1938. *Le Régime des taxes à la production en France (loi du 31 décembre 1936).* Ph.D. thesis, Toulouse.

Linares, Miguel Martorell. 2015. Hacienda y política en el primer tercio del siglo XX: las reformas tributarias. In *La evolución de la Hacienda Pública en Italia y España (siglos XVIII-XXI)*, 241–262. Servicio de Publicaciones.

Linnakangas, Esko. 2015. Tuloverotuksen synth ja kehitys. In *Verotus 1865–2015 – näkökulmia suomalaiseen verotukseen.* Veroskatt.

Liu, Chang, and Noah Williams. 2019. State-level implications of federal tax policies. *Journal of Monetary Economics* 105: 74–90.

Meimberg, Rudolf. 1944. Die Gewinnabführung in Deutschland als Kriegsgewinnsteuer. *Weltwirtschaftliches Archiv* 60(H. 3): 349–364.

Mertens, Karel, and Morten O. Ravn. 2013. The dynamic effects of personal and corporate income tax changes in the United States. *American Economic Review* 103(4): 1212–1247.

Morck, Randall K. 2007. *A history of corporate governance around the world: family business groups to professional managers.* University of Chicago Press.

Nakaoka, Shunsuke. 2016. The 1920 Japanese income tax reform: government, business and democratic constraints. London School of Economics and Political Science, Economic History Department.

Nina, Luigi. 1920. L'imposta sui profitti di guerra e sui patrimoni. *Giornale degli Economisti e Rivista di Statistica* 25–36.

of Finance, Ministry. 2010. Fiscal and monetary policies of Japan in reconstruction and high growth, 1945 to 1971. Office of Historical Studies, Institute of Fiscal and Monetary Policy, Ministry of Finance.

Onji, Kazuki, and John P. Tang. 2017. Taxes and the choice of organizational form in late nineteenth century Japan. *The Journal of Economic History* 77(2): 440–472.

P., A. L. 1917. Tax of war profits in Holland. *American Bar Association Journal* 696–700.

Palma, Clotilde C. 2022. *Nós e os impostos - Um contributo para a história dos impostos em Portugal.* Almedina, Manuais Universitários.

Perry, J. Harvey. 1955. *Taxes, tariffs, & subsidies: a history of Canadian fiscal development (Vol. 2).* University of Toronto Press.

Perry, J. Harvey. 1989. *A fiscal history of Canada: the postwar years.* Canadian Tax Foundation.

Pesaran, M. Hashem. 2007. A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics* 22(2): 265–312.

Pesaran, M. Hashem. 2015. Testing weak cross-sectional dependence in large panels. *Econometric Reviews* 34(6-10): 1089–1117.

Plehn, Carl C. 1920. War profits and excess profits taxes. *The American Economic Review* 10(2): 283–298.

Portillo Navarro, María José. 1997. Evolución del sistema impositivo español desde 1845 hasta la reforma tributaria silenciosa de Flores Lemus. *Anales de Derecho: Revista de la Facultad de Derecho* .

Ratchford, Benjamin Ulysses. 1945. The federal excess profits tax. Part one: development and present status. *Southern Economic Journal* 1–16.

Roesler, Konrad. 2017. *Die Finanzpolitik des Deutschen Reiches im Ersten Weltkrieg.* Duncker & Humblot, Berlin.

Romer, Christina D., and David H. Romer. 2010. The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks. *American Economic Review* 100(3): 763–801.

Sakamoto, Yuichiro. 2014. War finance (Japan). In *International Encyclopedia of the First World War*, edited by Ute Daniel, Oliver Janz Heather Jones Jennifer Keene Alan Kramer Bill Nasson, Peter Gatrell. Freie Universität Berlin.

Sebald, William J. 1935. *The excess profit tax law.* Kobe, The Japan Chronicle Press.

Sentralbyrå, Statistisk. 1968. Historisk oversikt omø skattesatser fram til 1968. Statistisk Sentralbyrå, Arbeidsnotater, IO 68/4.

Sentralbyrå, Statistisk. 1974. Det Norske skattesystemet, Hefte I, Direkte Skatter 1974. Statistisk Sentralbyrå, Samfunnsøkonomiske Studier Nr. 24.

Shavell, Henry. 1948. Taxation Reform in Occupied Japan. *National Tax Journal* 1(2): 127–143.

Shiomi, Saburo. 1935. The Development of the Income Tax in Japan. *The Kyoto University Economic Review* 10(1): 54–84.

Shiomi, Saburo. 1957. *Japan's Finance and Taxation 1940-1956.* Columbia University Press.

Shoup, Carl S. 1930. *The sales tax in France.* Columbia University Press.

Sobeck, K., R. Breunig, and A. Evans. 2022. *Corporate income taxation in Australia: theory, current practice and future policy directions.* Tax and Transfer Policy Institute (TTPI) Policy Report.

Stamp, Josiah C. 1917. The taxation of excess profits abroad. *The Economic Journal* 27(105): 26–37.

Steuerverwaltung, Eidg. 2010. Daten aus der Geschichte der Bundessteuern. Steuerinformationen herausgegeben von der Schweiz. Steuerkonferenz SSK, Vereinigung der schweizerischen Steuerbehörden.

Stikeman, H. Heward. 1948. Taxatio law: 1923-1947. *The Canadian Bar Review* 26: 308.

Tolmie, J. Ross. 1941. Excess profits taxation. *Canadian Journal of Economics and Political Science/Revue canadienne de economiques et science politique* 7(3): 350–363.

Touchelay, Béatrice. 2008. *D'une sortie de guerre à l'autre: de la contribution sur les bénéfices* *de guerre (1916) à la confiscation des profits illicites (1944-1945: l'état at-il appris à compter?* Presses universitaires de Rennes.

Turkkila, Juhani. 2011. *Tuloverotuksen reaalinen muuttuminen Suomessa – Kuusikymmentä vuotta verojen vuoristorataa.* ETLA, Elinkeinoelämän Tutkimuslaitos.

Valvanne, Heikki. 1947. *Yhteisöjen verotus Suomessa vuosina 1938-1945.* Jakaja: Akateeminen Kirjakauppa, Helsinki.

von Eheberg, Carlos T. 1936. *Hacienda pública.* Gustavo Gili.

Voutilainen, Miikka. 2016. *Poverty, inequality and the Finnish 1860s famine.* University of Jyväskylä.

Weaver, Anne S., and Chayim Herzig-Marx. 1978. A Comparative Study of the Effect of Leverage on Risk Premiums for Debt Issues of Banks and Bank Holding Companies. Federal Reserve Bank of Chicago, Occasional Papers 78-1.

White, Eugene N., Filippo Occhino, and Kim Oosterlinck. 2007. How occupied France financed its own exploitation in World War II. *American Economic Review* 97(2): 295–299.