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Corporate Income Tax and Bank Leverage

Bank Leverage in the 2010s

by

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Abstract

This paper studies the impact of corporate income taxation on leverage ratios (debts as a share of total assets) in the banking sector across 102 countries for the period 2012-2021, aiming to replicate the 2013 IMF paper *'Taxation, Bank Leverage, and Financial Crises'* by Keen, De Mooij and Orihara. With a sample of 5,829 banks, a system GMM is used, together with a fixed effects model to compare the two estimators and enable comparison with previous studies. Results are found to be highly dependent on the choice of estimator, with no significance in the GMM model, whereas connections between tax rates and leverage are found with the OLS approach. The strongest determinant of leverage ratios is found to be the size of the bank, defined as the log of total assets. Due to the lack of significance in the GMM model and concerns about the validity of the OLS results on the part of possible endogeneity, this paper finds no convincing support for the impact of corporate tax rates on the leverage ratios of banks between 2012-2021.

Keywords: corporate income tax, leverage, banks, debt bias

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Table of Contents

List of Tables

List of Figures

1. Introduction

In the wake of the Lehman Brothers collapse in 2007 and with the subsequent shock waves sent through the global banking system, there was a torrent of interest in financial crises, looking at the causes of crises amongst states and banking sectors, with an intense focus on debt levels for banks and governments alike. Research on the topic can be seen to fall into two categories, with one searching for growth effects, either higher or lower, of increased debt levels. The other category of studies looks not at growth directly, but operates on the assumption that there are factors (such as levels of debt or measures of liquidity in banks) influencing the risk of a banking crisis being triggered. Since crises are found to have strong and persistent negative effects on growth (Andersson and Karpestam, 2014), factors influencing the risk of a crisis can therefore impact growth, through the pathway of more or fewer crises occurring.

A factor found to be important in determining the probability of crises is the leverage ratio (how large debts are in relationship to total worth) among banks (Keen, De Mooij and Orihara, 2013) and several studies look at the determinants of leverage ratios to see whether such variables could be detrimental to growth through their impact on crises via leverage ratios. One such determinant is a tax bias in favor of debt.

This bias arises from differences in firms' financing costs for equity vs. debt, caused by differential tax treatment of the two sources of financing, a result of interest payments being tax-deductible, while dividends to shareholders are not. With few exceptions, corporate income tax is applied to a firm's earnings only once interest on its loans has been paid and before dividends are paid out. Alternative but less common tax systems also exist, such as the Allowance for Corporate Equity (ACE), which is present in Belgium and Italy and formerly also in Austria and Croatia. There's also the Comprehensive Business Income Tax (CBIT), which is not fully present anywhere but its principles are used to varying degrees.

The difference in deductibility of interest compared to dividends means that in order to repay an investment financed through equity (where the owners are repaid through dividends) corporate income tax must first be applied to the earnings. By contrast, if a firm finances its investments through debt (the return for investors there being the interest) it does not have to pay tax on the sum available to be paid to investors. The consequence is a debt bias, in which firms face tax incentives to finance investments through loans, as opposed to equity. Higher leverages (levels of debt) result in greater financial risks (Luca and Tieman, 2018), as firms can halt or delay payments to shareholders by means of reduced dividend payouts, but defaulting on their debts carries far worse consequences.

This inability of adapting cash flows in times of economic duress increases the risk of bankruptcy for the firm, and when the firm in question is a systemically important bank, a banking crisis is at hand. Banking crises carry large costs for society and governments alike (Reinhart and Rogoff, 2009) such as large buildups of government debt that may lead to more crises in the future, and banking crises are often followed by other economically distressing events, such as sovereign debt crises or currency crises (Laeven and Valencia, 2018; Böhm and Eichler, 2020). Given the importance bank leverage can have in financial instability (Luca and Tieman, 2018), it is important to assess the determinants of the banking sector's leverage. Improving our understanding of what determines bank leverage holds the twin benefits of increasing the odds of spotting a banking crisis coming (allowing steps to be taken to ward it off) or improving preparedness for future crises.

In order to study the impact of corporate income tax rates on leverage ratios, this paper will aim to replicate the IMF paper '*Taxation, Bank Leverage, and Financial Crises*' by Keen, De Mooij and Orihara (2013) which covered the first decade of the 21st century in 82 countries.

The connection between both tax and leverage and leverage and crisis risk is born out well by previous research looking at the time period up to the Great Financial Crisis or shortly after (Milonas, 2018; De Mooij, 2011; Feld, Heckemeyer, and Overesch, 2013; Luca and Tieman 2019; Keen and De Mooij, 2012; Keen, 2011a; b; Devereux, 2014; De Mooij, 2012; Coulter, Mayer, and Vickers, 2013; Ahrend and Goujard, 2014), but this research was often done in close proximity to the 2008 crisis, and looked mainly at the period leading up to the crisis, as opposed to incorporating the decade that followed. As a consequence, there is a paucity of studies looking at the leverage ratio consequences of the corporate income tax in the 2010s, a decade in which several important pieces of regulation concerning banks (such as Basel II and Basel III) were either drawn up or came into force. Additionally, the introduction of the BEPS in 2016, bringing together 141 countries (OECD 2022) to address tax planning and included actions to harmonize and limit the tax deductibility of interest payments (the primary mechanism of the bias toward leverage), could have fundamentally altered the relationship between tax rates and leverage.

The question this thesis aims to answer is the following: *are leverage ratios for banks impacted by tax levels in the 2010s?* The paper is structured as follows: Section 2 will introduce the theory and review previous studies, which provide earlier results on the relationship between taxes and leverage. The paper will then go on to describe the data in Section 3. Methodology and results will be presented in Section 4 and Section 5, respectively. In Section 6, we will discuss the implications based on the previous results. Finally, Section 7 concludes this paper and its findings.

2. Theory & literature review

This section will be split into two parts: first a brief overview of how corporate tax rates affect leverage, followed by a summary of the previous research on tax rates and leverage ratios. In the first part, the economic rationale of the connection between tax rates and leverage ratios is explained. Once the theoretical underpinning of the argument has been laid out in the first part, the second section summarizes previous studies and their findings.

2.1 Corporate tax rates and leverage

2.1.1 Theory and illustrative example

The theoretical argument, touched upon in the introduction, is straightforward, and this section endeavors to deepen and cement understanding of the concept, which has been known for a long time, but effective policies to deal with the issue have proved difficult to design, implement and sustain.

The core of the CIT (corporate income tax)-caused debt bias is that a firm's revenue is taxed only after interest has been paid, while profit going to dividends needs to face the corporate income tax before being paid out to shareholders. This effectively alters the cost of capital (i.e. the firm's financing costs) and means that for any profit before tax of amount X, the maximum amount of interest the company can pay is the full sum, i.e. X (no tax applied). By contrast, the maximum dividend payout the firm can afford is X*(1 - CIT rate). The result is that for any investment amount X required by a firm, the firm will be able to spend more on compensating new creditors than they would be able to compensate new owners. Put bluntly, firms can afford higher interest payments than dividend payments (the cost of debt can be higher than the cost of equity). The consequence of this is that high-risk projects or firms might not be able to afford high rates demanded by shareholders, and are thus left with only debt as a source of financing. This in turn, increases leverage ratios.

Another way of thinking about it is that for any demanded return on investment by shareholders and creditors, the company can raise more investment through debt, as opposed to equity. For example, if potential shareholders and creditors require the same rate of return (for the sake of argument, 5 percent), a firm facing the corporate tax rate in equation #Y can afford to finance a shareholder-financed investment of: (profit before tax * CIT rate)/ return required = Max loan. In this case: 100*0.5/0.05=1,000. The maximum amount available to the firm if they finance the investment through debt is 100/0.05= 2,000. The consequence of the debt bias here is that the firm can afford to invest twice as much if they chose to do so through loans instead of equity, getting two factories, trucks or ships (for example) instead of just one. The corporate income tax therefore creates an incentive to debt by allowing firms to make larger investments.

A third way in which the tax incentives favor debt over equity is a continuation of the previous point; if the firm is not interested in making twice the investment for the same cost (e.g. are only interested in buying one factory instead of two), debt is still favorable to equity. Given the previous example of a CIT rate of 50 percent and that the company only wishes to invest in one factory, it will only need to spend half as much on compensating the creditors compared to new shareholders. Reducing the repayment costs by half is a hefty reason to prefer debt over equity, and choosing the latter is tantamount to leaving money on the table. Financing any given investment amount through debt is thus, *ceteris paribus*, cheaper than financing through new equity. This is the third way the corporate income tax affects leverage.

2.1.2 Policy responses & limitations to substitution between debt and equity

Granted, a firm is not necessarily unconstrained in its choice of financing; it is possible for lenders to be unwilling to extend lines of credit to a firm if they suspect the investment is risky (such as if the firm is small, while larger firms may be seen as more stable and safer to lend to). This would diminish the size of the debt bias in any given circumstance, but unless the financing constraints can be assumed to completely negate the bias, it will only diminish the size of the debt bias of corporate income tax. However, in that case the debt bias would merely be replaced by another distortionary effect, wherein large companies gain an advantage over smaller competitors through differing access to lines of credit.

The above case arises in a standard double-taxation case, and is a simple description, but serves as an introduction. Moving on, the link between corporate income taxes and the debt bias is not a new discovery - yet effective policy responses have remained difficult to design and implement. The next paragraphs will give an overview of recent developments.

The field of policy responses to the debt bias throughout the decade has been highly active and is so still today, with a proposal for a EU Council Directive being published the very same month as this study (European Commission, 2022). In a slightly older example but still from within the time period this study looks at, the debt bias and potential solutions to it are outlined in a Swedish context in 2014 by Statens Offentliga Utredningar (SOU), which suggested limits to tax deductibility of interest payments. Some tax systems have managed to ameliorate or entirely negate the debt bias of the corporate income tax. For example, the Allowance for Corporate Equity (ACE) system gives firms a tax break based upon how much has been invested into the company by the owners. As a result, taking on new equity allows the firm to reduce its tax burden, making the tax system neutral between debt and equity financing, but at the cost of a smaller tax base (Brekke et al., 2017). The system has previously been used in Italy, Austria, and Croatia but is now discontinued. Brazil and Belgium use variants of the system.

Another approach is to reduce the interest rate tax deductibility, which in broad terms is the goal of the Comprehensive Business Income Tax (CBIT). While no fully implemented examples of this approach exist, several countries in some way, shape or form limit the degrees to which companies can deduct their interest payments from their tax bill (Brekke et al., 2017), and the general principle of reducing the maximum amount of interest deductible from a company's tax bill is the guiding principle of a similar system, such as thin-cap rules, which have the secondary effect of broadening the tax base. The drawing up of Basel III, which amongst other things limits the leverage ratios for banks, is one counteraction aimed specifically at the banking sector, and has been in the process of implementation since its beginning in 2009, in close proximity to introduction of Basel II in 2008.

International efforts have also resulted in the OECD agreement Base Erosion and Profit Shifting (BEPS), whose *Action 4* was designed in part to limit interest rate deductibility to combat its misuse in tax planning, with several countries having done so by 2019 (OECD, 2022)

2.1.3 Previous studies

There is a sizable previous literature regarding the consequences for leverage of the built-in debt bias of the corporate income tax, with much of it being written in close proximity to the Great Recession that occurred between 2007 and 2009. It tends to find effects of tax on the leverage of firms (Milonas, 2018; De Mooij, 2012; De Mooij, 2011; Feld, Heckemeyer, and Overesch, 2013; Luca and Tieman 2019; Keen and De Mooij, 2012; Keen, 2011a; b; Devereux, 2014; Coulter, Mayer, and Vickers, 2013). Much of this research is however directed at the first decade of the 2000s, and there are indications that the effect is smaller or not present in the wake of a banking crisis (Luca and Tieman, 2019).

The previous research can be divided into an earlier and a later section, with the earlier studies being made between the years 2011-2013, while the latter studies are clustered around 2018-2019. We will now give a brief overview of the studies on the topic.

In order to analyze the determinants of capital structure (the split of a firm's ownership into equity and debt), Feld, Heckemeyer, and Overesch (2013) review 48 studies over the past 25 years. Overall, the previous empirical research suggests that the corporate tax rate does have a positive impact on the debt ratio, even though the effects are strongly influenced by some factors such as estimation strategies, sample selection, tax rate proxy, and control variables. The authors conclude that the prediction ratio of tax effects on debt is approximately 0.27, given the potential bias.

In another meta-study that set out to determine heterogeneity effects, De Mooij (2011) identified the variations and sizable effects of the debt bias of taxation. The paper defines and computes the tax elasticity of debt based on 267 estimates in previous 19 studies. Drawing on extensive calculations and meta regressions, the author concludes that one percentage point increase in the tax rate could raise the debt to asset ratio by between 0.17 and 0.28 and that elasticities are larger in the recent data, indicating that the debt bias among firms has become stronger.

Keen and De Mooij (2012) investigated the possible connection between tax bias and bank leverage by using around 14,000 banks in 82 countries from 2001 to 2009. They find that higher tax leads commercial banks to be more leveraged and that different sizes of banks respond to tax incentives differently in a way that large banks (regarding assets holding) are insensitive to taxes, given that the financial model takes into consideration regulatory constraints and tax asymmetries.

In a more general study looking at tax effects for approximately 127,000 mostly unlisted firms across 13 European countries between 2004-2007, De Socio and Nigro (2012) find higher corporate tax rates to be connected to higher leverages, with OLS coefficients between 0.2 and 0.7, indicating a 10 percentage point increase in corporate tax rates translate to between a 2 and 7 percentage point increase in firm leverage.

Dwenger and Steiner (2014) study the effect of the introduction of a higher German corporate tax rate on the leverage ratios of approximately 740,000 firms (including both financial and non-financial firms) in the years 1998-2001. Using an instrumental variable approach, they spot a connection between tax rate changes and leverage ratios of 2:1 - i.e a 10 percent change in tax corresponds to a 5 percent increase in leverage ratios. An unusual finding for the banking context is that smaller firms were less impacted by the changed corporate tax rate than larger firms.

Gu, De Mooij and Poghosyan (2015) use a panel data set of 756 banks (including subsidiaries, making the total number of parent companies 92 of the 100 biggest banks in the world) over the period 1997-2012. Using an OLS estimator they find similar results as other studies looking at that time period, with an effect size of 0.3 that can fall to around 0.05 or sometimes slightly negative depending on which controls are included.

Three years later, one study by Milonas (2018), studied 10,000 US banks (whereof 7,000 bank holding companies) during the time period 1994-2011 and finds that a one percentage point increase in the CIT is associated with a 0.15 point increase in leverage. Luca and Tieman (2019), meanwhile, studies 13,990 banks in 131 countries over 17 years around the global financial crisis (which they deem to be a short time period) using a system GMM estimation method.

Together, these studies highlight the potential connection between taxation and leverage. However, previously, no study has used data for the later parts of the 2010s and some studies such as Gu, De Mooij and Poghosyan (2015) and De Socio and Nigro (2012) analyze the relationship by only using a standard OLS approach, meaning they are not robust to endogeneity. Therefore, the aim of this paper is to update previous research on the impact of the corporate income tax on leverage ratios and do so in an endogeneity-robust manner using the system GMM estimator and data including also the later parts of the 2010s.

3. Data

This section describes the data used in this paper. In order to analyze the effect of corporate income tax on leverage, panel datasets requiring tax rates and leverage ratios need to be constructed. Since higher leverage ratios in this branch of research are economically interesting due to their association with increased risks of banking crises, it is specifically to banks that this paper will restrict its analysis. This restriction is also in line with the structure in the paper by De Mooij, Keen, and Orihara (2013), which this paper aims to replicate. Like them, the banks we select for our sample are all commercial, savings or cooperative banks. What follows next is an overview of the data used.

The bank-level data corresponding to the years 2012-2021 from 102 countries are extracted from Orbis, a database which contains detailed financial information of 400 million companies all over the world. We select commercial banks, savings banks, as well as cooperative banks and drop inactive banks. The raw Orbis data used includes profits before tax, total liabilities and equity, total equity, and total assets. To generate the leverage ratio and return of assets (ROA) for each bank, leverage is calculated as liabilities and equity minus equity (i.e. just liabilities) divided by total assets. ROA is computed as the ratio of profit to total assets. The corporate tax rates are from KPMG's online historical table, which provides a view of corporate tax rates around the world. While Keen, De Mooij and Orihara (2013) use a time period of 2000-2009, this study instead uses the ten years 2012-2021, which is the longest period available through Orbis to the authors of this paper. Banking sector data is also used (in order to run country-level regressions), and while Keen, De Mooij and Orihara (2013) used the OECD Banking Statistics, that database has since been discontinued. In response to that challenge this paper aggregates bank-level Orbis data (more on which later).

Other macroeconomic data series used include inflation, GDP growth as well as savings rate, and are collected from the World Economic Outlook Database from the IMF. In all, the dataset encompasses 52,055 effective observations (5,829 banks over a maximum of ten years), each observation with values for the bank-level data, tax rates, and other macro variables (there are 63 more observations but these do not have available values for corporate tax rates and are therefore left out in the regressions). Brief descriptive statistics from Orbis are found below in Table 1.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Leverage	52,118	.877	.093	0	1.35
ROA	52,118	.014	.061	-.78	5.494
Logasset	52,118	12.855	2.041	5.298	22.353
$Logasset^2$	52,118	169.411	58.693	28.072	499.657
Tax rate	52,055	.338	.07	0	.55
Inflation	52,114	.02	.03	-.037	5.572
GDP growth	52,114	.021	.024	-.25	.252
Savings rate	52,114	.203	.046	-.153	.603

Given the large sample of banks included, it is important to be wary of potential heterogeneity impacting the results. For example, Keen and De Mooij (2012) conclude that the size of a bank matters for the way it reacts to tax incentives in financing decisions, with big banks usually displaying high leverage ratios regardless of tax rate, as opposed to smaller banks which were more responsive to CIT rates.

In light of that piece of research which finds that banks differ in their response to tax rates depending on how large the banks are, this study will segregate the micro-level bank data from Orbis into five groups, categorizing the banks according to their relative asset size. In line with Keen, De Mooij and Orihara (2013), the banks are split into the size categories in Table 2. Table 2 below shows how much total bank assets are found in each group. For example, the first group (the 85 percent of smallest banks) control a paltry 1.62 percent of total bank assets. By contrast, group 5 (the 2.5 percent largest banks) control 85.08 percent of total bank assets.

Table 2. Bank groups

Group	1	2	3	4	5
Percentile (size)	0-85	85-90	90-95	95-97.5	97.5-100
Asset share	1.62%	1.07%	4.35%	7.84%	85.08%

Note: 'Percentile' refers to a bank's position in the asset size distribution of banks, e.g. whether it is the 5th percentile (larger than 5 percent of banks). 'Asset share' is how much of the total assets the group of banks control (e.g. a value of 1.62 means that group 1 controls 1.62 percent of all bank assets, calculated by summing-up each group's assets divided by total the assets of all banks.

As for the remaining three groups, the shares of total assets controlled are relatively modest, with only group 4 controlling more than its size would suggest (7.84 percent of assets controlled by a group making up 2.5 percent of the banks). As for groups two and three, the share of total assets controlled is modest. To sum up the heterogeneity of banks in regards to their size, there are large differences in how much capital is controlled by each bank, with a tremendous amount of assets accumulated in the upper strata of banks, and an almost negligible amount in the smallest 90 percent of banks.

Figures 1 and 2 below show a plot of country-level data that illustrates the overall trends and levels of CIT rates and leverage ratios across the studied countries between 2012 and 2021. The figures are not meant to give precise information on any one country, but should instead be seen as a low-resolution overview of trends and levels across the globe. The reader wanting more detailed information is referred to the Appendix. Nonetheless, some features can be seen. First, generally speaking, almost every country has a corporate income tax rate of around 10-40 percent, with most countries falling into the slightly more narrow bandwidth of 17-37 percent.

Second, from Figure 2, one can see that all three types of banks (commercial banks, savings banks, and cooperative banks) are highly-leveraged even though the leverage ratios of these banks have fluctuated over the last nine years. More specifically, banks usually have a leverage level from roughly 85% to nearly 97%. The details of CIT rates and leverage ratios for each country are in Appendix Table A1 and Table A2.

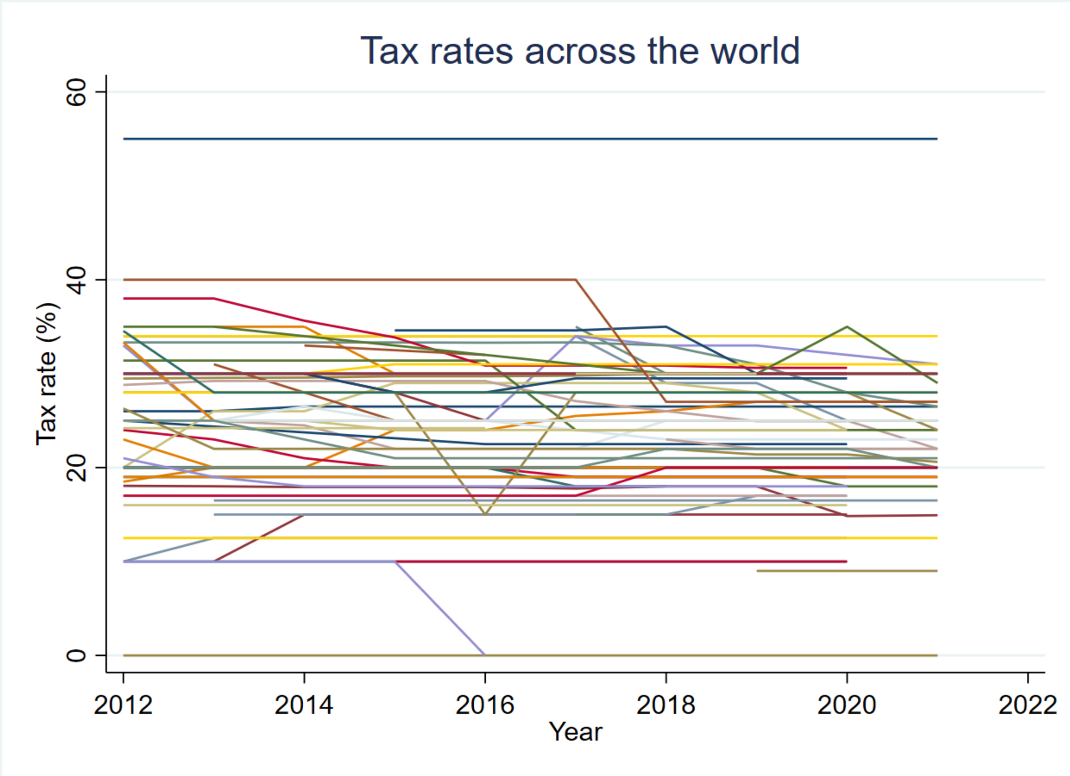

Figure 1 (KPMG, 2022)

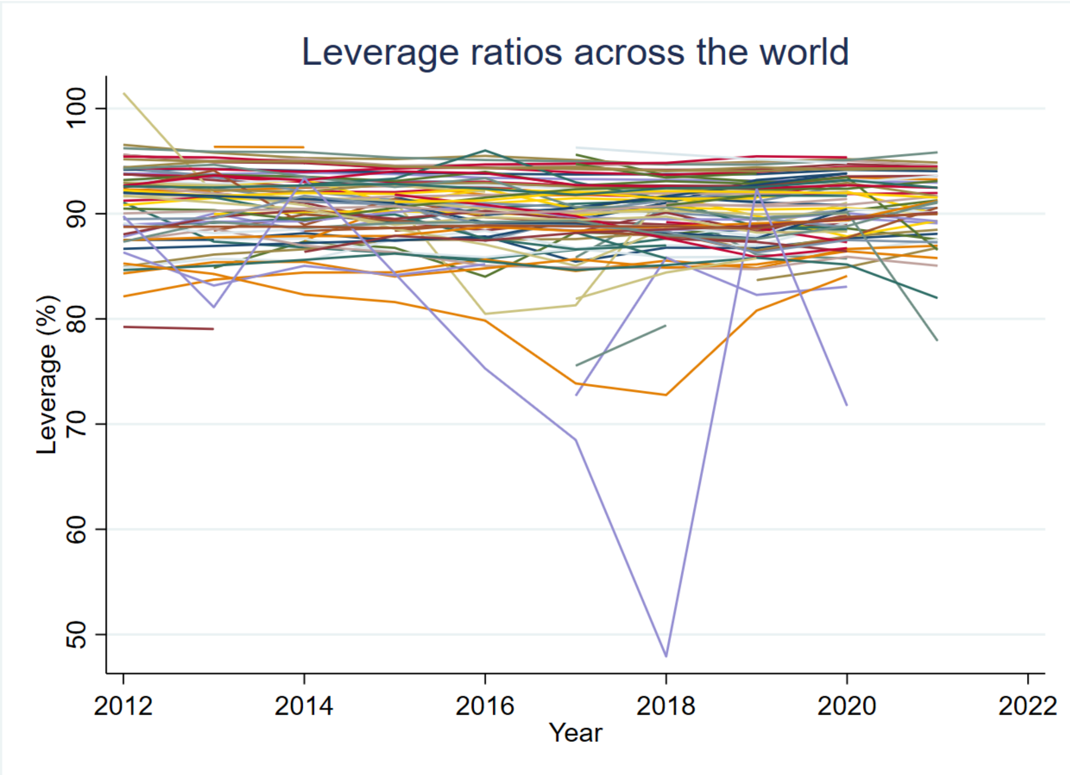

Figure 2 (Orbis, 2022)

4. Methodology

4.1 Background and method motivation

This paper, inspired by the study done by De Mooij, Keen and Orihara (2013), will start off by using the same regression style as their paper '*Taxation, Bank Leverage and Financial Crises*', using a GMM approach designed by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). The choice of the system GMM estimator is motivated below, with the details of GMM theory consigned to Appendix A3.

The choice of system GMM is based on two major parts. Most importantly is that it is able to deal with endogenous variables, whereas a standard OLS approach breaks down in the presence of endogeneity, which is a common econometric threat. Moreover, a system GMM approach is well suited to a dataset that is broad in terms of observations (n) but short in terms of time (t) (Roodman, 2009). With approximately 48,000 observations over 10 years, an estimator specialized for a large n and small t seems appropriate.

Additionally, there are more of the central characteristics of the system GMM that are at play in this study. One is that the dependent variable has been confirmed by previous studies to be autoregressive (dynamic). Next, the functional workings of the regression are linear in nature. Fixed effects between banks are implemented and both heteroscedasticity and autocorrelation of the dependent variable (leverage) are present within banks. These are the six typical conditions for implementing a system GMM approach (Roodman, 2009), and previous studies make extensive use of the method for precisely that reason.

There are exceptions to the rule of GMM being the prevailing estimation method, but these are few. For example, while there are a few previous studies using OLS regressions with various add-on control methods (Gu, De Mooij and Poghosyan, 2015), in light of the endogeneity issues this paper will stick to the methods of Keen, Orihara and De Mooij (2013) and use system GMM to estimate the impact of tax on leverage ratios (which is the predominant approach in the literature).

Using the system GMM estimator this paper will investigate the impact of corporate income tax rates on bank leverage ratios in our Orbis dataset between the years 2012-2021, following the guidelines laid out by Roodman (2009). The regression (1) is constructed as follows:

$$Y_{it}= \beta_0 +\beta_1 Y_{it-1}+ \beta_2 Tax_{it} + \beta_3{'}X_{it}+u_t+\alpha_i+\varepsilon_{it} \qquad (1)$$

What follows are notes for interpreting the equation, where i indexes an individual bank, t indexes time (measured in years). Y_{it} denotes the leverage ratio of bank i in year t and the one-period lagged dependent variable is identified by Y_{it-1}. β_0 represents the constant term and ε is the error term. Tax_{it} states CIT rate and β_2 corresponds to the effect of the tax rate on leverage. u_t and α_i are year fixed effects and bank fixed effects, respectively. X stands for a vector of controls which includes the natural logarithm of assets and the square of that value, ROA, GDP growth rate, inflation rate, and savings rate.

These control variables, while not of primary interest, might be suspected of influencing a bank's leverage ratio. For example, asset size could be connected to a bank's ability to take on more debt through at least two ways. First, lenders may feel that a large bank is a safer debtor than a small bank, and could therefore be more willing to extend lines of credit to larger banks. On a related note, the largest banks could be systemically important ones and viewed as too-big-to-fail, and are able to count on government bailouts if they would ever face the risk of bankruptcy. Both these examples would allow larger banks to have higher leverage ratios than smaller banks. Including asset size (in log form for the sake of simplicity) controls for any such effects. Including the square of the log value allows for the determination of whether these hypothesized effects display increasing or decreasing effects as a bank gets larger.

Return on assets (defined as revenues as a share of assets) is included as a measure to capture that lines of credit may be more accessible to banks that are highly profitable and thus seen as a safer investment. Included the return on assets thus allows us to parse apart the hypothetical effect of profitability on leverage ratios. GDP growth rates serve as a possible sentiment measure for the overall state of the economy; during boom years economic agents can be overoptimistic and more willing to lend money, allowing for higher leverage ratios, whereas bust years could see creditors being more restrictive with their much-valued liquidity. As a control variable, it allows for parsing out this potential effect on leverage ratios.

Savings are included to capture broad measures of investments available in the economy, in line with the textbook case of savings equals investments. More savings would allow more investments, allowing for higher leverage ratios. Including them makes sure that there is no mechanism like this that casts doubt on the results. Inflation is part of the equation to avoid a scenario in which banks decide to take in either new equity or new debt (i.e. increase or decrease their leverage ratios) depending on whether inflation is high or low. Finally, all the chosen variables are also included in the IMF paper by Keen, De Mooij and Orihara (2013), and wishing to see whether their results still hold, this paper follows their regression specifications and control variable choices.

As mentioned in section one, this paper will also be running a fixed-effects OLS, which is utilized by several researchers looking at the impact of corporate tax rates on leverage ratios such as Gu, De Mooij and Poghosyan (2015) and De Socio and Nigro (2012). However, the OLS estimator is (as mentioned earlier) susceptible to endogeneity. Despite this, including it as an alternative specification carries two benefits:

1) It enables the comparison with earlier results using OLS models.
2) It enables the comparison of results between OLS and GMM results, giving an indication of the magnitude of effect endogeneity might be having on the results - and by extension, potentially showing the degree of accuracy of previous studies that used only OLS.

Additionally, despite the vulnerability to endogeneity, the fixed effects model does integrate time-invariant differences between individuals (banks) well, which is a benefit of the approach. When applying the fixed effects model, the following specification will be used:

$$Y_{it} = \gamma_0 + \gamma_1 Tax_{it} + \gamma_2' X_{it} + \alpha_i + \varepsilon_{it} \qquad (2)$$

As before, the vector of control variables (X_{it}) includes the log of assets and its square, ROA, GDP growth rate, savings rate and inflation as controls.

4.2 Assumptions of endogeneity and exogeneity

In order to implement the system GMM regression, the variables need to be categorized as either endogenous or exogenous. As a consequence of there being no proper test for the endogeneity of a variable, the common causes of endogeneity are consulted to see whether some may be more or less likely in this scenario:

1) Measurement error
2) Simultaneity
3) Omitted variable bias

While consulting the list is helpful, it is not exhaustive, and the final choice of how to categorize the variables will boil down to the expected good sense of the authors and their economic intuition. Alas, for such a subjective assessment, the outcome will invariably (and regrettably) be somewhat arbitrary in nature. To mitigate this, the robustness checks will include running the regression with variations in endogeneity assumptions. While perhaps sounding far-fetched, it's not impossible for limiting the tax bias to be an argument for reducing corporate tax rates, meaning we will also be testing tax rate as an endogenous variable in the robustness checks. For starters, the variables assumed to be exogenous are the tax rate, asset size of banks and their return on assets. In other words, the macro-level variables (GDP growth rate, savings and inflation) are assumed to be endogenous.

5. Results

5.1 Overview

Figure 3 and Figure 4 present a graphical overview of the relationship between tax rate and leverage ratio for both the country-level data and bank-level, respectively. In Figure 3 (showing the country-level view), one can observe overall high leverage ratios, situated at around 90 percent, regardless of CIT rates. In Figure 4, the leverage ratios concern individual banks, and a short explanation will be given concerning the overall shape of the graph, specifically the two columns around 30 and 40 percent CIT. With a few countries (the US in particular) having many more banks than other countries, the consequence is that column-like figures can emerge in the graph, due to many banks with many different leverage ratios being present, while they are active in a country with the same corporate income tax.

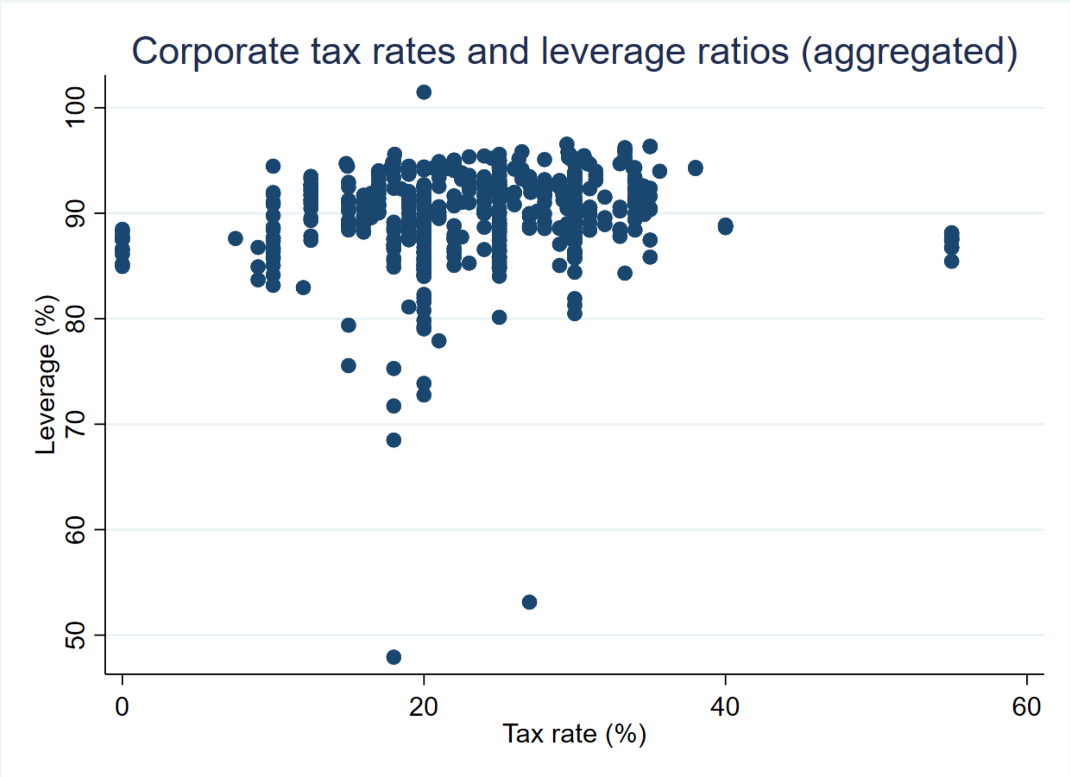

Figure 3 (Orbis, 2022)

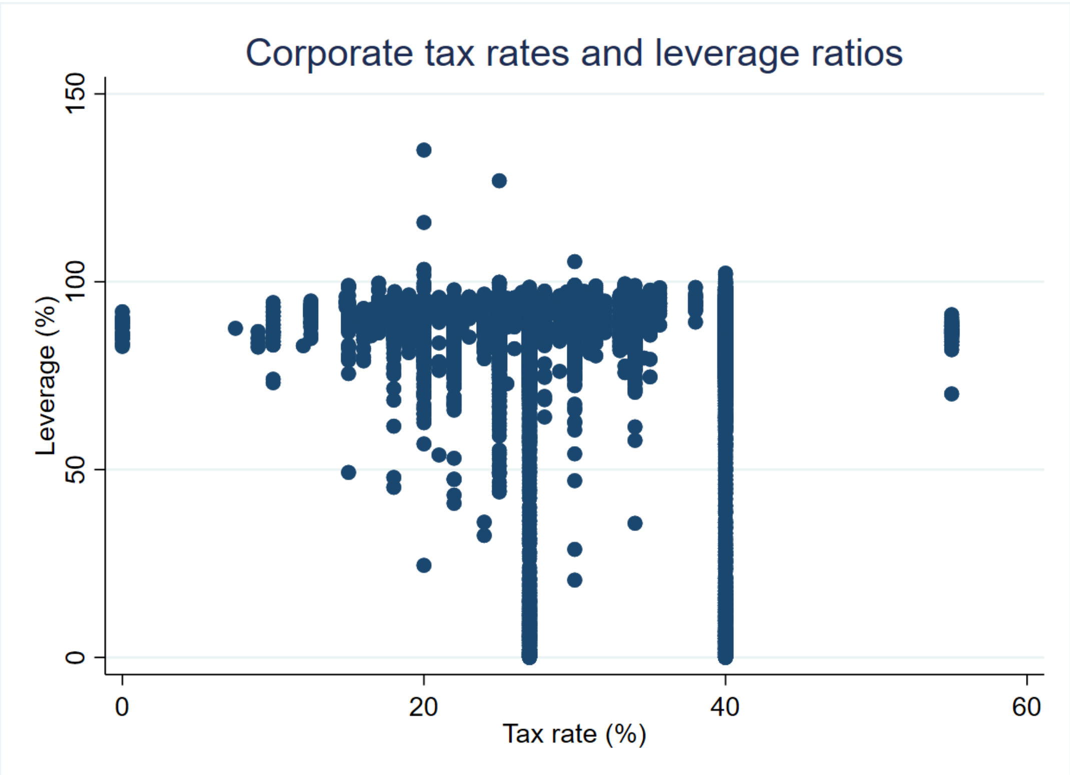

Figure 4 (Orbis, 2022)

In line with replicating the analysis in Keen, De Mooij and Orihara (2013), this paper follows their setup, which is as follows: First, the full sample is used as the base for the system GMM regression (first with and then without US banks), followed by a series of variations on the fixed effects model to derive the within-estimator. The restriction to non-US countries follows the setup of their 2013 paper. Data for the US banks make up the vast majority of the Orbis bank data, and studying how it impacts the regression result is highly interesting, not the least to avoid drawing non-representative conclusions. The variables are measured in percent, meaning that the coefficients should be interpreted as the impact of a one-hundred percent increase, in order to show the numbers more clearly.

In part one, aggregated data is used to perform a country-level analysis. Part two deals with bank-level analysis and has two subparts, one in which the full sample is used, and a second part where the banks are split up into five groups along the lines set out in Keen, De Mooij and Orihara (2013).

Throughout parts one and two, the system GMM regression will be run (first with and then without US banks), followed by a series of variations on the fixed effects model to derive the within-estimator. The restriction to non-US countries follows the setup of their 2013 paper. Data for the US banks make up the vast majority of the Orbis bank data, and studying how it impacts the regression result is highly interesting, not the least to avoid drawing non-representative conclusions.

5.2 Country-level (aggregated) data

This section deals with a macro-level approach to the question of the CIT on leverage ratios. This is done to give an insight into how the overall leverage in a country's banking sector reacts to varying tax levels, and by applying weights to the observations according to bank size (as a measure of importance for each country) gives a result that doesn't undervalue the influence of larger banks. This will be done by aggregating all observations by country and year. For example, all bank-level leverage observations for Denmark in 2015 will thus be merged into a single leverage ratio. However, as was demonstrated in the previous section, there are large differences between the different bank groups in terms of their responsiveness to CIT rates, coupled with major disparities in the size of each group's share of total assets.

The consequence of this is that taking an unweighted average would overstate the importance of the smaller banks' leverage ratios (since there are many more small banks than there are large). Conversely, the observations of the larger banks (which have most of the assets) would be undervalued and the resultant coefficients would be fundamentally misleading.

In order to prevent this, the bank-level observations are weighted in accordance with the respective bank's share of total assets within its country for that year. For example, if the Swedish bank Nordea made up 20 percent of the total assets of all Swedish banks in 2017, its values would be multiplied by 0.2. Having looked at the bank-level interactions between tax and leverage ratios, we next turn to make a country-level analysis of the relationship. In order to achieve that, this paper aggregates the individual bank observations, and weights them by the respective bank's share of assets within its country and that year. The importance of weighting is born out by the discussion in the previous sections. This then allows us to run the same regressions once more, but where the level of analysis is that of a country's overall leverage ratio, instead of that of an individual bank's.

Table 3 below shows the macro-level regressions regarding the tax effects on leverage where columns 1 and 2 are estimated by GMM and result from the fixed effects model are listed in columns 3 and 4. Here, the observations from each country's banks have been aggregated into a single value, taking account of the relative importance of each bank by weighting the observations by each bank's share of the total assets in its respective country and year. What immediately stands out in the table is that the coefficients of the tax rate in all four columns are insignificant. In contrast, leverage does seem to be affected by returns on assets (ROA), with no large variations in the coefficients, instead of laying stable around -1, meaning that if the average ROA in a country is one percent, leverage ratios would be roughly one percentage point lower, *ceteris paribus*.

Table 3. Tax effect on leverage: macro data

VARIABLES	(1) Leverage	(2) Leverage	(3) Leverage	(4) Leverage
Leverage (lag)	0.571**	0.576***		
	(0.222)	(0.220)		
Tax rate	0.030	0.028	-0.051	-0.056
	(0.046)	(0.049)	(0.063)	(0.081)
ROA	-1.159***	-1.157***	-0.979***	-0.979***
	(0.184)	(0.184)	(0.208)	(0.208)
Inflation	0.026	0.026	-0.017	-0.017
	(0.064)	(0.065)	(0.024)	(0.025)
GDP growth	0.086	0.085	0.009	0.009
	(0.094)	(0.095)	(0.026)	(0.026)
Savings rate	0.183	0.190	-0.083**	-0.083**
	(0.134)	(0.136)	(0.038)	(0.038)
Constant	0.352*	0.346*	0.945***	0.946***
	(0.198)	(0.195)	(0.016)	(0.020)
Observations	534	525	637	627
Arellano-Bond AR1	0.255	0.255		
Arellano-Bond AR2	0.378	0.379		
Hansen P-value	0.476	0.480		
US included?	Yes	No	Yes	No
R-squared			0.205	0.205
Number of country	80	79	90	89

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results in the GMM specifications show significant autoregressive tendencies in the leverage ratios, but what is the most interesting is that the return on assets has taken on significance, and does so across all variations of the regressions - both in the GMM and the fixed effects models, regardless of whether the US banks are excluded. With the exception of a negative effect of savings on leverage ratios still being present in the fixed effects model, all other variables are insignificant. It is interesting to wonder whether return on assets, which in lieu of asset size has become the potentially most important variable in the country-level case, is integrally related to the asset size of the banks. If so, we might simply be seeing a repeating of the results from the earlier, bank-level regression, but falling along profitability lines instead.

5.3 Bank-level regressions

5.3.1 Complete bank-level data

This section runs its regressions on the bank-level dataset. When running the main regression specification of this paper - the system GMM on the full data set (column 1 and column 2), there are a number of things that stand out in Table 4. In terms of column 1, no significant result is found regarding the impact of the CIT rate on the leverage ratio. The Hansen test is favorable, at 0.103, indicating the GMM instruments are valid. Additionally, there is a strong autoregressive component in the leverage ratios for one period, which is also borne out by the Arellano-Bond tests in the regressions, but not for the second, indicating that the choice to explicitly include one lag but not two was well-founded.

There are only three variables of strong significance: the lagged dependent variable, and the asset values. The log of the asset value, in particular, has a large effect on a bank's leverage ratio, with the interpretation of a doubling of bank size increasing the leverage ratio by 4.8 percentage points. This direction fits expectations well, with larger banks hypothesized to be seen as safer lenders, maybe even systemically important and (either implicitly or explicitly) deemed too-big-to-fail. Since the size of banks spans a large range of asset values, with multiple increases in size, asset size has a large potential for explaining the variation in leverage ratios. Not entirely surprising is the negative coefficient for the square of logged asset values, indicating that while there is a connection between bank size and its leverage, the relationship is diminishing as the size of the bank increases.

As for column 2, following the example of Keen, De Mooij and Orihara (2013) and splitting off the American banks, we find that any effects of CIT tax on leverage ratios are not found to be present and that the Hansen test score is not promising possibly because most banks are from the US. What's more, several significances drop away, most prominently the lagged dependent variable and a halving of the impact of asset size on leverage ratios. ROA is now found to have a significant inverse relationship to leverage, showing a 10 percent increase in returns on assets being associated with 8 percentage points lower leverage. What is interesting about this is that it runs counter to the argument outlined for the direction of profitability might have on leverage ratios. At least, in this case, it seems that more profitable firms might simply be less reliant on external sources of financing.

Table 4. Tax effects on leverage: micro data

VARIABLES	(1) leverage	(2) leverage	(3) leverage	(4) leverage
L.leverage	0.435***	0.299		
	(0.146)	(0.232)		
Tax rate	-0.002	0.023	0.098***	-0.062*
	(0.012)	(0.015)	(0.009)	(0.034)
Log of asset	0.048***	0.024***	0.083***	0.104***
	(0.012)	(0.007)	(0.016)	(0.017)
Square log of asset	-0.001***	-0.001***	-0.002***	-0.003***
	(0.000)	(0.000)	(0.001)	(0.000)
ROA	-0.247	-0.823***	-0.101*	-0.681***
	(0.200)	(0.130)	(0.055)	(0.069)
Inflation	-0.030	0.014	0.058***	0.063***
	(0.055)	(0.064)	(0.016)	(0.022)
GDP growth	-0.014	0.052	0.010*	0.073***
	(0.062)	(0.069)	(0.005)	(0.015)
Saving rate	0.043	-0.013	-0.082***	0.006
	(0.037)	(0.048)	(0.026)	(0.020)
Constant	0.127*	0.384***	0.138	-0.028
	(0.072)	(0.144)	(0.115)	(0.142)
Observations	45,820	4,186	52,055	5,730
Arellano-Bond AR1	0.004	0.092		
Arellano-Bond AR2	0.209	0.148		
Hansen P-value	0.103	0.000		
US included?	Yes	No	Yes	No
Year	12-21	12-21	12-21	12-21
R-squared			0.117	0.302
Number of Bank	5,585	922	5,829	1,139

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As for the results from the fixed effects model (shown in columns 3 and 4) the tax rate is found to have a significant impact on the leverage. If tax rate increases by one unit (a 100 percentage point increase), a strong positive correlation is found at just below 0.1, indicating an increase in leverage ratios of 10 percentage points when all banks are included in the sample, whereas leverage ratio can decrease by -0.062 (a six percentage point decrease) when it comes to only non-US banks. Similarly, the coefficients for the log of assets show the same direction as in the GMM specification, indicating that the more assets one bank possesses, the higher leverage it has, which is in line with the hypothesized direction. The effect size is larger than in the GMM case - almost twice as large in the full sample and more than four times for the non-US sample. Interestingly, macro variables including inflation, GDP growth, and saving rate now represent significant results. In all, inflation and GDP both positively influence the leverage ratio with the direction of GDP being entirely in line with expectations, while inflation's role in leverage ratios was more opaque in the theoretical stage. The results hold regardless of whether US banks are included or not, while the impact of savings seems dependent on the exclusion of American banks, which results in a negative coefficient in column 3, indicating that higher savings rates would be associated with lower leverage ratios.

5.3.2 Segmented bank data

With the previous section having performed the regressions on the full sample of banks, we now turn to the next step of the paper by Keen, De Mooij and Orihara (2013), namely investigating heteroscedasticity between banks. This is done to take account of the fact that there is a tremendous difference between banks in terms of size, with the top 2.5 percent of banks controlling around 85 percent of all bank assets. If one were to only look at the full-sample regressions, one would be valuing each observation equally - as opposed to taking a particular interest of a subcategory of banks (say the few percent of banks which stand for the vast majority of assets). If there are differences between banks in how they react to CIT rates (as Keen, De Mooij and Orihara found in 2013), the regression will be unable to pick these effects up. Therefore, in line with Keen, De Mooij and Orihara's 2013 paper, the banks are divided into five groups, namely the smallest 85 percent of banks (in terms of asset size), the 85th-90th percentile banks (the next five percent banks in the size distribution), the 90-95th percentiles, the 95th-97.5 percentiles, and finally the top 2.5 percentiles. For each subsection of banks, both the system GMM and the fixed effects model are applied.

The respective tax coefficients from the two regressions are presented for each bank group in Table 5 below. In contrast to Keen, De Mooij and Orihara (2013), when using the system GMM approach no differences between how the groups react to CIT rates are found, and additionally the coefficients are insignificant. Using the fixed effects, meanwhile, results in positive and significant relationships between tax rates and leverage ratios for the three smallest bank groups. The second largest group sees insignificant effects and the largest banks even display a significant negative relationship. The significant effects range between impacts of -0.5 to 0.9 percentage points of the leverage ratio per 10 percentage points change in CIT rates.

Table 5. Tax effects on leverage by bank groups

	(1)	(2)	(3)	(4)	(5)
Percentile (in asset)	0-85	85-90	90-95	95-97.5	Top 2.5 pct
Dynamic GMM estimator					
Marginal impact coefficient	-0.049	0.020	0.002	0.001	-0.017
	(0.044)	(0.041)	(0.024)	(0.015)	(0.020)
Between estimator					
Marginal impact coefficient	0.091***	0.057***	0.036***	-0.004	-0.048**
	(0.005)	(0.014)	(0.014)	(0.030)	(0.021)

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

What now follows is a slightly deeper delve into each of the bank groups' regression results.

For the smallest 85 percent of banks (by assets), the results were very much in line with the overall regression outputs. This includes a significant and positive tax effect on leverage when using a fixed effects model, with a size slightly below 0.1, which is not robust to changing the regression specification to a system GMM approach. The positive and significant relationship found in the fixed effects approach is very much in line with previous research, especially so since Keen, De Mooij and Orihara (2013) found that tax effects on the leverage ratios were the strongest for small banks, and not present at all for the largest groups. However, when using the more endogeneity-proof method of GMM, the significance falls away entirely.

For the next group of banks, in percentiles 85-90 of asset size, the results from the smallest banks repeat themselves. Significant and positive effects on leverage by the corporate income tax are observed as long as one sticks to the fixed effects approach, but the coefficient is smaller than for the smallest banks (approximately half as large), entirely in line with expectations. This indicates that this subsection of banks is qualitatively similar to the smallest banks, but that tax effects differ only in size but not direction. However, when wishing to implement a method more robust to endogeneity, the results become not significant.

In percentiles 90-95, the relationship between the results and bank size continues, with lower coefficients than in the former group, significance in the fixed effects model and lack of effects when using the system GMM. All three of these bank categories thus react similarly, with differences only in degree. That 95 percent of the banks are so similar is remarkable, and as the next results will show, the largest banks are qualitatively different from the others.

In this next group of two and a half percentiles between 95 and 97.5, results for tax effects continue along the trend set out by the first three groups, with smaller effect sizes but now go so far as to lose significance even in the fixed effects approach. That one needs to go so far up the asset size distribution before seeing a different impact underlines how different these top-performing banks are from their much smaller counterparts.

Finally, in the very largest 2.5 percent of banks, not only has the coefficient lost its significance (like had happened in the former group) but it is also negative, completely contrary to the hypothesized direction. That the results can be entirely contrary to expectation (at least according to theory, while not necessarily previous results) underlines how vital it is to split the banks apart to account for heterogeneity between them. If one wishes to estimate the impacts of the tax on overall leverage in the banking sector but fails to take into account that the largest 2.5 percent of the banks not only react differently, but that they make up over 85 percent of the entire industry (in terms of asset size) one will see results severely out of line with expectations if the expectations were based on studies not parsing apart the differential impacts between banks by asset size.

5.4 Limitations

In order to better help the reader understand what this paper finds and does not find, a brief discussion on the two limitations of this study will be given. First, there are large differences in results depending on whether the system GMM estimator or the fixed effects estimator is used. It seems that there is no significant impact of CIT on leverage from GMM results, whereas fixed effects results suggest pronounced differences. The second caveat is that the GMM results are heavily dependent on a long series of specification choices such as which variables are used as instruments (or conversely, which variables are assumed to be exogenous). Regardless of choices in this field, however, taxation never attains significance in the GMM regressions.

A third limitation, which proved difficult to work around, is the availability of data through Orbis, which was able to provide a ten-year period of data into the past, but not more. With older Orbis data covering the first years of the decades, the two years (2010-2011) between the end of the study by Keen, De Mooij and Orihara (2013), and the current start of this study would be fully accounted for, which would allow for an even broader econometric foundation of more observations.

6. Discussion

With section five having described the results in detail, this section turns to interpret them. Starting with the most prominent feature of the results is the discrepancy between the two major regression specifications: the system GMM and the fixed effects model. Like the paper by Keen, De Mooij and Orihara (2013) this study aims to replicate, the statistically significant relationships between tax rates and the leverage ratios of banks are found within the OLS fixed-effects framework, at first glance suggesting that their findings carry over and apply also in the second decade of the 21st century, with corporate income tax rates associated with higher leverage ratios.

Where this study diverges from theirs, however, is in the results pertaining to the GMM regressions. In these, there is no observed significance for the tax rate coefficients for any GMM approach, regardless of breakdown by bank size or exclusions of the US data. This lack of connection is highly interesting and runs against not only the results of Keen, De Mooij and Orihara (2013) but also many of the previous findings (such as Milonas, 2018; Feld, Heckemeyer, and Overesch, 2013; Luca and Tieman 2019; Devereux, 2014 and Coulter, Mayer, and Vickers, 2013), and has two major implications.

The first implication of these divergent results is that there are large differences in outcome between the OLS approach and the GMM approach. The GMM was chosen to better be able to function in a context of endogeneity and to see the method result in widely different results than the OLS might suggest that the fixed effects model (i.e. the OLS) is struggling in the assumed endogenous environment. That significant results can be attained in the model, despite the absence of evidence in the GMM indicates that there is a risk of studies that rely predominantly on an OLS approach, such as Gu, De Mooij and Poghosyan (2015) and De Socio and Nigro (2012), are misrepresentative of the actual relationship between tax rates and leverage ratios and should be taken with a grain of salt.

The second implication of the divergent result concerns the consequences this study has for those earlier findings demonstrating a link between tax rates and leverage in a GMM-style framework. Despite those earlier findings of a positive relationship (summarized in the meta-study by Feld, Heckemeyer, and Overesch in 2013), the relationship seems to have disappeared, and while the findings go against most earlier studies, a study by Luca and Tieman (2019) found the tax effect on leverage to be lower in the immediate aftermath of the Great Financial Crisis as banks focused on fortifying their balance sheets in the wake of the period of financial instability. While the desire to volatility-proof their balance sheets could certainly be a powerful short-term motivator for banks to change their leverage ratios, the authors of this paper are not entirely convinced this theory holds water in terms of explaining the findings of this study. With a whole decade's worth of observations, and up to 13 years after the start of the crisis, a short-term explanation is in the personal opinions of the authors not sufficient to upend the large amount of previous research, which looked at time periods that were no strangers to economic downturns.

Instead, we hypothesize that the results could be due to the impact of a large series of banking regulations that have been drawn up and entered into force, such as the Basel I-III regulations, which explicitly target areas such as asset reserves and liquidity for banks. Similarly, reductions in interest rate deductibility through thin-cap rules and the continued large degree of work by governments to implement solutions to the deductibility-induced debt bias of the CIT. If one is looking for indicators that countries may be coming to grips with the debt bias problem, this study presents tentative and cautiously hopeful results of the approach of more financing-neutral tax systems as concerns the banking sector.

Another exciting finding in this study concerns the impact of the size of the banks on their leverage ratios, with larger banks displaying significantly higher leverage ratios than small banks. These findings are incredibly robust to any and all changes in regression specifications this paper was able to throw at the results, including changes in standard robustness options for the regressions, different choices of estimators (GMM vs. OLS), differing assumptions of exogeneity or collapsed instruments. Regardless of the choices here the results were unanimously significant and the coefficient positive.

What are the implications of these findings on the positive influence of bank size on leverage? Firstly, it can be noted that it supports previous results showing the same relationship of larger banks having higher leverage ratios. This could be seen as support for the non-perfect levels of substitution the firms face when choosing between equity and debt financing. The point mentioned regarding lines of credit not being available to all firms equally would be a starting point, with larger banks having the advantage over smaller banks. The cause of this could lie in the benefit of name recognition and the subsequently higher confidence in the bank by investors. Another reason could be larger banks have the potential for more high-quality or specialized legal teams that are available to negotiate debt funding for the bank’s projects, whereas smaller banks may not have the resources for such groups. Regardless of the reason, however, the point that the larger banks have higher leverage ratios and that this seems to impact their ability to take on more debt still stands.

What are the economic consequences of this disparity in abilities of banks of different sizes to take on higher levels of debt? In line with the reasoning laid out in the early stages of this paper, higher leverage ratios would be a benefit to the banks able to access them (as debt is cheaper to finance than equity). This means that larger banks effectively gain a competitive advantage over their smaller counterparts; large banks have access to more of the cheaper debt financing opportunities than the small banks do. Essentially, the financing options become part of the economies of scale, which is the bane of any small enterprise forced to maintain either higher prices or get by on lower profits in comparison to the larger companies.

A possible follow-on interpretation of these economies of scale in financing alternatives is that it increases the difficulty for small banks to effectively challenge larger ones (since the smaller banks have at least one advantage less as regards the possibility to choose financing freely). The result of this, in turn, would be an ossifying force in the industry, reducing the capability of startups to take on the market dominance of the big banks.

However, what the results also support is that debt financing is not an endlessly attractive decision for the banks. For even as the banks grow in asset size and gain access to more debt financing (in line with the positive log asset coefficient), the square of the log of assets is negative. The implication of this is that the relationship between asset size and leverage is positive, but it shrinks as assets grow. The economic interpretation that could be made from this piece of evidence is that banks may in fact deem there to be unfavorable risks associated with the highest levels of leverage, and therefore refrain from utilizing their positions as potential borrowers to their fullest. By extension, it might be suspected that banks therefore are targeting a certain leverage ratio, where they deem the tradeoff between cheap financing and default risk can no longer be improved.

7. Conclusion

The aim of this study has been to investigate whether previous research on the influence of corporate income tax rates on the leverage ratios of banks still hold in the post-financial crisis years of the 2010s. In order to achieve this goal, this paper has endeavored to replicate the paper by Keen, De Mooij and Orihara (2013), using Orbis data on 5,829 banks, in 102 countries, over a ten-year period. Two separate regression specifications were used, with the primary one being a system GMM in line with the majority of the studied literature, and the secondary specification being a fixed effects OLS. The inclusion of the OLS allows this study to both compare its result with some earlier research which ran exclusively on an OLS approach, but also investigate whether there are differences in outcomes between the two approaches.

In contrast to both the Keen, De Mooij and Orihara (2013) paper this study has replicated, as well as much of the previous research, this study finds little evidence for the influence of tax rates on bank leverage as long as the GMM approach was used. Running counter to this were the OLS results, which did see tax rates influencing leverage ratios upwards, especially so when the banks were categorized according to size, with the smaller banks seeing larger and positive effects, while the large banks were unaffected.

What was found was the strong influence of bank size as defined by total assets (in log form) which demonstrated positive but decreasing effects on leverage throughout all regression specifications and every robustness check. The results of this study concerning the (lack of) impacts of CIT rates on leverage ratios, running counter to previous research, are hypothesized by the authors to potentially be a result of successful regulatory initiatives of the banking sector (such as the Basel II- III) and possibly more financing-neutral tax systems, but allowing for some degree of bank desire to stabilize their balance sheets in the wake of the crisis to have been a contributing factor, at least in the early part of the dataset.

To conclude, this study finds no convincing support for the view that corporate income tax rates meaningfully impact leverage ratios in the second decade of the 21st century, and that the support that is available in this study for the connection relies on endogeneity-vulnerable OLS approaches. It remains to be seen whether these findings will be the case also in the future and the debt bias of the corporate income tax is being addressed successfully, or if the findings are a temporary exception to the historical rule.

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Appendix

Table A1. Corporate tax rates across the world

Country(ISO code)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
AE	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%	55.00%
AL		10.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	
AM		20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	18.00%	18.00%
AO			35.00%	30.00%						
AR						35.00%	30.00%	30.00%	30.00%	
AT	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	
AU	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
AZ								20.00%	20.00%	
BD			27.50%							
BE	33.99%	33.99%	33.99%	33.99%	33.99%	33.99%	29.00%	29.00%	25.00%	
BG	10.00%	10.00%			10.00%	10.00%	10.00%	10.00%	10.00%	
BH	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
BO	25.00%				25.00%					
BR	34.00%	34.00%	34.00%	34.00%	34.00%	34.00%	34.00%	34.00%	34.00%	34.00%
BY	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	18.00%	
CA	26.00%	26.00%	26.50%	26.50%	26.50%	26.50%	26.50%	26.50%	26.50%	26.50%
CH	18.06%	18.01%	17.92%	17.92%	17.92%	17.77%	18.00%	18.00%	14.84%	14.93%
CI										
CL	18.50%	20.00%	20.00%	24.00%	24.00%	25.50%	26.00%	27.00%	27.00%	27.00%
CM				33.00%						
CN	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
CO	33.00%	25.00%	25.00%	25.00%	25.00%	34.00%	33.00%	33.00%	32.00%	31.00%
CR			30.00%	30.00%	30.00%	30.00%	30.00%	30.00%		
CU										
CY	10.00%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	
CZ	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	
DE	29.48%	29.55%	29.58%	29.72%	29.72%	29.79%	30.00%	30.00%	30.00%	30.00%
DK	25.00%	25.00%	24.50%	22.00%	22.00%	22.00%	22.00%	22.00%	22.00%	22.00%
DO					27.00%					
EC		22.00%	22.00%	22.00%	22.00%	22.00%	25.00%	25.00%	25.00%	25.00%
EG	25.00%				22.50%		22.50%	22.50%	22.50%	
ES	30.00%	30.00%	30.00%	28.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
ET									30.00%	30.00%
FM										
FR	33.33%	33.33%	33.33%	33.33%	33.30%	33.33%	33.00%	31.00%	28.00%	26.50%
GB	24.00%	23.00%	21.00%	20.00%	20.00%	19.00%	19.00%	19.00%	19.00%	19.00%
GH		25.00%								
GR	20.00%	26.00%	26.00%	29.00%	29.00%	29.00%	29.00%	28.00%	24.00%	
GT		31.00%	28.00%	25.00%				25.00%		
HK		16.50%	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%	16.50%
HR	20.00%	20.00%		20.00%	20.00%	18.00%	18.00%			
HU								9.00%	9.00%	9.00%

ID	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	22.00%
IE	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%	12.50%		12.50%	12.50%
IL	25.00%	25.00%	26.50%	25.00%	25.00%	24.00%	23.00%	23.00%	23.00%	23.00%
IN				34.61%	34.61%	34.61%	35.00%	30.00%	30.00%	
IS	20.00%	20.00%								
IT	31.40%	31.40%	31.40%	31.40%	31.40%	24.00%	24.00%	24.00%	24.00%	24.00%
JM	33.33%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
JO									20.00%	20.00%
JP	38.01%	38.01%	35.64%	33.86%	30.86%	30.86%	30.86%	30.62%	30.62%	
KG										
KR	24.20%	24.20%	24.20%	24.20%	24.20%					
KZ	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
LB		15.00%	15.00%	15.00%	15.00%	15.00%	15.00%	17.00%	17.00%	
LC										
LK	28.00%	28.00%	28.00%	28.00%	15.00%	28.00%	28.00%	28.00%	28.00%	24.00%
LU	28.80%	29.22%	29.22%	29.22%	29.22%	27.08%	26.01%	24.94%	24.94%	
MA		30.00%	30.00%	31.00%	31.00%	31.00%	31.00%	31.00%	31.00%	31.00%
MD				12.00%						
ML										
MN						25.00%	25.00%	25.00%	25.00%	
MO										
MT		35.00%	35.00%							
MU						15.00%	15.00%			
MW							30.00%	30.00%	30.00%	
MX	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
MY	25.00%	25.00%	25.00%	24.00%	24.00%	24.00%	24.00%	24.00%	24.00%	
NA			33.00%		32.00%					
NE										
NI						30.00%	30.00%			
NL	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
NO							23.00%	22.00%	22.00%	22.00%
NZ	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%
PA	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%	25.00%
PE	30.00%		30.00%	28.00%	28.00%	29.50%	29.50%	29.50%	29.50%	
PH	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%	
PK	35.00%	35.00%	34.00%	33.00%	32.00%	31.00%	30.00%	30.00%	35.00%	29.00%
PL	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%	19.00%
PT	25.00%	25.00%	23.00%	21.00%	21.00%	21.00%	21.00%	21.00%	21.00%	21.00%
PY				10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	
QA	10.00%	10.00%	10.00%	10.00%	0.00%					
RO	16.00%	16.00%	16.00%	16.00%	16.00%	16.00%	16.00%	16.00%	16.00%	
RS										
RU	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
SA	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
SE	26.30%	22.00%	22.00%	22.00%	22.00%	22.00%	22.00%	21.40%	21.40%	20.60%
SG	17.00%			17.00%	17.00%	17.00%	17.00%	17.00%	17.00%	
SK										
SM										
SN						30.00%				

SV			30.00%	30.00%	30.00%	30.00%		30.00%		30.00%
TG										
TH	23.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	
TR	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%	22.00%	22.00%	22.00%	20.00%
TW	17.00%	17.00%	17.00%	17.00%	17.00%	17.00%	20.00%	20.00%	20.00%	20.00%
UA	21.00%	19.00%	18.00%		18.00%	18.00%	18.00%	18.00%	18.00%	
UG						30.00%	30.00%	30.00%		
US	40.00%	40.00%	40.00%	40.00%	40.00%	40.00%	27.00%	27.00%	27.00%	27.00%
UZ									7.50%	
ZA	34.55%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%	28.00%
ZW									24.00%	

Note: data is collected from KPMG historical corporate tax rate.

Table A2. Leverage ratios across the world

Country(ISO code)	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
AE	85.96%	86.30%	86.99%	83.73%	86.99%	85.87%	86.98%	87.20%	87.77%	87.84%
AL		91.97%	91.04%	89.25%	88.42%	89.30%	88.97%	88.69%	89.03%	
AM		81.10%	85.01%	84.40%	79.33%	85.09%	85.65%	86.05%	86.07%	86.94%
AO			87.46%	90.71%						
AR						88.48%	90.68%	84.41%	85.22%	
AT	91.24%	91.52%	92.11%	92.05%	92.54%	91.84%	91.55%	91.65%	92.95%	
AU	93.61%	93.74%	93.72%	93.60%	92.91%	93.22%	93.19%	93.13%	93.09%	92.95%
AZ								86.71%	90.31%	
BD			90.19%							
BE	93.66%	93.75%	94.08%	93.67%	93.16%	92.65%	93.18%	93.37%	93.70%	
BG	83.61%	85.49%			85.36%	86.58%	87.63%	88.67%	88.45%	
BH	85.38%	86.44%	86.94%	87.69%	87.79%	87.79%	87.82%	85.84%	87.61%	87.87%
BO	91.98%				93.06%					
BR	89.11%	88.24%	87.73%	88.73%	86.63%	88.25%	88.30%	87.77%	89.11%	87.80%
BY	84.90%	85.72%	85.51%	86.57%	88.43%	83.05%	83.82%	84.16%	87.18%	
CA	94.23%	94.35%	94.02%	93.97%	93.86%	93.70%	93.77%	93.39%	93.66%	93.90%
CH	96.37%	94.89%	94.33%	93.79%	93.77%	93.75%	93.78%	93.87%	94.59%	94.40%
CI						95.37%	93.51%	92.50%	92.76%	
CL	91.58%	91.91%	91.94%	92.33%	91.34%	89.08%	90.99%	92.01%	92.16%	93.07%
CM				90.22%						
CN	93.30%	92.82%	92.49%	92.69%	92.75%	92.59%	92.19%	91.73%	91.90%	91.96%
CO	87.88%	90.00%	88.39%	89.42%	88.90%	88.61%	88.79%	88.72%	89.84%	88.91%
CR			91.42%	84.92%	80.48%	80.21%	85.71%	91.53%		

CU				88.38%	89.10%	89.44%				
CY	94.46%	92.70%	91.87%	91.18%	89.03%	89.91%	91.66%	91.57%	92.58%	
CZ	92.00%	91.45%	90.87%	89.14%	88.97%	88.86%	89.60%	90.25%	90.40%	
DE	95.50%	94.81%	94.67%	94.41%	94.58%	94.54%	94.27%	94.49%	95.01%	94.86%
DK	93.36%	92.72%	93.04%	91.58%	91.55%	90.66%	91.79%	91.06%	90.79%	90.46%
DO					53.13%					
EC		84.09%	84.28%	83.42%	81.21%	84.23%	82.22%	81.92%	82.00%	85.04%
EG	86.66%				87.74%		91.04%	91.80%	91.29%	
ES	94.96%	92.69%	92.11%	92.11%	91.69%	91.10%	91.77%	91.93%	93.06%	94.38%
ET									90.26%	91.27%
FM	82.14%	83.74%	84.41%	84.43%	85.64%	84.56%	85.54%	84.82%	86.65%	86.96%
FR	95.45%	93.79%	94.63%	92.33%	91.21%	90.43%	89.19%	89.29%	90.22%	95.97%
GB	93.34%	93.62%	94.15%	92.53%	93.19%	92.86%	93.10%	93.40%	93.83%	94.44%
GH		80.14%								
GR	101.27%	91.81%	90.72%	82.38%	86.95%	85.01%	87.80%	87.93%	91.61%	
GT		88.39%	89.93%	90.02%				87.38%		
HK		91.89%	91.15%	90.86%	91.00%	91.26%	89.87%	88.26%	90.82%	90.27%
HR	88.91%	89.14%		89.93%	87.64%	86.61%	86.98%			
HU								83.69%	83.77%	86.76%
ID	89.00%	90.54%	86.09%	86.37%	85.07%	86.60%	85.40%	85.69%	84.58%	85.75%
IE	92.49%	92.56%	93.26%	90.63%	92.32%	89.97%	91.40%		87.84%	89.32%
IL	93.36%	92.96%	93.45%	92.89%	92.78%	92.46%	92.38%	92.24%	93.01%	93.59%
IN				91.56%	86.95%	89.60%	91.61%	90.02%	90.67%	
IS	79.24%	79.04%								
IT	92.70%	92.75%	92.90%	92.21%	91.83%	92.07%	92.67%	90.15%	90.11%	86.56%
JM	83.26%	83.20%	84.59%	83.05%	84.34%	85.58%	85.01%	85.89%	86.91%	85.78%
JO									89.34%	91.04%
JP	94.39%	94.19%	93.95%	94.01%	94.52%	94.58%	94.67%	94.99%	95.37%	
KG						72.69%	84.47%	81.74%	84.35%	
KR	92.67%	92.31%	92.23%	92.48%	92.11%					
KZ	92.99%	96.62%	88.54%	89.34%	90.14%	87.40%	84.42%	84.39%	85.72%	89.52%
LB		92.89%	91.81%	90.71%	89.72%	89.79%	90.90%	92.76%	93.16%	
LC			92.76%	93.33%	96.01%	92.99%	91.32%	88.76%	88.65%	
LK	90.43%	90.97%	88.03%	86.90%	87.96%	91.71%	91.43%	90.53%	91.22%	89.65%
LU	93.20%	92.49%	91.92%	92.32%	92.41%	92.29%	92.00%	92.32%	92.40%	
MA		89.46%	89.99%	90.35%	90.63%	89.13%	91.50%	91.42%	91.17%	89.97%
MD				82.95%						
ML					89.89%	90.58%			93.83%	

MN						88.41%	85.68%	88.29%	89.85%	
MO						94.73%	93.43%	93.82%		
MT		96.36%	96.32%							
MU						75.55%	79.39%			
MW							89.20%	88.64%	87.29%	
MX	88.10%	88.09%	88.28%	89.35%	90.09%	88.89%	89.16%	88.07%	88.39%	83.91%
MY	91.44%	91.44%	90.03%	90.35%	90.24%	88.07%	89.32%	88.98%	88.55%	
NA			88.37%		88.93%					
NE								89.58%	88.71%	
NI						89.29%	87.36%			
NL	94.39%	95.30%	90.98%	90.68%	91.17%	92.84%	90.64%	91.06%	88.47%	94.20%
NO							90.99%	90.71%	90.85%	91.64%
NZ	93.03%	92.44%	92.52%	92.60%	92.90%	92.34%	92.40%	92.37%	92.46%	92.08%
PA	90.45%	88.77%	89.29%	89.16%	89.77%	89.57%	89.39%	88.11%	88.93%	88.45%
PE	91.96%		91.40%	89.94%	89.19%	88.74%	88.05%	87.75%	90.59%	
PH	87.06%	89.04%	90.42%	90.22%	90.42%	89.83%	89.36%	88.80%	87.39%	
PK	91.20%	90.05%	88.83%	90.22%	91.66%	92.42%	92.61%	93.26%	92.80%	93.52%
PL	87.76%	88.72%	88.02%	88.29%	88.61%	88.21%	88.83%	89.70%	90.26%	91.78%
PT	92.79%	93.54%	92.79%	91.98%	92.89%	89.37%	82.65%	85.20%	84.56%	77.91%
PY				91.82%	90.84%	89.77%	88.78%	85.87%	86.72%	
QA	86.32%	83.17%	85.05%	84.15%	85.19%					
RO	90.56%	90.91%	89.66%	88.38%	89.63%	88.73%	88.11%	86.39%	87.27%	
RS									78.71%	
RU	89.10%	89.13%	91.12%	90.52%	88.09%	93.11%	87.70%	79.58%	83.41%	87.50%
SA	84.74%	85.62%	86.08%	86.02%	85.27%	84.47%	85.18%	85.72%	84.65%	82.23%
SE	95.10%	94.85%	94.96%	94.48%	94.30%	94.41%	94.04%	94.40%	94.18%	94.28%
SG	90.03%			90.71%	90.05%	90.23%	90.76%	90.83%	91.40%	
SK				91.12%	91.26%	92.06%	91.42%	91.45%		
SM						96.29%	95.71%	95.16%	94.82%	
SN						91.09%				
SV			86.38%	87.89%	87.45%	85.77%		88.75%		90.13%
TG							90.80%	92.04%		
TH	85.27%	84.27%	82.30%	81.60%	79.84%	73.87%	72.77%	80.79%	84.08%	
TR	87.58%	85.85%	87.77%	88.77%	89.10%	88.31%	88.66%	86.18%	88.92%	91.60%
TW	92.24%	93.00%	92.60%	92.91%	92.63%	92.42%	92.34%	92.23%	92.29%	92.77%
UA	89.77%	81.12%	93.38%		75.28%	68.49%	47.91%	76.30%	70.65%	
UG						81.91%	84.41%	85.76%		
US	87.72%	87.90%	87.49%	87.41%	87.46%	87.29%	87.06%	86.57%	87.46%	87.90%

UZ									87.61%	
ZA	92.59%	92.53%	92.68%	92.89%	90.96%	91.77%	92.42%	92.46%	93.13%	92.47%
ZW									88.68%	

Note: the leverage ratio of each country is aggregate from Orbis bank-level data.

A3. GMM theory

What follows is a condensed description of the GMM estimator developed by Arellano and Bover (1995) and Blundell-Bond (1998), later described in terms of practical implementation in Roodman (2009), wherefrom the following information is taken. The GMM estimator solves a system of equations along the following:

$$Y = X'\beta + \varepsilon \quad (1)$$

where X is a column of explanatory variables that happen to be correlated with the error term (denoted ε). As such, endogeneity is present and results in the standard OLS regressor being compromised. In order to get around this problem, a vector of instruments (Z) is chosen, with:

$$E(\varepsilon \mid Z)=0 \quad (2)$$

A common problem that needs to be addressed when using GMM estimators is that despite the problem of endogeneity in equation one is solved by the introduction of instruments assumed to be orthogonal to the error term (E[Zε]= 0), it is possible for the system to end up with fewer equations than there are variables. If that happens, the equations become unsolvable, and thus the extraction of a value for the impact of the x variables (the chosen variables such as tax rate, GDP, etc.) also becomes impossible. This situation is called overspecification, and arises when the number of instruments outnumbers variables, coupled with attempting to make the empirical error term in the equation below go zero (in order to reach an unbiased estimator) as one increases the sample size towards infinity.

$$E_N(z\varepsilon) \equiv (1/N)Z'\hat{E} \quad (3)$$

This problem thus lies at the heart of GMM, for while the instruments are chosen to avoid endogeneity, their inclusion makes it impossible to bring the vector of empirical moments (En[Zε] in the equation above) to zero. The problem is expressed most clearly by Roodman (2009), who puts it the following way, "*Because we cannot expect to satisfy all the moment conditions at once, the problem is to satisfy them all as well as possible in some sense, that is, to minimize the magnitude of the vector $E_N(z\varepsilon)$*"

That vector can be expressed in the following way:

$$\| E_N(\mathbf{z}\varepsilon) \|_{\mathbf{A}} = \| \frac{1}{N}\mathbf{Z}'\widehat{\mathbf{E}} \|_{\mathbf{A}} \equiv N\left(\frac{1}{N}\mathbf{Z}'\widehat{\mathbf{E}}\right)'\mathbf{A}\left(\frac{1}{N}\mathbf{Z}'\widehat{\mathbf{E}}\right) = \frac{1}{N}\widehat{\mathbf{E}}'\mathbf{ZAZ}'\widehat{\mathbf{E}}$$

Minimizing with respect to the estimator (βA) gives:

$$\mathbf{0} = d/(d\widehat{\beta}) \| \mathbf{Z}'\widehat{\mathbf{E}} \|_{\mathbf{A}}$$

And when expanded:

$$\mathbf{0} = \frac{d}{d\widehat{\beta}} \| \mathbf{Z}'\widehat{\mathbf{E}} \|_{\mathbf{A}} = \frac{d}{d\widehat{\mathbf{E}}} \| \mathbf{Z}'\widehat{\mathbf{E}} \|_{\mathbf{A}} \frac{d\widehat{\mathbf{E}}}{d\widehat{\beta}} = \frac{d}{d\widehat{\mathbf{E}}}\left\{\frac{1}{N}\widehat{\mathbf{E}}'(\mathbf{ZAZ}')\widehat{\mathbf{E}}\right\}\frac{d\left(\mathbf{Y}-\mathbf{X}\widehat{\beta}\right)}{d\widehat{\beta}}$$

Which, with some transformations:

$$\frac{2}{N}\widehat{\mathbf{E}}'\mathbf{ZAZ}'(-\mathbf{X})$$

And finally:

$$\widehat{\beta}_{\mathbf{A}} = (\mathbf{X}'\mathbf{ZAZ}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{ZAZ}'\mathbf{Y}$$

Given a sample size going towards infinity, using GMM results in a consistent estimator approaching β, provided the conditions are appropriate (Hansen, 1982). However, with the risk of overidentifying arising from too high of an instrument count, it is vital to ensure that the included instruments are in fact valid. In order to test the validity, the Hansen test or Sargan test can be used. With a null hypothesis of no overidentification, insignificant results support the validity of instruments, while significant results undermine the trustworthiness of the regression.