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Trading offshore: evidence on banks' tax avoidance*

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Abstract

Little is known about how banks shift profits to low-tax countries. Because of their specific business model, banks use other profit-shifting channels than non-financial firms. We propose a novel and bank-specific method of profit shifting: the strategic relocation of proprietary trading to low-tax jurisdictions. Using regulatory data from the German central bank, we show that a 1 percentage point lower corporate tax rate increases banks' fixed-income trading assets by 3–4 percent and trading derivatives by 9 percent. Suggestively, this increase does not arise from a relocation of real activities (i.e., traders); instead, it stems from the relocation of book profits.

Keywords: Multinational banks; profit shifting; tax avoidance

JEL classification: *F*21; *G*21; *H*25

1. Introduction

During the financial crisis of 2007–2008, bank bailouts burdened governments with large debts. The bailout of just one Irish bank, Anglo Irish, cost the Irish government €25 billion, or 11.3 percent of GDP

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(Acharya et al., 2014). A natural response by many commentators was to ask whether banks pay their "fair share" in taxes. Academic research finds it difficult to answer this question: while corporate tax avoidance in general is well studied, almost all of these studies exclude the financial sector. This omission is all the more surprising as the financial sector contributes significantly to corporate tax revenue: in Germany in 2014, financial institutions paid 26 percent of total corporate tax revenues (Statistisches Bundesamt, 2019).

One reason for excluding the financial sector when studying corporate tax avoidance is that the business model of financial firms differs so substantially from that of other firms. For manufacturing and non-financial services, the literature has pointed out three main profit-shifting channels: cross-border borrowing, the manipulation of transfer prices, and the strategic relocation of intellectual property. The question of how financial firms shift profits is largely unanswered. To address this question, we propose a quantitatively important profit-shifting channel specific to the financial sector: the strategic relocation of assets held for proprietary trading.[1]

A second reason why few researchers have studied banks' profit shifting is that most large datasets on multinational firms and banks only cover subsidiaries, not branches.[2] However, banks use branches extensively: about a quarter of foreign affiliates of the 100 largest banks worldwide are branches, and the choice between opening a subsidiary or a branch varies systematically with a country's regulatory environment (Cerutti et al., 2007). In particular, as we show below, in many countries, banks hold trading assets exclusively in branches. In this paper, we use a newly available regulatory dataset provided by the German central bank (the External Positions of Banks database). This dataset includes information on all foreign subsidiaries and branches of German banks. The data are of exceptional quality and provide a complete picture of the foreign activities of all German banks. We supplement our analysis by also examining banks headquartered outside Germany using Bureau van Dijk's Bankscope dataset.

We predict that banks relocate assets held for proprietary trading to low-tax countries to shift profits there. Proprietary trading refers to all investment activities that a bank does for its own direct financial gain (and not to earn commission by trading on behalf of clients). It can include trades in stocks, bonds, derivatives, or any other financial instrument. A substantial

[1]As we discuss in Section 2.1, this profit-shifting strategy is in some ways similar to the strategy of relocating intellectual property to tax havens.

[2]A subsidiary is a legally separate company owned by the parent bank; a branch is an office of the parent bank that is not a separate legal entity. We use the term "affiliate" to refer to both subsidiaries and branches.

share of banks' profits comes from proprietary trading, so relocating assets held for this purpose to low-tax jurisdictions lowers total tax payments substantially.[3] It thus has the potential to constitute a major profit-shifting channel. At the same time, gains from proprietary trading are very mobile, especially as banks do not necessarily develop the trading strategy in the same country as where they execute the trades.

Our results confirm that banks indeed relocate assets held for proprietary trading to countries with lower tax rates. Using monthly panel data on the stock of trading assets held in each foreign affiliate of German banks, we study variation in tax rates over time and across countries among the affiliates of a bank group. We find that a 1 percentage point lower tax rate increases fixed-income proprietary trading assets held in an affiliate by 3–4 percent on average, and trading derivatives by 9 percent. We focus on these asset classes as the External Positions of Banks database does not include information on other asset classes held for trading purposes. Our results are robust to different specifications, for example, adding country fixed effects to control for time-constant country characteristics, using a selection model to control for the strategic placement of affiliates, or using a different, international dataset. Despite the clear reaction to tax rates, we also observe that the largest stocks of trading assets are in Germany, likely because of the non-tax benefits of holding these assets at headquarters.

We estimate a tax semi-elasticity between −3 and −4 for fixed-income trading assets. Comparing this number to other estimated tax semi-elasticities in the literature, it becomes clear that proprietary trading reacts especially strongly to taxation. The consensus estimate in the literature for the overall tax semi-elasticity of pre-tax profits is a value of −0.8 (Dharmapala, 2014; Heckemeyer and Overesch, 2017). However, studies of specific methods of profit shifting have found decidedly higher tax semi-elasticities. For example, Karkinsky and Riedel (2012) document a semi-elasticity of −3.8 for patent applications; Dudar and Voget (2016) find a semi-elasticity of −6.2 for trademarks. These comparisons indicate that the tax sensitivity of assets held for proprietary trading is high, but comparable to other assets that firms relocate specifically in response to tax differentials.

Does the relocation of proprietary trading actually constitute a profit-shifting strategy? Or should we view it as a real response, similar to how firms relocate investments in response to taxation? In principle, both interpretations are possible. Banks can either move all activities related to trading (including, for example, the employees who set the trading strategy), or transfer only the book assets to lower-taxed affiliates. We interpret the

[3]From 2009 to 2014, proprietary trading accounted on average for 32 percent of the after-tax profits of German banks (Deutsche Bundesbank, 2016).

second strategy as profit shifting. We provide suggestive evidence that the effect of the corporate tax rate on trading assets is not based on relocating employment, suggesting that the relocation of proprietary trading can be considered a profit-shifting strategy.

We also document that the relocation of proprietary trading is quantitatively important. Using our estimated semi-elasticities, we conduct a back-of-the-envelope calculation. With conservative assumptions about the profitability of trading, we find that the German tax authorities lose 5 percent of the tax revenue currently collected from banks due to this profit-shifting strategy alone. While this estimate relies on a multitude of assumptions and therefore needs to be treated cautiously, it indicates that the relocation of proprietary trading has non-negligible consequences.

Our paper contributes to three separate strands of literature. First, we contribute to the literature on the effect of taxation on the location of corporate profits (see, e.g., Clausing, 2003; Desai et al., 2004; Desai and Dharmapala, 2006; Egger et al., 2010; Huizinga and Laeven, 2008; Dischinger and Riedel, 2011; Dharmapala and Riedel, 2013; Langenmayr and Liu, 2020) by documenting a novel profit-shifting channel. Most of this literature excludes the financial sector, but there are a few exceptions. Demirgüç-Kunt and Huizinga (2001) provide indirect evidence for profit shifting by multinational banks.[4] Huizinga et al. (2014) show that corporate tax rates negatively affect foreign direct investment and pre-tax profits of banks.

Second, a related literature shows that banks react to taxation in various dimensions. In particular, they adjust leverage in response to taxation and to international tax differentials (Gu et al., 2015; Heckemeyer and de Mooij, 2017). Loan loss provisions respond to taxation in countries that permit general provision tax deductability (Andries et al., 2017). Merz and Overesch (2016) analyze the association between various balance-sheet items of multinational banks and taxation.[5] Reiter et al. (2021) show that tax rates affect banks' internal debt financing.

Third, we also add to the literature on the determinants of global bank activities by describing how corporate taxation influences the location of proprietary trading assets. Previous papers focus on other country-level determinants of the banks' international asset choice, such as expropriation

[4]They show that the profitability of foreign banks rises relatively little with their domestic tax burden, indicating that foreign banks do not pass the tax on to their consumers. One explanation for this result is that the banks themselves can avoid the tax by shifting profits abroad.

[5]Their analysis also includes a regression on trading gains, where they find that these profits are particularly responsive to corporate tax rates. In contrast to our paper, Merz and Overesch (2016) do not differentiate between profit shifting and the relocation of real activities; nor can they exclude that other country characteristics correlated with tax rates drive the results.

risk (Dell'Ariccia and Marquez, 2010), regulation (Buch, 2003; Houston et al., 2012), comparative advantage (de Blas and Russ, 2013; Niepmann, 2016), and nationalizations (Kleymenova et al., 2016). We also contribute to the more specialized literature on proprietary trading. Studying German equity trades, Hau (2001a,b) show that foreign traders realize lower proprietary trading profits than domestic traders. Fecht et al. (2018) analyze the interaction between proprietary trading and the returns obtained by the bank for retail investors, showing that banks push underperforming stocks from their proprietary portfolios into the portfolios of retail customers. So far, this literature on proprietary trading has not considered the impact of taxation.

The following section provides some background on proprietary trading and the taxation of banks. In Section 3, we discuss our main hypothesis and describe the data. In Sections 4 and 5, we provide evidence on fixed-income assets and on derivatives held for trading, respectively. In Section 6, we offer a back-of-the-envelope calculation of the magnitude of the effects. We conclude in Section 7.

2. Background

2.1. Profit and risk shifting in the banking sector

Banks engage in three main activities: they charge interest on money that they lend, they impose fees for services (e.g., investing on behalf of a customer), and they trade with financial instruments in the financial markets. The first two activities are closely linked to the location of the customer, and we conjecture that they are thus more difficult to shift to low-tax countries.[6] Therefore, our focus in this paper is on the trading activities of banks.[7] We study proprietary trading (i.e., investments with the bank's own money). Investments on behalf of a customer are not as suited to profit shifting, as

[6]In principle, investments on behalf of customers could also be used to shift profits to low-tax countries: the customer pays a fee to the investing affiliate; the bank can lower its overall tax burden if this fee is taxed in a low-tax country. We leave it to future research to examine this question.

[7]What other profit-shifting strategies can banks use? For non-financial firms, the literature (summarized by Dharmapala, 2014) has established three main profit-shifting channels: the manipulation of transfer prices for intra-firm traded inputs, the relocation of intellectual property, and the strategic use of internal debt. The first two strategies do not work well with the business model of banks. The third is a viable strategy for banks, but in the non-financial sector, this strategy explains only a relatively small share of tax avoidance (Heckemeyer and Overesch, 2017). Reiter et al. (2021) show that banks indeed use internal debt to lower their tax burden, and do so more aggressively than firms in other sectors.

the bank does not profit directly from the return of the investment, but only from a fee paid by the customer.

As we show below, banks invest predominantly in risky assets such as derivatives. Thus, proprietary trading is a very risky activity. Therefore, the insights from Becker et al. (2020), who study how multinational firms of all industries allocate risk across jurisdictions with different tax rates, are also relevant for our paper. They point out a key trade-off in the allocation of risk, which arises because transfer pricing rules require that risk is compensated with a higher expected return. On the one hand, there is a risk-sharing incentive, which implies that firms should locate risk in high-tax countries to maximize risk-sharing with the government.[8] On the other hand, there is the classical profit-shifting incentive, which implies that firms should locate activities with high expected returns (and, thus, risk) in low-tax countries. These two motives are also at play in the location decision for proprietary trading.

Therefore, we only expect that proprietary trading assets are located in low-tax countries in so far as the profit-shifting motive dominates the risk-shifting motive. In the empirical part of their analysis, Becker et al. (2020) show that the profit-shifting motive indeed dominates for the firms in their sample, measuring risk with overall measures such as the standard deviation of returns. In a rather different setting, focusing on banks and a specific activity (proprietary trading), we also find that the profit-shifting motive dominates.

Why is the relocation of assets held for proprietary trading potentially a promising profit-shifting strategy? Two criteria are important for moving a function to a low-tax country. First, the activity or assets should be relatively mobile, so that the cost of relocating it is low. Second, it should be highly profitable, so that there is a large tax saving when moving to a low-tax country.

Proprietary trading activities are highly mobile. Banks do not have to develop their trading strategies in the same location as where they execute the trades. While some trading activities, especially high-frequency trades, profit from being close to stock exchanges, other trading activities can be commissioned from almost anywhere in the world. Thus, there is large scope for relocation in response to taxation. However, note that international tax rules, in particular the arm's length principle, oblige the trading affiliate to pay a fee to the affiliate where the trading strategy was developed. As there are no comparable third-party transactions, banks are able to set these

[8]This risk-sharing incentive arises because of tax loss offset, in particular loss carrybacks: the government takes on part of a firm's risk as it refunds previously paid taxes in the case of the loss. As this refund depends on the tax rate, it poses an incentive to locate risk in high-tax countries.

fees at values substantially below the trading gains, enabling them to shift profits.

Proprietary trading is also highly profitable (in the sense of a high expected return). In our international Bankscope sample, gains from proprietary trading account on average for 39 percent of banks' pre-tax profits (see Appendix A); for German banks, Deutsche Bundesbank (2016) reports that gains from trading account for 32 percent of after-tax profits. Therefore, relocating these trading activities to low-tax jurisdictions implies substantial tax savings.[9]

The relocation of proprietary trading is in many ways similar to the well-known profit-shifting strategy of relocating intellectual property to tax havens (see, e.g., Dischinger and Riedel, 2011; Karkinsky and Riedel, 2012; Griffith et al., 2014; Baumann et al., 2020). Both proprietary trading and developing intellectual property are highly risky activities, and both are very profitable if successful. Trading assets as well as intellectual property are highly mobile assets, as they can be relocated to a different country by legal contracts alone, without the transport costs, etc., necessary for other assets. Thus, one can view the profit-shifting strategy presented in this paper as a financial sector-specific analogue to the well-researched profit-shifting strategy of relocating intellectual property to low-tax countries.

As a first, descriptive test of the idea that banks strategically locate proprietary trading assets in low-tax countries, we can compare the level of these assets held in low-tax and high-tax countries. Figure 1 shows the ratio of fixed-income trading assets to total external assets for our sample of German multinational banks. It demonstrates that banks hold substantially more trading assets in low-tax affiliates than in high-tax affiliates. Note, however, that Figure 1 does not control for other determinants of trading assets, such as regulation, which might correlate with tax rates.

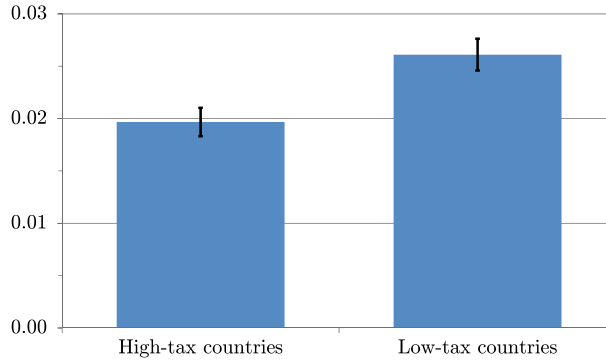
2.2. Taxation of bank profits

Each subsidiary of a German bank pays corporate tax on its profits in the country where it is active. As Germany has a territorial tax system, almost no additional tax is due on repatriated profits.[10] Similar rules apply to foreign branches of German banks if Germany has a double taxation

[9]Because of regulation, banks might be constrained in the amount of proprietary trading they are able to carry out. Assuming a decreasing return to proprietary trading, this might also explain why trading is a relatively profitable activity for banks.

[10]In more detail, 95 percent of dividend payments to the German headquarters are exempt from taxation in Germany. Note that dividends on short-term assets in the bank's trading book would not be exempt from taxation in Germany; however, the majority-owned foreign subsidiaries we consider are part of banks' fixed assets and thus 95 percent exempt from taxation.

Figure 1. Trading assets as share of total assets



Notes: Fixed-income trading assets relative to total external assets in our sample of German multinational banks and their foreign affiliates (described in Section 3). High-tax countries are countries with a statutory corporate tax rate ≥30 percent (the German tax rate) in the respective month, and low-tax countries are all other countries. Bars indicate 95 percent confidence intervals.
Source: Deutsche Bundesbank's External Positions of Banks database 2010–2015.

agreement with the host country.[11] This is the case for almost all countries in our sample. Therefore, in most countries, taxes do not affect the choice between opening a subsidiary or a branch.

In most countries, gains from proprietary trading are taxed at the same rate as profits from other activities. Note, however, that a few countries have specific corporate tax rates on banks or apply different tax rates on capital gains of corporations. Examples are Hong Kong and Singapore, both of which have a special zero tax rate for corporate capital gains. These tax rates apply also (but not only) to profits generated by the propriety trading activities of banks.[12] In this paper, we use these specific tax rates when applicable; we also take specific taxes on foreign branches into account.

[11]Germany does not have double tax treaties with seven countries in our sample (Brazil, Cayman Islands, Chile, Hong Kong, Peru, Qatar, and Saudi Arabia). In these cases, the tax treatment depends on whether the branch is considered a non-resident taxpayer. Unfortunately, as the definition of branches in tax law and banking law differs, we cannot determine whether this is the case. If a branch is considered a non-resident taxpayer, then the profits of the foreign branch are taxable in Germany (with either a credit for taxes paid, or foreign taxes being deductible). When we drop observations from branches in the seven countries without double tax treaties with Germany, our results are similar to those reported in the following.

[12]Curaçao applies special tax rules to E-zone companies. As we cannot observe whether banks are located in an E-zone, we drop the (very few) observations from Curaçao. Similarly, Ukraine applied a 10 percent rate to some forms of trading in 2014. We also drop these observations as we cannot identify the relevant tax rate. In a further robustness check, we drop all observations from Chile, Hungary, Peru, and Ukraine, as these countries had special capital gains tax rules and bank levies and we cannot entirely ensure that we use the appropriate tax rate. Results remain similar.

Appendix B gives an overview over the general corporate tax rate, the tax rate applying to banks, and the capital gains tax rate applying to banks' proprietary trading profits. During our sample period, 13 countries changed their tax rates on banks' profits by 3 percentage points or more. Other tax rules, in particular controlled-foreign-corporation (CFC) rules, usually exempt bank profits.[13]

2.3. Regulation

All bank activities are highly regulated. In November 2010, most countries agreed on a new global regulatory framework, Basel III. It started to be in force beginning in 2013, but most rules only became relevant in later years, often 2018 or 2019. Most capital ratios relevant for the Basel III regulations are calculated at a consolidated basis and should therefore not affect the incentives to shift assets between countries.

In addition to the regulation at the bank group level, subsidiaries (but not branches) have to comply with the capital requirements in the country where they are active. Such regulation could affect the incentives to hold specific assets in the respective country. In particular, stricter regulation might make it less attractive to hold highly risky trading assets in a country. We therefore control for the introduction of the first Basel III regulations in all specifications.

3. Hypothesis, data, and descriptive analysis

Our paper aims to answer whether banks strategically relocate their proprietary trading to low-tax countries. Thus, in the main part of the paper, we test the following hypothesis.

Hypothesis. Proprietary trading assets of banks are decreasing in the corporate tax rate.

[13]CFC rules, often in place in high-tax countries, attribute passive income from foreign subsidiaries to the tax base of the parent company. However, in most countries, bank profits are exempt from CFC rules; see Deloitte's "Guide to Controlled Foreign Company Regimes", available online at https://www2.deloitte.com/al/en/pages/tax/articles/guide-to-controlled-foreign-company-regimes.html. German CFC rules, in particular, exclude banks under relatively loose conditions (i.e., if the affiliate is a "commercially organized business operation"; Förster and Schmidtmann, 2004; Ruf and Weichenrieder, 2012). According to a decision by the German Federal Fiscal Court, it is not even necessary that the affiliate has own employees or offices to fulfill this condition (BFH 13 Oct 2010, I R 61/09). As all banks in our main dataset on the external positions of German banks are headquartered in Germany, only the German CFC rule could be relevant. As a robustness test, we have thus interacted a dummy for the applicability of CFC rules with the tax variable. The interaction term is insignificant and close to zero in all specifications (as is the coefficient on the CFC dummy itself); the coefficient on the tax rate is similar to the main specifications (see Table 5).

To test this hypothesis, we require detailed information on multinational banks. We obtain such data from a regulatory dataset of the German central bank. In a robustness test, we also use Bureau van Dijk's Bankscope dataset.

Our main data source is the External Positions of Banks database of the German central bank. The Bundesbank collects these data both for regulatory purposes and as an input to calculate monetary and balance of payment statistics. It includes detailed information on the financial positions of the bank affiliates, but not on general variables such as profits or employment. The database covers all German banks, including all their majority-owned foreign subsidiaries and branches. We observe every foreign subsidiary individually and an aggregated observation for all branches of a bank group in a country.[14] The sample consists of 61 internationally active bank groups in Germany, with foreign subsidiaries in 33 countries and branches in 46 countries. The three largest banks together have subsidiaries in 29 countries and branches in 42 countries. The data are available on a monthly basis from December 2010 to December 2015. As reporting to the Bundesbank is mandatory, we observe the complete population of German banks.

In further tests, we use information on employment. We obtain these data from the Microdatabase Direct Investment (MiDi), also provided by the Bundesbank. This dataset includes foreign subsidiaries and branches whose total assets exceed €3 million. It is available on a yearly basis.[15] Moreover, to construct our control variables, we use country-level information from various sources (see Appendix C for details).

Our main test uses fixed-income assets held for proprietary trading as the dependent variable. In additional tests, we also use derivatives held for proprietary trading (which we observe only for a shorter period, from December 2013 to December 2015). Both variables measure the current value of trading assets held in an affiliate.[16] We cannot use equities held for trading, as the Bundesbank data do not differentiate between equities held for trading and those held as liquidity reserve.

In which countries do German banks hold their trading assets? In Table 1, we list the top ten countries in which German bank groups had

[14]We also observe information on the German headquarters. As Dischinger et al. (2014a) show that firms are reluctant to shift profits away from their headquarters, we do not use this information when estimating tax semi-elasticities. When we include data on headquarters, results are qualitatively similar, but of smaller magnitude (i.e., consistent with the findings of Dischinger et al., 2014a, for non-financial firms).

[15]For a detailed description of this dataset, see Lipponer (2011).

[16]In line with international financial reporting standards, German banks have to assign trading assets their fair value. The lowest value principle (which is usually the mandatory accounting principle for assets in Germany) does not apply to bank assets held for trading.

Table 1. Top 10 countries for foreign trading activities in 2014

No	Fixed-income trading assets			Trading derivatives		
	Country	Total (in m€)	% held in branches	Country	Total (in m€)	% held in branches
1	Germany	50,315		Germany	1,171,000	
2	United Kingdom	42,596	100	United Kingdom	259,500	100
3	United States	7,417	95	United States	203,800	100
4	Italy	2,589	23	Italy	61,513	100
5	Singapore	2,422	40	Singapore	6,621	100
6	Cayman Islands	1,493	100	Poland	1,419	0
7	Poland	670	0	Luxembourg	823	0
8	Japan	539	96	Japan	636	100
9	Luxembourg	380	0	Hong Kong	420	100
10	China	379	9	Spain	122	0
	Total	117,800	52	Total	1,816,000	35

Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015. Totals of fixed-income securities and derivatives that are held for trading by German multinational banks in foreign affiliates, in million euro. Countries in which less than three banks are active are not shown here due to confidentiality requirements.

the most proprietary trading assets in 2014.[17] Outside of Germany, most trading assets are in countries with large financial sectors (e.g., the United Kingdom or the United States), but also in tax havens such as Singapore or the Cayman Islands.[18] In some of these countries, banks hold most of their proprietary trading assets in branches (e.g., in the United Kingdom or the Cayman Islands); in other countries, these assets are in separate legal entities (i.e., subsidiaries, for example, in Poland). Banks tend to hold more derivatives than fixed-income assets for proprietary trading.

Table 1 also shows that the largest stock of trading assets is in Germany. This observation is in line with empirical evidence that multinationals bias the location of profits and highly profitable assets in favor of the headquarters location (Dischinger et al., 2014b). It does not contradict that trading assets are used to shift profits to low-tax jurisdictions: previous literature has shown that multinationals are reluctant to shift profits away

[17]Because of the confidentiality requirements of the Bundesbank, we cannot list countries in which fewer than three German banks conduct proprietary trading in this table.

[18]In the United States, a substantial part of trading assets is likely in affiliates in Delaware, where banks can also profit from various corporate tax benefits and can at least lower state-level taxes (see Dyreng et al., 2013, for a discussion of Delaware as a domestic tax haven). For instance, seven of Deutsche Bank's eight securities trading firms in the United States are based in Wilmington, Delaware (see Deutsche Bank AG's Annual Report 2014, available online at https://www.db.com/ir/en/annual-reports.htm). Unfortunately we cannot observe the exact address of a bank affiliate within the United States in our dataset. As a robustness check, we also estimate equation (1) without affiliates in the United States and find similar results.

from their headquarters, but still react to taxation, in particular in the allocation of assets among subsidiaries (Dischinger et al., 2014a).

The main drawback of the Bundesbank data is that the sample is relatively small, even though it covers the full population of German multinational banks. Moreover, one might worry about external validity, given that the dataset contains only banks headquartered in Germany. To address these concerns, we rerun our analysis using Bureau van Dijk's Bankscope dataset in Appendix D, and we discuss these results in Section 4.6. Large parts of the literature on the taxation and regulation of banks use this dataset (see, e.g., Houston et al., 2012; Huizinga et al., 2014; Gu et al., 2015; Merz and Overesch, 2016).

Bankscope provides comprehensive information on balance sheets, income statements, and ownership for banks and bank subsidiaries worldwide. The main advantages of this dataset are that it covers banks headquartered anywhere in the world, and that it is available for a longer time period. However, Bankscope has substantial drawbacks regarding both the extent of coverage of affiliates, and the quality of the data. First, Bankscope has information only on subsidiaries but no information on branches. This is a major disadvantage: Table 1 confirms that in some countries, German banks hold their trading assets exclusively in branches (e.g., in the United Kingdom or the Cayman Islands). Thus, using a dataset that does not include branches might introduce selection bias. Second, the coverage – even of subsidiaries – in the Bankscope data is unclear. There are many missing values for total trading assets, and we do not observe all subsidiaries of multinational bank groups. For example, the Bundesbank database reports seven actively trading subsidiaries of German banks in Singapore. However, in Bankscope, there is only one German-owned bank active in Singapore, and there is no information on its trading assets.[19] Overall, we prefer the Bundesbank data because these have comprehensive sample coverage and are of excellent quality. Nevertheless, we also use Bankscope as a consistency check for our results.

Table 2 gives an overview over the descriptive statistics for the main variables in the Bundesbank dataset. Fixed-income trading assets amount on average to €257 million per foreign affiliate. The value of derivatives held for trading is significantly higher (on average, €2.721 billion per affiliate). As we observe derivatives only from December 2013 to December 2015, there are only 6,460 observations for trading derivatives, compared to 16,668 observations for the other monthly variables. On average, foreign affiliates of German banks have total external assets of €4.9 billion.

[19]The Bankscope data also do not report historical ownership, so our analysis implicitly assumes that ownership has not changed for the banks in our sample.

Table 2. Descriptive statistics

Variable	Obs.	Mean	Std dev.	p3	p50	p97	Freq.
Fixed-income trading assets (m€)	16,668	257	2,410	0	0	1,237	M
Trading derivatives (m€)	6,460	2,721	28,600	0	0	56,000	M
Total external assets (m€)	16,668	4,883	27,100	0.2	727.5	19,800	M
Corporate tax rate	16,668	0.24	0.10	0.00	0.25	0.40	M
Nominal GDP (m€)	16,668	122,520	236,086	246	36,221	1,037,047	Q→M
Inflation rate (%)	16,668	2.15	2.93	−0.82	1.82	7.08	M
GDP growth (%)	16,668	1.93	2.76	−2.86	1.86	7.31	Q→M
Regulation	16,668	1.35	0.68	1	1	3	–
Financial sector share	16,668	0.11	0.10	0.04	0.07	0.42	–
Subsidiary dummy	16,668	0.28	0.45	0	0	1	M
Basel III dummy	16,668	0.04	0.19	0	0	1	M
Bank group total ext. assets (m€)	16,668	347,000	504,000	93	65,800	1,370,000	M
Employees (yearly)	1,290	785	3,478	0	64	16,314	A

Notes: Sample period from December 2010 to December 2015, except for trading derivatives, which are only available from December 2013 to December 2015. M, Q, and A indicate monthly, quarterly, and annual frequency. We calculate monthly GDP from interpolated quarterly GDP values using the proportional Denton method as described in Bloem et al. (2001), and monthly GDP growth from these values. For data sources, see Appendix C.

A German bank group as a whole (including German headquarters) holds €46 billion of fixed-income assets, and €959 billion of derivatives for trading on average (in 2014). Across foreign affiliates, the distribution of trading assets is relatively unequal, with the top decile holding 97.7 percent of fixed-income assets (in 2014, the share for derivatives is even higher). In our sample, 31 of the 61 bank groups (and 147 of the 325 bank affiliates) hold fixed-income assets and/or derivatives for trading. Nevertheless, there are banks with trading assets even in the smallest size decile. Conditional on holding trading assets at all, the average affiliate has fixed-income trading assets worth €1,250 million, and trading derivatives worth €7,415 million (in 2014).

4. Evidence on fixed-income trading assets

4.1. Case study

We first consider some illustrative evidence from the United Kingdom. The United Kingdom started a series of annual corporate tax rate cuts in 2011. In a first step, it cut the corporate tax rate from 28 percent to 26 percent in April 2011, and simultaneously announced further cuts.[20] As the United Kingdom is the largest foreign country in which German banks hold trading assets (see

[20]See the BBC report of 23 March 2011, Budget 2011: corporation tax to be cut to 23% by 2014, available online at http://www.bbc.com/news/business-12828434.

Table 1), these tax rate cuts lend themselves to a case study. In this case study, we track how fixed-income trading assets developed in the United Kingdom after the tax rate cut, compared with other countries. We expect that trading assets in the United Kingdom increased after the tax rate cut.

As London is such an exceptional location for banks, it might be a worry that results from the United Kingdom alone are not representative.[21] Therefore, this case study is meant solely as a first illustration of our results, to show that trading assets indeed respond to tax rate cuts. To ensure that the United Kingdom is not driving our results, we re-estimate the main regressions also without the United Kingdom (see below).

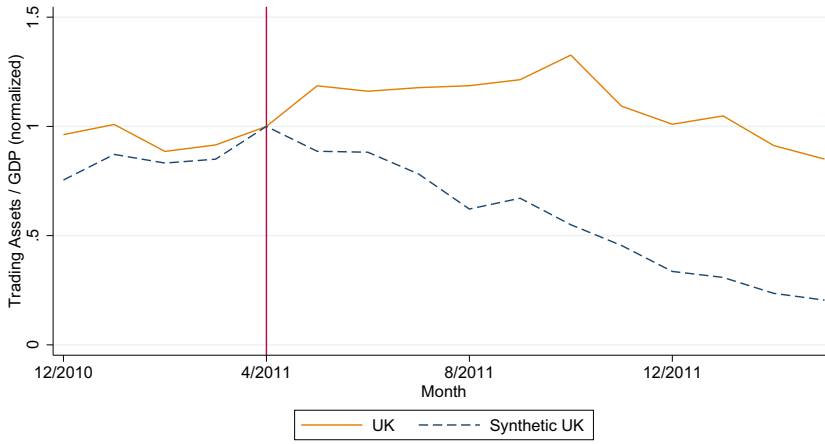
For the case study, we construct as a counterfactual a synthetic control country for the United Kingdom as suggested by Abadie et al. (2010), based on trading assets/GDP in the pre-treatment period. Potential control countries (the "donor pool" to construct the synthetic control country) are all countries in which at least three German multinational banks have affiliates.[22] To improve comparability across countries, we normalize the total fixed-income trading assets held by German banks in each country by the respective country's GDP.

Figure 2 shows time trends in these variables for the United Kingdom and the synthetic control country. While trading assets in the United Kingdom increased after the tax rate cut in April 2011, the volume of trading assets in the synthetic control declined until the series went back to the common trend in September 2011. Banks thus took a few months to respond to the tax rate change. Note that part of the decline in the synthetic control might arise because trading assets from the control countries are relocated to the United Kingdom. Even accounting for the fact that we might double-count some of the change in asset allocation, the effects in this case study are large. This might be because of the exceptionality of London as a location for European banks. Note also that a comparison with the magnitudes from Section 4.3 is not possible, as the values of both the UK and the synthetic control are normalized to 1 for April 2011 (because of confidentiality requirements), but diverge in reality.

[21]Another potential issue is the UK bank levy, introduced in 2011, but it is unlikely to affect the results. First, the tax base for levy payments in 2011 was total liabilities as of 1 January 2011. Therefore, banks should have responded to the bank levy in the second half of 2010. Second, the bank levy was designed as a tax on total liabilities. With a very moderate rate of 0.05 percent in 2011, it increased the funding costs of banks. This implies that some (trading) assets with a relatively low expected return are no longer profitable (in line with Devereux et al., 2019, who show that bank levies increase the average risk weight of assets). Third, it is unlikely that bank levies caused a shift from other asset types to trading assets.

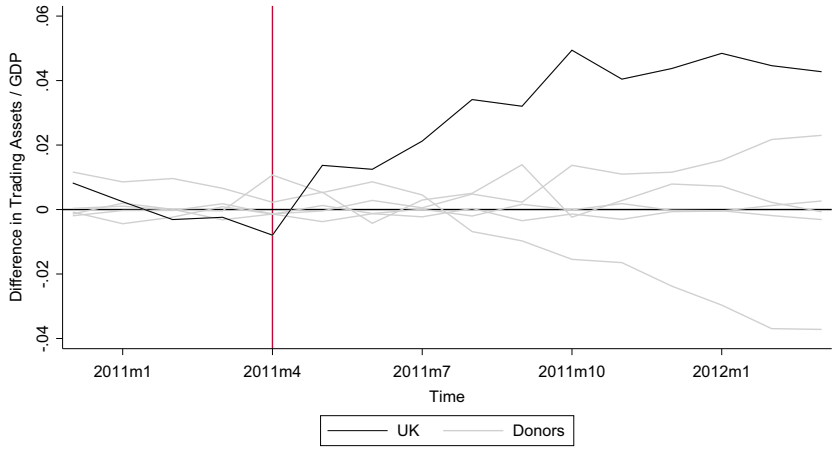
[22]The resulting synthetic control country for the United Kingdom consists of 96 percent Hong Kong and 4 percent Singapore. The restriction to the five countries with affiliates from at least three bank groups is necessary because of the confidentiality requirements of the Bundesbank.

Figure 2. Trading assets/GDP in the UK and in a synthetic UK



Notes: The orange solid line shows the time trend in fixed-income trading assets/GDP of German bank affiliates in the United Kingdom. The blue dashed line shows the time trend of the same variable of a synthetic control for the United Kingdom. Series are normalized (April 2011 = 1) because of confidentiality restrictions. The trading assets-to-GDP ratio never exceeds 10 percent.
Source: Deutsche Bundesbank's External Positions of Banks database 2010–2015.

Figure 3. Placebo tests



Notes: The black line shows the time trend in the difference in fixed-income trading assets / GDP between German bank affiliates in the United Kingdom and affiliates in a synthetic United Kingdom. Grey lines are placebo tests for countries in the donor pool (Germany, Hong Kong, Poland, Singapore and the United States).
Source: Deutsche Bundesbank's External Positions of Banks database 2010–2015.

In Figure 3, we carry out a placebo test to show that the difference between the United Kingdom and its synthetic control is unlikely to arise by chance. In the placebo test, we run the same analysis using the other countries in the donor pool as treated countries. Because of the confidentiality restrictions of the Bundesbank, we conduct this analysis only for countries in which more than three German bank groups have subsidiaries or branches. The dark line in Figure 3 again depicts the difference in trading assets/GDP between the United Kingdom and its synthetic control; the grey lines show the same analysis for the other countries in the donor pool. In these countries, we cannot find a similar increase in trading assets relative to the respective synthetic control country, confirming that the higher levels of trading assets in the United Kingdom after April 2011 are likely caused by the lower tax rate.

This case study on the corporate tax rate cut in the United Kingdom in April 2011 therefore illustrates our hypothesis that banks adjust the location of their proprietary trading activities in response to changes in taxation. We next provide broader evidence for this relationship.

4.2. Empirical strategy

Our main hypothesis proposes that more trading takes place in low-tax affiliates. To test this relation, we look at the variation in tax rates that different affiliates of a multinational bank face. Accordingly, we estimate the following equation:

$$IHS(Trading\ assets_{ijkt}) = \beta_0 + \beta_1 CTR_{jt} + \beta_2 X_{ijkt} + \delta_k + \gamma_t + \phi_j + u_{ijkt}. \quad (1)$$

The dependent variable, $IHS(Trading\ assets_{ijkt})$, is the inverse hyperbolic sine of fixed-income trading assets held by affiliate i of bank group k in country j as of year-month t. The inverse hyperbolic sine transformation can be interpreted just like the logarithmic transformation, but has the advantage that it is also defined at zero (and for negative values).[23] The main explanatory variable of interest is CTR_{jt}, the statutory corporate tax rate of country j. We additionally use several control variables X_{ijkt}, discussed below. In equation (1), δ_k are bank-group fixed effects, γ_t are monthly time fixed effects, and ϕ_j are country

[23]The inverse hyperbolic sine transformation is $IHS(y) = \ln[y_i + (y_i^2 + 1)^{0.5}]$, which is approximately equal to $\ln 2y_i = \ln 2 + \ln y_i$ (except for very small values of y_i). It is suited for the transformation of dependent variables and allows consistent estimation of the regression equation (Burbidge et al., 1988; MacKinnon and Magee, 1990). It does, however, have the disadvantage that it cannot be interpreted as a percentage change if the pre-transformation value of the variable was close to zero. In our case, this disadvantage is small: if a bank has trading assets, then the value of these assets exceeds several million euros (the average in our sample is €257 million). In Table 4, we separate responses at the intensive and extensive margins, and also provide results that do not rely on the inverse hyperbolic sine transformation.

fixed effects. Under our main hypothesis, we predict $\beta_1 < 0$, as banks prefer to conduct their proprietary trading in low-tax countries.

We first estimate equation (1) without country fixed effects. This estimation has the advantage that countries with 0 percent corporate tax rates during the whole sample period also contribute variation to the estimation. Previous literature has shown that much of the profit shifting is towards such zero-tax countries, and that shifting elasticities can be underestimated when ignoring these countries (Davies et al., 2018).

However, a potential threat to identifying a causal effect in these cross-country regressions is that country characteristics other than the tax rate determine a country's attractiveness for proprietary trading. To address this concern, we use three strategies.

First, we include country fixed effects in the main regression to control for time-constant country characteristics. Note, however, that our sample is relatively short, and identification in this specification is thus based on relatively few tax rate changes.[24] Second, we use a selection model, which explicitly estimates the attractiveness of each country for proprietary trading (discussed below). Third, we use the difference between an affiliate's tax rate and the bank group's average tax rate as the explanatory variable, so that variation in tax rates stems from foreign affiliates and is less likely to be correlated with home country characteristics (also discussed below). In addition, we employ several time-varying country-level control variables.

In particular, we control for the inverse hyperbolic sine of GDP as a proxy for country size, as larger countries also provide a larger market for raising funds that banks can use for proprietary trading. We also include inflation rates, as higher inflation can, on the one hand, discourage trading activities in a country because of higher risk premiums and, on the other hand, make alternative capital investments at fixed nominal interest rates less attractive (lowering opportunity costs of proprietary trading). We control for GDP growth as countries that grow at higher rates offer more attractive markets for banks. We include the share of country j's financial sector in the gross value added to account for the attractiveness of financial centers as the location of proprietary trading.[25] We also include an index on the regulation of securities activities based on the World Bank survey on bank regulation in 2011.[26] It measures the extent to which banks might engage

[24]In total, there are 52 changes in statutory tax rates in our sample. However, none of the tax havens in our sample changed its tax rate.

[25]We use the share of financial and insurance activities in total gross value added. This measure reflects the role of important financial centers: in 2014, for instance, it is 8 percent in the United Kingdom and 13 percent in Singapore, compared to 4 percent in Germany and 4 percent in France. To avoid endogeneity, we keep this value fixed at the beginning of the sample period.

[26]See the World Bank's 2011 Bank Regulation and Supervision Survey, available online at https://www.worldbank.org/en/research/brief/BRSS.

in underwriting, brokering, and dealing in securities, and takes on values between 1 (unrestricted) and 4 (prohibited). As this regulatory measure is time-invariant, we include it only in the regressions without country fixed effects. In addition, we include a dummy variable that is one when the observation is affected by the countercyclical capital buffers introduced by Basel III (i.e., when the observation is a subsidiary and the respective country has such a regulation in place). The countercyclical capital buffer was part of the earliest Basel III regulations; most other aspects of Basel III only took effect after our data set ends. Appendix C provides detailed information on variable definitions and data sources.

To allow for a more precise estimation, we also include the inverse hyperbolic sine of total assets as a bank-level control variable to account for an affiliate's size. As data on total assets are not available, we proxy total assets by total external assets, which comprise claims against non-residents (including the German headquarters) as well as money market papers, bonds, and shares issued by non-residents. Moreover, we control for the inverse hyperbolic sine of the bank group's overall total assets, again proxied by total external assets. This variable absorbs shocks that influence the whole bank group, such as large indemnity payments. Moreover, we include a dummy describing whether an affiliate is a subsidiary (a separate legal entity) or a branch (an office of the parent company). We also show results of a specification with affiliate fixed effects, which control for all time-constant affiliate and country characteristics.

Our second strategy to control for the attractiveness of countries is to estimate a selection model using a two-stage estimator. A selection model accounts for the fact that banks can only hold trading assets in countries in which they have affiliates (if banks based the decision where to locate trading assets solely on the explanatory variables outlined above, they might choose a location in a different country). As the decision to open a subsidiary or a branch also depends on various variables, including the tax rate, our results might suffer from selection bias. To account for this issue, we use the estimator proposed by Wooldridge (1995), which extends the Heckman (1976) selection model to panel data. We are able to do so as our sample includes all subsidiaries and branches of German banks.[27] This estimation strategy explicitly controls for banks strategically locating their subsidiaries, for example, in low-tax jurisdictions.[28] We proceed as follows.

[27] Sample selection models are rarely used in the profit-shifting literature, as this literature usually uses datasets that have incomplete samples (e.g., Orbis, Amadeus) or that are limited by size-based reporting requirements (e.g., MiDi). Huizinga et al. (2014) are an exception – they employ a Heckman selection model to estimate banks' pre-tax profit response to corporate tax rates.

[28] Huizinga and Voget (2009) show that international tax liabilities matter for mergers and acquisitions, and thus for the structure of multinational firms.

In the first step, we estimate the selection model using the following probit specification for each time period t:

$$P_{jkt}(Affiliate_{jkt} = 1|CTR_{jt}, X_{jkt}, Z_{jkt}) = \beta_0+\beta_1 CTR_{jt}+\beta_2 X_{jkt}+\beta_3 Z_{jkt}+u_{jkt}. \quad (2)$$

Here, the dependent variable is the probability that bank group k holds an affiliate in country j at time t. We use two instruments so that identification does not only rely on the functional form. These instruments Z_{jkt} are the inverse hyperbolic sines of the total assets of the parent and the population of the host country.[29] In the second step, we use the predicted probabilities from the probit regression to construct additional explanatory variables (the inverse Mills ratios interacted with monthly time dummies), which capture the likelihood that a bank group will have subsidiaries or branches in a particular location in the respective month. In the last step, we estimate our main model, equation (1), with these additional explanatory variables.

Our third strategy aims to control for a potential bias from unobserved country characteristics by using a (partially) different source of variation. Instead of the corporate tax rate of the affiliate, we use the difference between this tax rate and the bank group's average tax rate (weighted by assets). Variation in this tax rate differential stems largely from variation in tax rates faced by other affiliates of the same bank group. This variation is less likely correlated with characteristics of the specific affiliate's home country.

4.3. Results: relocation of proprietary trading assets

In Table 3, we present results for the effect of statutory tax rates on fixed-income trading assets. We bootstrap all standard errors and cluster them by bank group and country–month–year. This clustering accounts both for shocks that affect the bank group as a whole (e.g., negative press coverage) and for time-specific shocks in individual countries (such as new laws that affect all affiliates in the country). In Column 1, we report results for the specification without country or affiliate fixed effects to use the full variation present in the sample. We find a significantly negative coefficient of −2.99. This coefficient indicates that a 1 percentage point lower corporate tax rate implies on average 3 percent more fixed-income assets held for proprietary trading.

Column 2 includes country fixed effects to control for unobserved time-constant country characteristics. We find a similar coefficient (−4.38),

[29]These instruments are relevant as larger firms are more likely to open new affiliates (Arndt et al., 2012; Antras and Yeaple, 2014; Egger et al., 2020), and countries with higher demand are more likely to host foreign direct investment (Ramondo et al., 2015). At the same time, they should have no direct effect on proprietary trading, given the control variables we use in equation (1). The amount of proprietary trading assets in an affiliate should depend on total assets of the bank group, not on the proportion held in the headquarters; and how much trading takes place depends on economic activity (measured by GDP), not on population.

Table 3. Effect of tax rates on fixed-income trading assets

	(1)	(2)	(3)	(4) W95	(5)
Corporate tax rate	−2.985***	−4.376*	−3.058**	−2.893***	
	(−6.69)	(−1.70)	(−1.98)	(−6.37)	
Corporate tax differential					−3.034***
					(−6.92)
IHS(Total assets)	0.551***	0.516***	0.128***	0.547***	0.551***
	(34.10)	(30.69)	(5.81)	(38.96)	(34.12)
IHS(Bank group total assets)	0.807***	0.612***	0.437***	0.851***	0.837***
	(9.06)	(7.29)	(8.89)	(8.16)	(9.35)
IHS(GDP)	0.226***	−1.365***	−1.971***	0.297***	0.227***
	(6.01)	(−3.15)	(−6.35)	(7.15)	(6.05)
Inflation rate	0.251***	−0.091***	−0.057***	0.236***	0.252***
	(7.41)	(−5.98)	(−6.52)	(6.84)	(7.44)
GDP growth	0.131***	0.066***	0.055***	0.121***	0.129***
	(9.59)	(5.18)	(6.84)	(8.77)	(9.53)
Financial sector share	0.866			2.215***	0.871
	(0.42)			(3.25)	(1.43)
Regulation	0.963***			0.949***	0.965***
	(14.41)			(13.95)	(14.43)
Basel III	−0.021	0.696***	0.267	−0.025	−0.020
	(−0.11)	(3.12)	(1.58)	(−0.12)	(−0.11)
Subsidiary dummy	−0.217**	−0.212		−0.224**	−0.217**
	(−2.01)	(−1.76)		(−2.34)	(−2.02)
Monthly time FE	Yes	Yes	Yes	Yes	Yes
Bank group FE	Yes	Yes	No	Yes	Yes
Affiliate FE	No	No	Yes	No	No
Country FE	No	Yes	No	No	No
Observations	16,668	16,721	16,720	16,668	16,668
R^2	0.423	0.547	0.880	0.425	0.424

Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015. The dependent variable is the inverse hyperbolic sine of fixed-income securities held for trading. Appendix C defines all variables. In Column 4, we report the results of the Wooldridge (1995) selection model (W95). Monthly bank data for December 2010 to December 2015. z-statistics are given in parentheses, based on bootstrapped standard errors clustered by bank group and by country–month–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

significant at the 10 percent level. In Column 3, we include affiliate fixed effects, which control for time-constant attributes of the individual subsidiaries and branches.[30] In this specification, we again see a similar coefficient (−3.06), significant at the 5 percent level.

[30]If an affiliate relocates to a different country, our data would show one affiliate closing and a new one opening. Therefore, as affiliates do not change location, affiliate fixed effects subsume country fixed effects.

Column 4 reports the results of the selection model. The estimated coefficient for the tax rate is −2.89. The inverse Mills ratios are positive and significant on a 10 percent level for 32 of the 49 months in this sample, implying that there are selection effects. As one might expect, this means that countries in which banks prefer to hold trading assets are also more attractive to establish an affiliate.

In Column 5, we use the difference between an affiliate's tax rate and asset-weighted average tax rate of the bank group as the main explanatory variable. This specification has the advantage that it uses variation in the tax rate in all countries where the bank is active, and not just in the host country. Thus, a potential correlation between changes in tax rates and confounding factors at the host-country level is less likely. We find a highly significant coefficient of −3.03.

In all specifications, the tax semi-elasticity of fixed-income trading assets is around −3 to −4. We further explore the composition of this response by separating effects at the intensive and extensive margin in Table 4. In Columns 1 and 2 we use only observations with positive trading assets to study the intensive margin. We now use the natural logarithm of fixed-income trading assets (instead of its inverse hyperbolic sine) as the dependent variable.[31] We find a tax coefficient of −3.3 in the specification without country fixed effects. When including country fixed effects, the coefficient is imprecisely estimated. Because of the small number of observations with positive trading assets and the short sample period, we likely lack the power to precisely estimate the coefficient.

To study responses at the extensive margin (i.e., whether affiliates are more likely to start holding fixed income trading assets when the tax rate decreases), we use a dummy variable that is equal to 1 if an affiliate has any fixed-income trading assets, and 0 otherwise, as the dependent variable in Columns 3 and 4. We find that a 10 percentage points lower profit tax rate increases the probability to hold trading assets by 1.4 percent to 5.6 percent (in the specifications without and with country fixed effects, respectively). These effects are small, suggesting that the decision whether an affiliate holds trading assets or not is also driven by many non-tax factors, such as the compliance costs of regulation. Note also that we do not observe all asset classes, and banks may decide to hold other trading assets.[32]

[31] While the inverse hyperbolic sine has the advantage of being defined at zero (see footnote 23), its interpretation for values close to zero is difficult. Thus, as the inverse hyperbolic sine has no advantage in a specification that does not include observations with zero trading assets, we use the natural logarithm here instead. For consistency, we also use the natural logarithm instead of the inverse hyperbolic sine for all control variables.

[32] In a further robustness test, we use the ratio of trading assets to total assets as the dependent variable. Results are qualitatively similar, with an estimated coefficient of −0.24 (z-statistic of

Table 4. Extensive and intensive margin responses

Dependent variable	ln(Trading assets)		Trading assets Yes/No	
	(1)	(2)	(3)	(4)
Corporate tax rate	−3.263***	0.520	−0.136***	−0.563***
	(−8.57)	(0.24)	(−3.92)	(−2.79)
ln(*Total assets*)	0.731***	0.764***	0.037***	0.035***
	(55.93)	(40.59)	(34.39)	(35.86)
ln(*Bank group total assets*)	0.038	−0.076	0.075***	0.057***
	(0.17)	(−0.36)	(8.49)	(8.17)
ln(*GDP*)	0.231***	−0.436	0.004	−0.135***
	(5.80)	(−1.39)	(1.33)	(−3.49)
Inflation rate	0.033***	−0.049***	0.022***	−0.007***
	(3.10)	(−4.05)	(9.25)	(−5.24)
GDP growth	−0.020**	−0.022***	0.012***	0.006***
	(−2.10)	(−2.62)	(9.59)	(5.00)
Financial sector share	0.760		−0.117**	
	(1.29)		(−2.30)	
Regulation	0.120***		0.076***	
	(2.84)		(15.40)	
Basel III	−1.441***	−0.317***	0.063***	0.097***
	(−7.86)	(−2.35)	(3.38)	(5.03)
Subsidiary dummy	−0.402***	−0.567***	0.012	0.001
	(−4.98)	(−5.72)	(1.32)	(0.11)
Monthly time FE	Yes	Yes	Yes	Yes
Bank group FE	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes
Observations	3,400	3,400	16,665	16,718
R^2	0.606	0.774	0.407	0.548

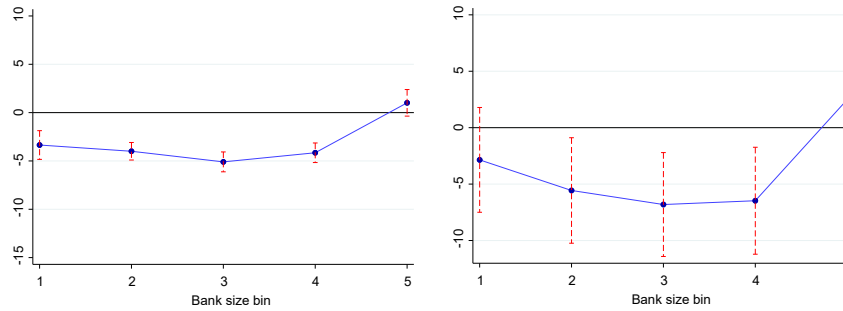
Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015. The dependent variable is the natural logarithm of fixed-income securities held for trading in Columns 1 and 2, and a dummy variable that is equal to one if the affiliate holds fixed-income securities for trading in Columns 3 and 4. Appendix C defines all variables. Monthly bank data for December 2010 to December 2015. z-statistics are given in parentheses, based on bootstrapped standard errors clustered by bank group and by country–month–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

4.4. Heterogeneity and robustness

We start by exploring whether the response of banks to tax incentives varies by size. Heckemeyer and de Mooij (2017) show that the leverage ratios of the very largest banks respond less to tax incentives than those of smaller banks – a surprising finding, given that large non-financial firms

−8.40) without country fixed effects, and −0.24 (z-statistic of −1.35) with country fixed effects. Note also that the estimated coefficients for the extensive margin only tell us how many affiliates start trading, and not how many trading assets they hold. The effects for these affiliates can be large.

Figure 4. Heterogeneity by bank size



Notes: Estimated coefficients and 95 percent confidence intervals for different quintiles of bank size. The left (right) panel shows coefficients for regression without (with) country fixed effects. The cut-offs for the size bins are 86 million, 491 million, 1.3 billion and 3.5 billion euros. Data from the Deutsche Bundesbank's External Positions of Banks database, December 2010 to December 2015.

are more responsive to taxation than smaller firms. We thus divide the bank affiliates in our sample into size quintiles (based on total assets), and estimate the effect of the tax rate by interacting it with the quintile indicator. Figure 4 shows the results when using the full variation, that is, without country fixed effects (in the left panel) and with country fixed effects (in the right panel). In both specifications, effects increase with bank size for the first three quintiles. Surprisingly, but similar to the results of Heckemeyer and de Mooij (2017), the largest banks (with total assets of at least 3.5 billion euros) do not react to tax incentives at all. There are two potential explanations for this finding. First, the largest bank affiliates might not be paying profit tax, either because they make or made losses, or because they have other, more cost-effective tax planning strategies. Second, regulatory constraints on the amount of proprietary trading might be binding.

Next, we test whether branches or subsidiaries react more strongly to tax incentives to relocate proprietary trading assets in response to tax rate differentials. To do so, we re-estimate equation (1) adding an interaction term between the tax rate and a dummy for branches. Columns 1 and 2 in Table 5 present the results. In the specification with country fixed effects (Column 2), it shows that a 1 percentage point lower corporate tax rates implies 4.7 percent more proprietary trading assets in branches, but only 1.9 percent more proprietary trading assets in subsidiaries. Also, in the specification without country fixed effects, branches drive the effect. A potential explanation is that branches are only regulated as part of the consolidated entity (and not additionally on their own, as subsidiaries are); therefore, it is more attractive to hold highly risky assets in branches.

We also test whether German CFC rules are effective at curbing the relocation of proprietary trading assets. We create a dummy variable that

Table 5. Heterogeneity analysis

	(1)	(2)	(3)	(4)
Corporate tax rate	3.027***	−1.864	−2.644***	−4.405
	(3.55)	(−0.71)	(−5.38)	(−1.61)
Branch × tax rate	−8.519***	−2.823**		
	(−8.81)	(−2.47)		
CFC dummy × tax rate			−0.347	−0.247
			(−0.39)	(−0.25)
Subsidiary	−2.157***	−0.853***		−0.216*
	(−8.72)	(−3.01)		(1.95)
CFC dummy			0.304	0.157
			(1.50)	(0.72)
Control variables	Yes	Yes	Yes	Yes
Monthly time FE	Yes	Yes	Yes	Yes
Bank group FE	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes
Observations	16,668	16,721	16,668	16,721
R^2	0.428	0.548	0.424	0.547

Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015. The dependent variable is the inverse hyperbolic sine of fixed-income securities held for trading. Appendix C defines all variables. Monthly bank data for December 2010 to December 2015. *z*-statistics are given in parentheses, based on bootstrapped standard errors clustered by bank group and by country–month–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

is one for affiliates for whom the German CFC rule might be binding (i.e., the dummy is one in countries outside the European Economic Area that have a tax rate of less than 25 percent). We then interact this dummy variable with the corporate tax rate. Columns 3 and 4 in Table 5 present the results, showing specifications without and with country fixed effects. The interaction term is insignificant and close to zero in both specifications (as is the coefficient on the CFC dummy itself), indicating that CFC rules are ineffective at curbing this form of profit shifting. As discussed in footnote 13, this might be the case because the German CFC rule exempts banks under relatively loose conditions.

In the following, we try to address potential issues with our analysis. There might be a worry that the United Kingdom alone is driving these results, as London is the most important banking location in Europe. Table 1 confirms this observation: German bank groups hold more trading assets in the United Kingdom than in any other foreign country. To address this issue, we re-estimate our regressions after dropping affiliates in the United Kingdom from the sample.[33] Results are very similar to the main

[33]The resulting sample includes 15,172 observations from 59 bank groups.

regressions, with an estimated coefficient for the tax rate variable of −3.46 (z-statistic, −7.8) with bank group and time fixed effects, and −13.99 (z-statistic, −4.5) when additionally including country fixed effects.[34]

As our dataset spans a relatively short time period, many of the tax rate changes we use for identification in the specification with country fixed effects are relatively small. As larger changes in the tax rates are more salient than small changes, we might expect a stronger response to larger tax rate changes. To test this, we re-estimate our regressions using only the 13 countries that changed their tax rate by more than 3 percentage points between December 2010 and December 2015. As expected, we find substantially larger semi-elasticities in these tests: with bank group and time fixed effects, we estimate a coefficient for the tax rate of −4.8 (95 percent confidence interval: −8.1; −0.9), and of −11.1 (95 percent confidence interval: −19.6; −2.6) when additionally including country fixed effects. Note that the confidence intervals are large, as these effects are identified using relatively few countries.

In some countries, commercial banking and proprietary trading have to be in separate legal entities. Germany, which is the home country of the banks in our main dataset, passed such a law in 2013. It became effective in July 2016. In principle, we expect that such laws do not affect the incentives to relocate proprietary trading to low-tax jurisdictions.[35] Moreover, our data end in December 2015, more than half a year before the law came into effect, and the law affects only the largest banks. Nevertheless, in a further robustness check, we aggregate the data over all affiliates of a bank group in a country to account for a potential shifting of trading assets between entities in anticipation of the new law. The regression results are very similar to the main results.

4.5. Profit shifting or shifting of real activity?

Banks can relocate proprietary trading in two ways. One possibility is to move all activities related to proprietary trading (such as formulating the trading strategy, deciding on individual investments, and actual trading) to a low-tax country (i.e., to relocate "real" activities). The other possibility is to relocate only the actual trading assets to the low-tax country, while the

[34]When we exclude both the UK and the US, the tax rate coefficients are −3.30 (z-statistic, −7.1) and −13.20 (z-statistic, −4.1) in the specifications with and without country-fixed effects, respectively.

[35]The law requires a bank in Germany to separate proprietary trading if its holds more than € 100 billion trading assets on its balance sheet or if it has total assets of more than € 90 billion of which at least 20 percent are trading assets. For a discussion of the German specialized banking law, see Dombret et al. (2014).

investment specialists, who set the investment strategy and decide in which specific securities to invest, remain in headquarters or in other, specialized affiliates. In this case, only book assets are relocated, and the relocation of these assets would constitute a pure profit-shifting strategy.[36]

As investment specialists are well educated, costly personnel, the tax incentive is to deduct their cost in the high-tax country. Thus, to minimize their tax burden, we expect that banks relocate proprietary trading activities in name only, while most of the real activity (i.e., decisions on trading strategy, etc.) remains in high-tax countries.

It is important to separate profit-shifting strategies from the relocation of real activities (which would be the case if all trading activities were relocated), as the welfare implications of the two strategies can differ. While profit shifting erodes tax revenues in high-tax countries, it can also increase investment there as it lowers the cost of capital. Its overall effect on welfare in the host country is thus ambiguous (see Peralta et al., 2006; Hong and Smart, 2010). In contrast, the welfare effect of the relocation of real activities is usually negative, as tax revenue and employment are lost. This conclusion holds even if banks' proprietary trading activities cause negative externalities, as these negative effects likely persist also when the bank relocates its trading activities to a tax haven. Thus, while a government might strategically choose to allow some profit shifting, it will not desire to allow the relocation of real activity.

Empirically, separating these two options is challenging, as we do not observe information on the number of traders. The closest we can get is by matching information on the total number of employees from the MiDi, also provided by the Bundesbank.[37] These data are available at the yearly level and for foreign subsidiaries and branches whose total assets exceed €3 million.

As a first test, we check whether the number of employees reacts to taxation, estimating

$$IHS(Employees_{ijkt}) = \beta_0 + \beta_1 CTR_{ijkt} + \beta_2 X_{ijkt} + \delta_k + \gamma_t + \phi_j + u_{ijkt}. \quad (3)$$

The dependent variable is now the inverse hyperbolic sine of the number of employees in affiliate i of bank group k in country j at time t, γ_t

[36] In this distinction, we follow the idea from the OECD's base erosion and profit shifting (BEPS) project that in the absence of profit shifting, profits should be taxed where value is created. Following the literature that assesses aggregate amounts of profits shifted (e.g. Tørsløv et al., 2018), we use employment as a proxy for value creation.

[37] Unfortunately, there is no data on the share of employees working in proprietary trading, and for most banks annual reports do not report it. Deutsche Bank reports that about 9 percent of its employees work in "Corporate Banking & Securities", which includes trading. We presume that the share of employees in trading is larger for smaller banks, which have few branches for direct customer access.

Table 6. Effects on real activity (IHS of employees)

		IV: trading of headquarters			
		All		Low-tax	High-tax
	(1)	(2)	(3)	(4)	(5)
CTR	0.173				
	(0.06)				
IHS(Trading)		0.126	0.142	0.153	0.201**
		(1.09)	(0.69)	(0.35)	(0.17)
Controls	Yes	Yes	Yes	Yes	Yes
Year and bank group FE	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	No	Yes	No	No
First-stage coefficient		0.304***	0.283***	0.280***	0.362*
First-stage F		20.923	12.822	8.326	9.185
Observations	960	1,060	1,059	734	326
R^2	0.726	0.284	0.110	0.301	0.228

Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015 and Microdatabase Direct Investment 2010–2015. The dependent variable is the inverse hyperbolic sine of the number of employees. "All" indicates that the sample consists of all foreign affiliates of German banks. "Low-tax" refers to affiliates that face a lower tax rate than the German headquarters (30 percent) and "high-tax" refers to the other entities. *IHS(Trading)* is the inverse hyperbolic sine of fixed-income trading assets, instrumented by the inverse hyperbolic sine of trading assets in the German headquarters. Yearly data from 2010 to 2015. z-statistics are given in parentheses, based on standard errors clustered by bank group and by country–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

are now year dummies, and all other variables are as defined above. If banks relocate real activities in the form of traders in response to a lower tax rate, we would see a negative coefficient for β_1. If the coefficient is close to zero, it suggests that the relocation of proprietary trading is profit shifting. Note that we include country fixed effects ϕ_j in the estimation of equation (3) to control for time-constant unobserved characteristics that might co-determine tax rates and the number of employees, such as being a remote island.

Column 1 of Table 6 reports the results. We find a small and insignificant coefficient of 0.17, which suggests that employment, and thus the number of traders, does not react to tax rate changes. However, one needs to treat this result cautiously, as the coefficient is imprecisely estimated.[38]

To strengthen these results, we employ a second strategy and test whether the trading activity itself affects the number of employees. We estimate the following model,

[38] In a regression without country fixed effects (not reported in the table), we also obtain a small and insignificant coefficient of −0.23. The coefficient remains insignificant also when using lagged values of the tax rate.

$$IHS(Employees_{ijkt}) = \beta_0 + \beta_1 IHS(Trading_{ijkt}) + \beta_2 \Xi_{kt} + \delta_k + \gamma_t + \phi_j + u_{ijkt}, \quad (4)$$

where Ξ_{kt} are the country-level control variables discussed in Section 4.2. Again, if the relocation of proprietary trading constitutes a profit-shifting strategy, we expect an insignificant coefficient for β_1. If banks relocate real activities when they shift trading assets to low-tax countries, we should observe a positive and significant coefficient for β_1. Note, however, that insignificant results in these regressions might again also indicate insufficient variation, and that proprietary trading is carried out with little personnel and instead largely based on algorithms.

As more employees can also manage more proprietary trading assets, there might be a reverse causality problem. To address this, we instrument $IHS(Trading_{ijkt})$ with the sum of trading assets in the headquarters of affiliate i. Trading assets in the headquarters should not directly influence employment in a particular affiliate, but are related to the trading assets in the considered affiliate via the bank group's overall trading strategy.

Table 6 presents the results. Columns 2 and 3 present these results without and with country fixed effects. In both specifications, we find an insignificant estimate for the effect of trading assets on employment. These estimates indicate that an increase in trading assets does not necessarily induce an increase in the number of traders. However, as the standard errors are large, this interpretation has again to be treated with caution.

In Columns 3 and 4, we further analyze the relationship between trading assets and employment by splitting the sample into low-tax and high-tax countries (defined as countries with a lower/higher tax rate than that of the German headquarters, 30 percent). We find that there is no significant relationship in low-tax countries, but in high-tax countries the number of employees increases with the volume of trading assets. The estimated coefficient is significant and more than double the coefficient from Column 4. Hence, more trading assets imply more traders in high-tax countries, but not in low-tax countries. Taken together, these results suggest that the relocation of trading assets indeed most likely constitutes a profit-shifting strategy.

4.6. Robustness test with Bankscope data

We now turn to evidence from bank groups headquartered all over the world by using Bureau van Dijk's Bankscope dataset. We first assess the relevance of the disadvantages of this dataset. As discussed above, Bankscope has several problems regarding its coverage. First, information from tax havens is missing systematically, as in other datasets provided by Bureau van Dijk (Tørsløv et al., 2018). Second, it does not include branches. The latter would

not be problematic if branches and subsidiaries responded in the same way to tax incentives. In the regressions above, we included a subsidiary dummy, which is significant in many specifications. Table 5 additionally confirmed that branches largely drive our findings. Thus, at least for German banks, ignoring branches would lead to systematically biased results.

Nevertheless, as a robustness test and to see whether our results also hold in a more international sample, we also re-estimate our regressions using the Bankscope dataset (see Appendix D for details). Using this dataset, we find tax semi-elasticities of trading assets around −8 using variation across countries. The estimated coefficients are larger than those in Table 3, indicating that German banks are less responsive to taxation than their international competitors, possibly because Germany has relatively strict banking regulation and anti-tax avoidance rules. Estimating the same regressions with country fixed effects, we continue to find negative coefficients, but statistically not different from zero. Likely, the estimated coefficients are not significant due to the low coverage of bank subsidiaries especially in low-tax countries, combined with the fact that few low-tax countries substantially changed their tax rates.

In sum, the results using Bankscope data confirm our main results, even though the Bankscope dataset does not include information on branches, which hold a large share of trading assets, and coverage of subsidiaries is also patchy. Appendix D discusses the Bankscope results in more detail.

5. Descriptive evidence on trading derivatives

So far we have considered fixed-income trading assets. From December 2013 onwards, the Bundesbank data also include information on derivatives held for trading. As banks hold, on average, far more derivatives than fixed-income trading assets (see Table 2), we now provide some descriptive evidence that banks also relocate trading derivatives in response to tax rate differentials.

The data on derivatives are only available for December 2013 to December 2015, and there were only very few tax rate changes during this period. Thus, we cannot use country fixed effects. Instead, in Table 7, we present descriptive evidence using the cross-country variation (Column 1), the selection model (Column 2), and using the tax rate differential as an explanatory variable (Column 3).[39]

In all specifications, the estimated coefficient for the corporate tax rate is significant and negative. The results indicate tax semi-elasticities between

[39]In the selection model, 20 of the 25 inverse Mills ratios are significant, again suggesting that selection effects matter in principle, despite the similar coefficients for the tax rate.

Table 7. Effect of tax rates on trading derivatives

	(1)	(2) W95	(3)
Corporate tax rate	−9.346***	−9.133***	
	(−20.16)	(−17.56)	
Corporate tax differential			−4.026***
			(−12.79)
IHS(*Total assets*)	0.728***	0.723***	0.729***
	(20.47)	(23.40)	(19.98)
IHS(*Bank group total assets*)	−0.310	−0.338	−0.276
	(−1.29)	(−1.16)	(−1.08)
IHS(*GDP*)	0.721***	0.810***	0.717***
	(11.98)	(10.98)	(12.40)
Inflation rate	0.167***	0.143***	0.168***
	(4.22)	(3.44)	(4.74)
GDP growth	0.094***	0.088***	0.093***
	(3.65)	(3.67)	(3.66)
Financial sector share	−6.149***	−4.562***	−6.172***
	(−6.47)	(−3.97)	(−6.15)
Regulation	0.961***	0.937***	0.961***
	(10.86)	(10.57)	(11.50)
Basel III	−1.161***	−1.170***	−1.161***
	(−4.53)	(−4.69)	(−4.41)
Subsidiary dummy	−1.381***	−1.362***	−1.381***
	(−8.41)	(−8.31)	(−7.70)
Monthly time FE	Yes	Yes	Yes
Bank group FE	Yes	Yes	Yes
R^2	0.571	0.573	0.571
Observations	6,398	6,398	6,398

Notes: Data from the Deutsche Bundesbank's External Positions of Banks database 2010–2015. The dependent variable is the inverse hyperbolic sine of derivatives held for trading. Appendix C defines all variables. In Column 3, we report the results of the Wooldridge (1995) selection model (W95). Monthly bank data for December 2013 to December 2015. z-statistics in parentheses, based on bootstrapped standard errors clustered by bank group and by country–month–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

−4 and −9. This suggests that derivatives may respond even more strongly to tax rate differentials than fixed-income trading assets do. Given that derivatives – as the more risky asset – should be more profitable than fixed-income trading assets, it is not surprising that they also respond strongly to profit-shifting incentives.[40]

[40]As a robustness check, we again re-estimate this specification without bank affiliates in the United Kingdom. The estimated tax coefficient of −8.86 (z-statistic: −8.93) confirms that also the results on derivatives are not driven by this financial center.

6. Importance of proprietary trading as a profit-shifting channel

The financial sector is very important for tax revenues in some countries: in the United Kingdom in 2000, it contributed 36 percent of tax revenues, while employing only 4 percent of the workforce (Devereux et al., 2004). In Germany, too, the financial sector is a very important revenue source, contributing 26 percent of corporate tax revenues in 2014 (Statistisches Bundesamt, 2019).

How much of these tax revenues are lost because of the relocation of trading assets? This is an important question for policymakers looking into whether implementing rules against this form of profit shifting (e.g., by strengthening CFC rules) is sensible. To help answer this question, we conduct a back-of-the-envelope calculation and apply the estimated elasticities on the observed data of trading assets. While such an estimation has to rely on many assumptions and can deliver only a rough estimate, it provides some sense for the importance of the profit-shifting channel discussed in this paper.

We proceed as follows. We take the estimated tax semi-elasticities in Column 1 of both Table 3 and Table 7 and estimate the percentage change in trading assets if the affiliate had paid a tax of 30 percent (like the German headquarters). We then multiply this percentage change with the actual level of trading assets in each affiliate.[41] We interpret the result as the amount of trading assets that are located in the affiliate for tax reasons. We then multiply these trading assets with an exogenously chosen trading profitability. Finally, we multiply these trading gains with the German tax rate (30 percent) to arrive at an estimate for the tax revenue loss.

There are several potential problems with this approach. First, we apply our estimated semi-elasticities to non-marginal increases in the tax rate.[42] Second, we do not account for the general equilibrium effects of a hypothetical tax increase in all affiliates that pay less tax than the German headquarters. Third, we do not know how profitable the proprietary trading activities are.

To calculate the revenue loss, we need to make an assumption about the profitability of trading assets. For fixed-income trading assets, we assume a constant profitability of 1 percent (a relatively conservative estimate). For derivatives, assuming an average return is difficult, as some derivatives are

[41] If our estimated semi-elasticities imply a decline by more than the total volume of trading assets held in the affiliate, we assume that the affiliate reduces its trading assets to zero.

[42] For better comparability, we use the estimated coefficient from the specification without country fixed effects also for fixed-income trading assets. Using the smaller coefficient from the regression without country fixed effects yields a slightly more conservative estimate. Unfortunately, we are unable to use elasticities that differ by bank affiliate size, as this would violate the confidentiality requirements by the Bundesbank. Given that the results in Figure 4 indicate no effect for the largest bank affiliates (but larger effects for medium-sized banks), our back-of-the-envelope estimate might overestimate the revenue loss.

Table 8. Implied tax revenue loss in million euros

Year	Fixed-income trading assets	Trading derivatives
2011	38.6	
2012	41.4	
2013	39.6	
2014	45.7	269.5
2015	53.4	389.1

Notes: Calculated annual revenue loss of the German tax authorities due to German multinational banks relocating proprietary trading activities, assuming an exogenous profitability of fixed-income trading assets (trading derivatives) of 1 percent (0.3 percent).

valued at notional values and/or held for hedging purposes. Therefore, we collected by hand information about the average profitability of proprietary trading from the financial statements of the major German banks, using information specific to derivatives where available. The average return for 2014 and 2015 (i.e., the years from which we have data on derivatives) was 0.3 percent. We therefore assume a 0.3 percent return in our back-of-the-envelope calculation. Note that our revenue loss estimates a linear in the return; that is, if we assume twice this return, our estimates double (if we assume half this return, they halve).

We only consider trading assets that were shifted out of Germany, and not those assets that might be shifted to Germany for tax reasons. We do so as our back-of-the-envelope calculation asks what would happen if Germany implemented strict rules against this form of profit shifting. To answer this policy-relevant question, only profit shifted out of Germany is of interest.

Table 8 summarizes the results of this back-of-the-envelope calculation. With the assumptions discussed above, we estimate that the German government lost €442 million in tax revenues in 2015, or about 5 percent of the total taxes paid by German banks.

While these calculations present only a rough estimate and should thus be treated with caution, they nevertheless show that the strategic location of proprietary trading activities is a quantitatively important channel for tax avoidance in the financial sector. Note that we can only calculate tax revenue losses for two specific asset types. As banks can also use other asset types for proprietary trading (e.g., equities), the total revenue loss is likely higher.

7. Conclusion

In this paper, we analyze how banks relocate their proprietary trading in response to corporate taxation. With our preferred data on German multinational banks, we find in our baseline regressions that a 1 percentage point lower corporate tax rate increases fixed-income trading assets held in an affiliate in that country by about 4 percent, and trading derivatives by

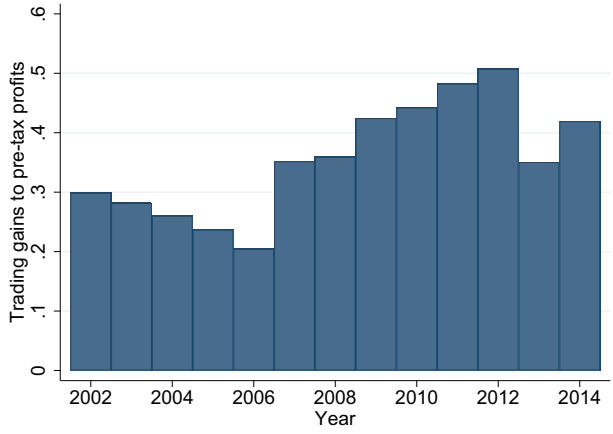
about 9 percent. Our results are qualitatively robust to estimation with more international data from Bankscope. Moreover, we find suggestive evidence that the increase mainly stems from an "artificial" shifting of trading activities: banks transfer only trading assets to lower-taxed affiliates, not employees.

Our results show that proprietary trading responds very strongly to tax rate differentials. This observation calls for a policy response – for example, re-thinking the broad exemptions for banks in CFC rules, which are one of the main policy measures to limit profit shifting. However, differentiating active and passive income for banks requires different criteria than for firms in other sectors. In addition, our results point out that proprietary trading is very mobile in general. Thus, it is likely also to be highly responsive to non-tax incentives (e.g., regulatory differences). Regulators need to take these results into account: if a new regulation on proprietary trading only shifts activities abroad, it might not fulfill its aims. The high mobility of proprietary trading supports the call for an internationally harmonized banking regulation.

Future research could expand our work in several ways. First, it would be interesting to know more on the types of assets that banks hold for proprietary trading in low-tax countries. The Bundesbank data only provide information on fixed-income trading assets and on trading derivatives. The information offered in Bankscope on different types of trading assets is also very sparse. Second, future work could address whether the shifting patterns change when a bank or its affiliates make losses.

Appendix A. Trading Profits, 2002–2014

Figure A1. Mean trading gains as share of pre-tax-profits



Notes: Trading gains relative to pre-tax profits for banks in our Bankscope sample (described in Appendix D), profitable banks only.
Source: Bankscope.

Appendix B. Corporate tax rates on bank profits

Table B1. Corporate tax rates (CTRs) and capital gains tax rates (CGTs) in percent

Country	2011			2014		
	CTR general	CTR banks	CGT banks	CTR general	CTR banks	CGT banks
Argentina	35	35	35	35	35	35
Australia	30	30	30	30	30	30
Austria	25	25	25	25	25	25
Belgium	33.99	33.99	33.99	33.99	33.99	33.99
Brazil	34	40	40	34	40	40
Bulgaria	10	10	10	10	10	10
Canada[a,b]	28	28	19.75	26.5	26.5	19
Cayman Islands	0	0	0	0	0	0
Chile	20	20	20	20	20	20
China	25	25	25	25	25	25
Czech Republic	19	19	19	19	19	19
Denmark	25	25	25	24.5	24.5	24.5
Finland	26	26	26	20	20	20
France	34.43	34.43	34.43	34.43	34.43	34.43
Germany	29.37	29.37	29.37	29.58	29.58	29.58
Greece	20	20	20	26	26	26
Hong Kong	16.5	16.5	0	16.5	16.5	0
Hungary	19	19	19	19	19	19
India	32.45	32.45	32.45	33.99	33.99	33.99
Indonesia[a]	25	25	25	25	25	25
Iran	25	25	25	25	25	25
Ireland[b]	12.5	12.5	25	12.5	12.5	33
Italy	31.4	32.15	32.15	31	31.7	31.7
Japan	40.69	40.69	40.69	36.9	36.9	36.9
Jersey	0	10	10	0	10	10
Korea	24.2	24.2	24.2	24.2	24.2	24.2
Luxembourg	28.8	28.8	28.8	29.22	29.22	29.22
Malaysia	25	25	25	25	25	25
Malta	35	35	35	35	35	35
Mauritius	18.4	18.4	18.4	18.4	18.4	18.4
Mexico	30	30	30	30	30	30
Netherlands	25	25	25	25	25	25
New Zealand	28	28	28	28	28	28
Norway	28	28	28	27	27	27
Pakistan	35	35	35	34	35	35
Peru	30	30	30	30	30	30
Philippines	30	30	7	30	30	7
Poland	19	19	19	19	19	19
Portugal	29	29	29	31.5	31.5	31.5
Qatar	10	10	10	10	10	10

Table B1. Continued

Country	2011			2014		
	CTR general	CTR banks	CGT banks	CTR general	CTR banks	CGT banks
Russian Federation	20	20	20	20	20	20
Saudi Arabia	20	20	20	20	20	20
Singapore	17	17	0	17	17	0
Slovakia	19	19	19	22	22	22
South Africa[a]	34.55	34.55	14	28	28	18.648
Spain	30	30	30	30	30	30
Sri Lanka	28	28	0	28	28	0
Sweden	26.3	26.3	26.3	22	22	22
Switzerland	18.31	18.31	18.31	17.92	17.92	17.92
Taiwan	17	17	17	17	17	17
Thailand	30	30	30	20	20	20
Turkey	20	20	20	20	20	20
Ukraine	23	23	23	18	18	10
United Arab Emirates	0	20	20	0	20	20
United Kingdom	26	26	26	21	21	21
United States	40	40	40	40	40	40
Vietnam	25	25	25	22	22	22

Notes: Tax rate data from Ernst & Young (2011–2015) and KPMG (2016). CTR denotes statutory corporate tax rates. [a]indicates countries where we take special taxes on branches into account. Other countries can also levy branch taxes, but these are not applied to capital gains or not relevant for firms headquartered in Germany. [b]indicates countries that do not apply the capital gains tax rate to frequent trading activities that are part of a business's purpose; therefore, the corporate tax rate is relevant for proprietary trading. Countries listed are all countries in which German banks have affiliates (except Curaçao, which we exclude because we cannot determine the appropriate tax rate).

Appendix C. Variable definitions

Variable definitions and sources are as follows (note that data sources marked with an asterisk are complemented by data from national statistical offices available online).

Bundesbank data.

Fixed-income trading assets. Bonds and debt securities held for trading (Source: External Positions of Banks database 2010–2015).

Trading derivatives. Absolute sum of derivatives with positive and negative fair value that are held for trading (Source: External Positions of Banks database 2010–2015).

Total assets. Total external assets held in the affiliate (Source: External Positions of Banks database 2010–2015).

Bank group total assets. Total external assets in all affiliates and in the headquarters of a bank group (Source: External Positions of Banks database 2010–2015).

Employees. Number of employees in the affiliate (Source: Microdatabase Direct Investment 2010–2015).

Subsidiary dummy. This equals 1 if foreign affiliate is a separate legal entity (Source: External Positions of Banks database 2010–2015).

Bankscope data.

Trading assets. Total trading assets at fair value (Source: Bankscope).

Total assets. Total assets of the affiliate (Source: Bankscope).

Country-level variables.

Corporate tax rate. Statutory tax rate applicable to bank profits in the form of corporate capital gains (Source: Ernst & Young (2011–2015)).

Corporate tax differential. Difference between the statutory tax rate on bank profits in the affiliate's home country and the average tax rate of the bank group, weighted by assets (Source: Own calculations).

GDP. Nominal gross domestic product, interpolated from quarterly to monthly values using the proportional Denton method (Bloem et al., 2001) (Source: IMF, OECD*).

Inflation rate. Consumer price inflation rate (Source: IMF*).

GDP growth. Annual growth rate of real GDP (Source: IMF*).

Financial sector share. Share of the banking and insurance sector in a country's gross value added, fixed at the beginning of the sample period (Source: OECD*).

Regulation. Index on the regulation of securities activities (securities underwriting, brokering, dealing, and all aspects of the mutual fund industry); unrestricted = 1, permitted with limits = 2, tight restriction = 3, prohibited = 4 (Source: Barth et al. (2013)).

Basel III. Dummy that equals one for subsidiaries if the country where the subsidiary is active has the countercyclical capital buffer as required by Basel III in place, zero otherwise (Source: Basel Committee on Banking Supervision (2020)).

Appendix D. Analysis with Bankscope data

We use Bankscope data from 2002 to 2014.[43] We consider a bank to be a subsidiary if the parent bank owns more than 50 percent of its shares. We use only unconsolidated data and eliminate central banks and governmental credit institutions from our sample. After dropping all observations with missing or negative total assets, loans, or trading assets, 3,886 firm–year observations remain. The sample covers 1,011 individual banks, which belong to 698 bank groups. Table D1 presents the basic descriptives for this dataset.

Table D1. Descriptive statistics for Bankscope data

Variable	Obs.	Mean	Std dev.	p1	p50	p99
Trading assets (million USD)	3,886	1,457	15,210	0	5	27,320
Total assets (million USD)	3,886	20,980	103,600	34	2,321	304,200
Corporate tax rate	3,886	0.317	0.094	0.000	0.373	0.407
Nominal GDP (billion USD)	3,886	7,673	7,289	16	2,667	17,442
Inflation rate (%)	3,886	2.440	2.450	−0.666	1.999	10.621
GDP growth (%)	3,886	1.991	3.019	−2.861	1.877	10.630
Regulation	3,886	2.048	0.956	1	2	3
Financial sector share	3,886	0.086	0.353	0.027	0.067	0.210
Basel III dummy	3,886	0.075	0.263	0	0	1

Notes: Data from the Bankscope database of Bureau van Dijk. All variables at annual frequency for 2002 to 2014.

[43]Note that Bankscope is no longer available. Bureau van Dijk replaced it with Orbis Bank Focus at the end of 2016. Orbis Bank Focus contains only three years of historical data for most banks and has similar coverage issues as Bankscope.

Table D2. Regressions with Bankscope data

	Sample I		Sample II	
	(1)	(2)	(3)	(4)
Corporate tax rate	−8.015***	−5.303	−5.177**	−5.752
	(−3.24)	(−0.73)	(−2.15)	(−0.70)
Controls	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Bank group fixed effects	Yes	No	Yes	No
Country fixed effects	No	Yes	No	Yes
R^2	0.845	0.601	0.612	0.426
Observations	3,886	3,886	1,450	1,450

Notes: Data from the Bankscope database of Bureau van Dijk. The dependent variable is the inverse hyperbolic sine of trading assets. Control variables are the inverse hyperbolic sines of total assets, bank group total assets and GDP, inflation, GDP growth, financial sector share, regulation, and Basel III dummy. Sample I includes all banks, and sample II is a subsample of banks that have at least one foreign subsidiary within the Bankscope dataset. Yearly bank data for 2002–2014. z-statistics in parentheses, based on bootstrapped standard errors clustered by bank group and by country–year. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

As the Bankscope dataset is not complete and is missing information on foreign branches, we cannot exactly identify which bank groups are active internationally and which are not. We thus run our regressions on two subsamples. First, we use the full sample, which also includes purely domestic banks (sample I). Second, we restrict the sample to banks that either have at least one subsidiary in a foreign country within the Bankscope data, or are themselves a subsidiary of an internationally active bank group (sample II). As Bankscope does not have full coverage of all affiliates, this sample selection step implies that we also drop some banks that were, in fact, multinational.

Table D2 presents the estimation results. We regress the inverse hyperbolic sine of overall trading assets on the corporate tax rate and a set of control variables. As shown in Columns 1 and 3, we find that a 1 percentage point decrease in the tax rate increases trading assets by 8.0 percent in sample I, and by 5.2 percent in sample II.[44] In Columns 2 and 4, we report results including country fixed effects. The point estimates are similar also in these regressions, but not significant. This is likely because there is little variation in the tax rates, and almost no variation in tax havens.

[44]The fact that we find a smaller coefficient in sample II indicates that some banks that are only in sample I react strongly to tax rates. Likely, these banks use branches in other countries. Note, however, that the difference between the estimates is not statistically significant.

Supporting information

Additional supporting information can be found online in the supporting information section at the end of the article.

Replication files

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