CESifo WORKING PAPERS

6664
2017

September 2017

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
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Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
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CESifo *Working Paper No. 6664*
Category 1: Public Finance

Trading Offshore: Evidence on Banks' Tax Avoidance

Abstract

Little is known about how banks shift profits to low-tax countries. Because of their specific business model, banks use profit shifting channels different from those of other 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 one percentage point lower corporate tax rate increases banks' fixed-income trading assets by 4.0% and trading derivatives by 9.0%. This increase does not arise from a relocation of real activities (i.e. traders); instead, it stems from the relocation of book profits.

JEL-Codes: H250, G210, F210.

Keywords: profit shifting, multinational banks, corporate taxation, proprietary trading.

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September 2017
We thank Mihir Desai, Philipp Dörrenberg, Tom Gresik, Andreas Hauer, Niels Johannesen, Ken Okamura, Thomas Schwab, Martin Simmler, Hans-Werner Sinn, John Vella and participants of the MaTax meeting in Mannheim, the Doctoral Meeting of the Oxford University Centre for Business Taxation, the CESifo Area Conference on Public Sector Economics, the annual conference of the International Institute for Public Finance, and of seminars in Augsburg, Bergen, Mannheim and Munich for helpful comments and suggestions. Langenmayr visited Oxford University Centre for Business Taxation while working on this paper; she is grateful for their hospitality. She also gratefully acknowledges financial support from the German Research Foundation (LA 3565/1-1) and Deutsche Bundesbank. Reiter gratefully acknowledges financial support from the Egon-Sohmen-Foundation. We also thank Deutsche Bundesbank for granting access to the External Position of Banks database.

1 Introduction

During the financial crisis of 2007-2008, bank bailouts burdened governments with enormous debts. The bailout of just one Irish bank, Anglo Irish, cost the Irish government € 25 billion, or 11.3% of GDP (Acharya, Drechsler, and Schnabl, 2014). In this situation, many commentators asked whether banks pay their fair share in taxes. Anecdotal evidence indeed suggests that banks pay little tax: According to The Independent (2015), five of the world's biggest investment banks (JP Morgan, Bank of America Merrill Lynch, Deutsche Bank AG, Nomura Holding and Morgan Stanley) paid no corporate tax in the United Kingdom in 2014, despite some of them reporting profits of several hundred million U.S. dollars there. Yet despite the importance of the financial sector, there is little systematic evidence on this question, as most studies on corporate tax avoidance exclude the financial sector.

One reason for excluding the financial sector when studying profit shifting is that the business model of financial firms differs so substantially from other firms. For manufacturing and non-financial services, the literature has pointed out three main profit shifting channels: Internal loans, the manipulation of transfer prices, and the strategic relocation of intellectual property. Of these three, banks can primarily use internal loans to shift substantial amounts to low-tax countries.[1] At the same time, research has shown that internal debt is not the dominant profit shifting channel (Heckemeyer and Overesch, 2017). Thus, the question how financial firms shift profits is largely unanswered. To address this question, we propose a new and quantitatively important profit shifting channel specific to the financial sector: The strategic relocation of assets held for proprietary trading.

A second reason why few researchers have studied banks' tax avoidance is that most large datasets on multinational banks only cover subsidiaries, not branches. 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 tax rate (Cerutti, Dell'Ariccia, and Peria, 2007). In this paper, we use a newly available regulatory dataset provided by the German central bank (the External Positions of Banks database). This dataset

[1] To a limited extent, banks can also use the other two profit shifting channels. Banks may have some intellectual property (e.g. their brand name), and also set transfer prices (e.g. for fees or loans). However, the amounts shifted in these ways are small relative to other sectors (e.g. the intellectual property of Apple or Amazon, or the transfer pricing possibilities in a vertically integrated manufacturing firm).

includes information on all foreign subsidiaries and branches of German banks. The data is of exceptional quality and provides a complete picture of the foreign activities of all German banks. We also confirm that our findings hold for banks headquartered outside Germany by using Bureau van Dijk's Bankscope dataset.

We propose that banks relocate proprietary trading to shift profits to low-tax countries. Proprietary trading is very profitable, so relocating it to low-tax jurisdictions lowers total tax payments substantially.[2] 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 carry out the trades.

Our results confirm that banks indeed relocate proprietary trading to countries with lower tax rates. Using variation within bank groups and over time, we show that a one percentage point lower tax rate increases fixed-income proprietary trading assets held in an affiliate by 4.0% on average, and trading derivatives by 9.0%. These results are robust to different specifications, e.g. using a selection model to control for the strategic placement of affiliates, and to using a completely different, international dataset.

We find a tax semi-elasticity of -4.0 for fixed-income trading assets. Comparing this number to other estimates of tax semi-elasticities from the literature, it becomes clear that proprietary trading reacts especially strongly to taxation. According to the meta-study of Heckemeyer and Overesch (2017), the average tax semi-elasticity of pre-tax profits is -0.8. 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. As gains from proprietary trading are large, the strategic relocation of proprietary trading constitutes a major profit shifting channel.

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

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

interpret the second strategy as profit shifting. In our empirical study, we test if banks also increase employment in response to a tax-induced increase in proprietary trading. We find that a tax-induced increase in trading assets does not result in additional employment, confirming that the tax-induced relocation of proprietary trading is indeed a profit-shifting strategy.

We also document that taxes are a quantitatively important determinant of the location of trading assets. Using our estimated semi-elasticities, we conduct a back-of-the-envelope calculation of the implied tax savings. Assuming a 2% return to proprietary trading, banks lower their total tax payments by about 8% due to this profit shifting strategy alone.[3]

Our paper contributes to three separate strands of literature. First, it adds 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 risk (Dell'Ariccia and Marquez, 2010) and regulation (Buch, 2003; Houston, Lin, and Ma, 2012).

Second, we also contribute to the more specialised literature on proprietary trading. Studying German equity trades, Hau (2001a) and Hau (2001b) show that foreign traders realize lower proprietary trading profits than domestic traders. Fecht, Hackethal, and Karabulut (2017) 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 has not considered the impact of taxation.

Third, we also contribute to the literature on the effect of taxation on the location of corporate activities and corporate profits (see e.g. Clausing, 2003; Desai, Foley, and Hines, 2004; Desai and Dharmapala, 2006; Huizinga and Laeven, 2008; Dischinger and Riedel, 2011; Dharmapala and Riedel, 2013; Dharmapala, 2014) by pointing out 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, Voget, and Wagner (2014) show that corporate tax rates negatively affect foreign direct investment and pre-tax profits of

[3]The implied loss for the German tax authorities is 32% of the tax revenue currently collected from banks. Banks' tax payments decrease by a lower amount, as they have to pay tax elsewhere.

[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.

banks. Heckemeyer and de Mooij (2017) study the influence of taxation on leverage for both banks and non-banks and find that on average, the marginal effect of taxation is similar in both groups. Gu, de Mooij, and Poghosyan (2015) show that bank debt reacts to both corporate tax rates and within-firm tax differentials, indicating profit shifting by internal debt. Merz and Overesch (2016) analyze how various balance-sheet items of multinational banks respond to taxation. 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.

The following section provides some background on proprietary trading and the taxation of banks. Section 3 discusses our hypotheses and Section 4 describes the data. Section 5 provides evidence on fixed-income assets, and Section 6 on derivatives held for trading. Section 7 offers a back-of-the-envelope calculation of the magnitude of the effects. Section 8 concludes.

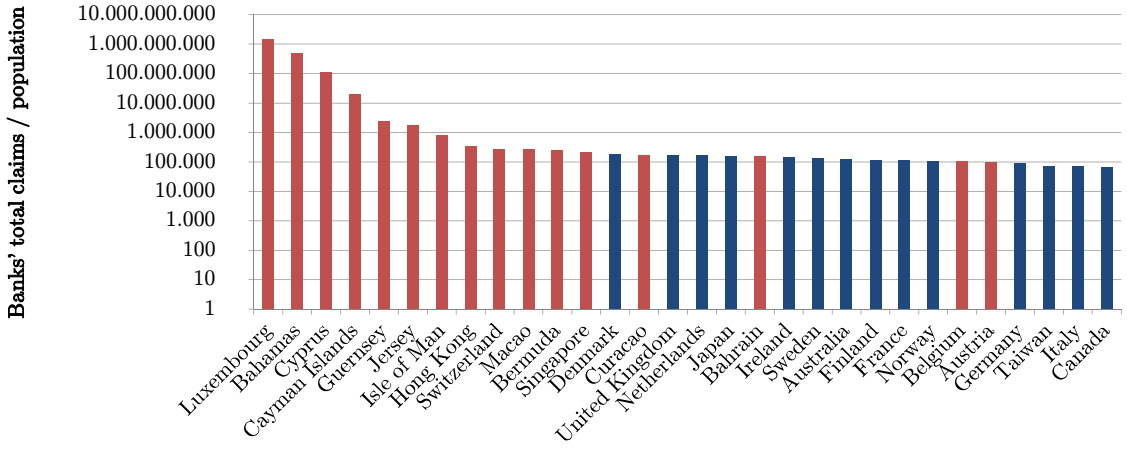
2 Background: Proprietary Trading and Tax Incentives

Banks are very active in tax havens (see Figure 1). However, Figure 1 tells us nothing about the kind of activities that banks carry out in these countries. In general, two criteria are important for moving a function to a low-tax country. First, the activity should be relatively mobile, so that the cost of relocating it are low. Second, it should be highly profitable, so that there is a large tax saving of moving it to the tax haven. One candidate for such an activity is banks' proprietary trading.

Proprietary trades are all trades in stocks, bonds, derivatives or any other financial instrument that a bank carries out with its own money (as opposed to the depositors' money). Many banks derive a large share of their profits from proprietary trading. In our international Bankscope sample, gains from proprietary trading account on average for 39% of banks' pre-tax profits; for German banks, Bundesbank (2016) reports that gains from trading account for 32% of after-tax profits. Proprietary trading thus meets the criterion of being highly profitable.

Proprietary trading activities are also highly mobile. Banks do not have to develop the trading strategy in the same location as where they carry out the trades. While

FIGURE 1: Banks are very active in tax havens

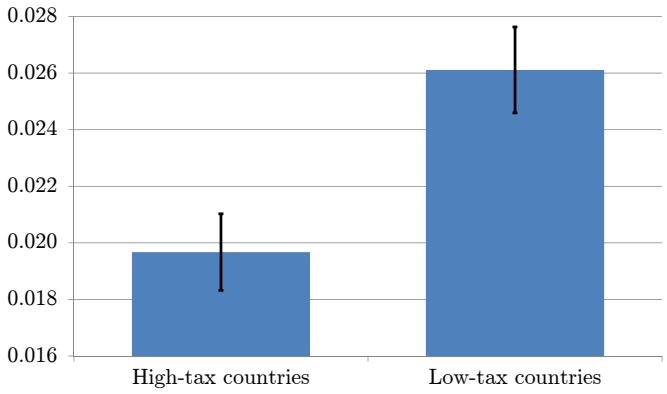


Banks' total claims per capita as of Q4/2015. Red bars indicate countries that Johannesen and Zucman (2014) classify as tax havens. Logarithmic scale on the vertical axis. Calculated from bank asset data from the Bank for International Settlements (2017) and population data from the International Monetary Fund (2016).

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.

Figure 2 shows the ratio of fixed-income trading assets to total 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.

FIGURE 2: Trading assets as share of total assets



Fixed-income trading assets relative to total assets in our sample of German multinational banks and their foreign affiliates (described in Section 4). High-tax countries are countries with a statutory corporate tax rate $\geq 30\%$ (the German tax rate), low-tax countries are all other countries. Bars indicate 95% intervals. Source: Bundesbank (2015a).

In the following, we will differentiate between "profit shifting" and the "real" relocation of proprietary trading. We will call the relocation of trading activities "profit shifting" if banks relocate few employees to the low-tax country, i.e. when the bank sets the trading strategy in a high-tax country and traders in the low-tax country only carry out the exact instructions they receive from abroad. In contrast, if a bank relocates a significant number of employees, we will classify this action as a relocation of real activities.

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 data set, 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.[5] Moreover, our data ends in December 2015, more than half a year before the law came into effect. Furthermore, the law affects only the largest banks. As a robustness check, we also 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, and find very similar results.

Gains from proprietary trading are usually taxed at the same rate as profits from

[5]It 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% are trading assets. For a discussion of the German specialized banking law see Dombret, Liebig, and Stein (2014).

other banking activities. Note, however, that a few countries have specific corporate tax rates on banks or apply other tax rates on capital gains of corporations. An example 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. In this paper, we use these specific tax rates when applicable. Appendix 1 gives an overview over both the tax rate that applies to banks' proprietary trading profits and the general corporate tax rate.

What other tax rules could be relevant? Controlled-foreign-corporation rules (CFC rules) come to mind. Such rules, often in place in high-tax countries, attribute passive income from foreign subsidiaries to the tax base of the parent company. However, in many countries, bank profits are exempt from CFC rules (Deloitte, 2014). German CFC rules, in particular, exclude banks under relatively loose conditions.[6] As all banks in our main dataset on the External Positions of German Banks are headquartered in Germany, we will not incorporate CFC rules in the following considerations.

3 Hypotheses

Our paper aims to answer two questions: Do banks strategically relocate their proprietary trading to low-tax countries? And, if they do so, is this a profit shifting strategy or do they relocate real activities?

An extensive literature has shown that firms relocate activities in response to tax rate differentials (for a survey see Devereux and Loretz, 2013). However, most firms remain headquartered in high-tax countries, and face additional costs when they relocate activities away from their headquarter (Dischinger, Knoll, and Riedel, 2014b). Therefore, when deciding which activities to relocate to low-tax countries, firms will take into account two factors: first, the cost of relocating the activity; and second, its profitability, which determines the potential tax savings.

As discussed in Section 2, proprietary trading meets these two criteria. Thus, in the first part of the paper, we test the following hypothesis:

[6]German CFC rules completely exclude income from banking under the condition of a 'commercially organized business operation' in the foreign affiliate (see 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). In that case, a service contract with another affiliate was sufficient.

Hypothesis 1 *Proprietary trading activities of banks are decreasing in the corporate tax rate.*

Banks can relocate proprietary trading in two ways: One possibility is to move all activities related to proprietary trading (such as the formation of trading strategy, the decision on individual investments and the actual trading) to a low-tax country. The other possibility is to relocate only the actual trading to the low-tax country, while the investment specialists, who set the investment strategy and decide in which specific securities to invest, remain in the headquarter or in other, specialised affiliates. As these 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. We thus propose the following second hypothesis:

Hypothesis 2 *The relocation of trading activities to low-taxed affiliates takes place without additional employees in low-tax countries.*

If this hypothesis holds, the relocation of proprietary trading would constitute a "profit shifting" strategy, similar to shifting profits by relocating patents in industrial firms.[7] 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 may 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 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.

[7]For empirical evidence on the relocation of patents, see e.g. Karkinsky and Riedel (2012).

4 Data and Descriptive Analysis

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

Our main data source is the External Positions of Banks database of the German central bank (Bundesbank, 2015a). The Bundesbank collects this data for regulatory purposes as well as an input to calculate both monetary and balance of payment statistics. The database covers all German banks, including all majority-owned foreign branches and subsidiaries. We observe every foreign subsidiary and an aggregated value for each bank's branches in a country.[8] The sample consists of 106 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 is 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.

To study whether the relocation of proprietary trading is a form of profit shifting or the relocation of real activity, we merge in employment 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.[9] Moreover, to construct our control variables, we use country level information from various sources (see Appendix 2 for details).

To test Hypothesis 1, we use two different dependent variables: Fixed-income assets held for proprietary trading, and derivatives held for proprietary trading. Both variables measure the current value of trading assets held in an affiliate.[10] We cannot use stocks held for trading, as the Bundesbank data does not differentiate between stocks held for trading and those held as liquidity reserve. Unfortunately, the data for derivatives are available only for a shorter time period (December 2013 to December 2015).

In which countries do German banks hold their trading assets? In Table 1, we

[8] We also observe information on the German headquarter. As Dischinger, Knoll, and Riedel (2014a) show that firms are reluctant to shift profits away from their headquarters, we do not use this information when estimating tax semi-elasticities.

[9] For a detailed description of this data set, see Lipponer (2011).

[10] 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.

list the top ten countries in which German bank groups had the most proprietary trading assets in 2014.[11] Outside of the home market 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.[12] 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 legally independent subsidiaries (e.g. in Luxembourg). Banks tend to hold more derivatives than fixed-income assets for proprietary trading. However, derivatives are more concentrated in the home market Germany.

Table 1: Top 10 countries for trading activities in 2014

	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

Data from External Positions of Banks database of Bundesbank (2015a). Totals of fixed-income securities and derivatives that are held for trading by German multinational banks, in million euro. Countries in which less than three banks are active are not shown here due to confidentiality requirements.

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

[11] Due to the confidentiality requirements of the Bundesbank, we cannot list countries in which less than three German banks conduct proprietary trading.

[12] 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. For instance, seven of Deutsche Bank's eight securities trading firms in the US are based in Wilmington, Delaware (Deutsche Bank AG, 2014). Unfortunately we cannot observe the exact location of a bank affiliate within the US in our data set. As a robustness check we also estimate eq. (1) without affiliates in the US and find similar results.

headquartered in Germany. To address these concerns, we rerun our analysis using Bureau van Dijk's Bankscope dataset in Appendix 3. Large parts of the literature on the taxation and regulation of banks use this dataset (see e.g. Gu, de Mooij, and Poghosyan, 2015; Houston, Lin, and Ma, 2012; Huizinga, Voget, and Wagner, 2014; 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 data set 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 may introduce selection problems. 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 subsidiaries of German banks that are active in trading in Singapore. But in Bankscope there is only one German-owned bank active in Singapore, and there is no information on its trading assets.[13] Overall we prefer the Bundesbank data due to its comprehensive sample coverage and its 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 €255 million per foreign affiliate. There are significantly more derivatives held for trading (on average €2.721 billion per affiliate). As we observe derivatives only from 12/2013 to 12/2015, there are only 6,460 observations for trading derivatives, compared to 16,793 observations for the other monthly variables. On average, foreign affiliates of German banks have total assets of €4.8 billion.

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% of fixed-income assets (in 2014; the share for deriva-

[13]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.	p1	p50	p99	Frequ.
Fixed-income trading assets (million €)	16,793	255	2,401	0	0	2,910	M
Trading derivatives (million €)	6,460	2,721	28,600	0	0	56,000	M
Total assets (million €)	16,793	4,851	27,000	0	727	95,300	M
Corporate tax rate	16,793	0.241	0.103	0.000	0.250	0.400	M
Nominal GDP (million €)	16,793	121,626	235,432	197	35,523	1,175,961	Q → M
Inflation rate (%)	16,793	2.154	2.946	-1.399	1.818	11.468	M
GDP growth (%)	16,793	1.922	2.753	-4.426	1.829	9.436	Q → M
Regulation	16,793	1.349	0.681	1	1	3	-
Financial sector share	16,793	0.106	0.095	0.031	0.069	0.422	Q → M
Subsidiary dummy	16,793	0.280	0.449	0	0	1	M
Bank group total assets (million €)	16,793	345,000	503,000	29	65,200	1,410,000	M
Employees (yearly)	1,290	785	3478	0	64	16,314	A

Sample period from 12/2010 to 12/2015, except for trading derivatives, which are only available from 12/2013 to 12/2015. $M/Q/A$ indicate monthly, quarterly and annual frequency. We calculate monthly GDP from interpolated quarterly GDP values using the proportional Denton method as described in Bloem, Dippelsman, and Mæhle (2001), and monthly GDP growth from these values. We derive the monthly financial sector share by cubic spline interpolation. For data sources see Appendix 2.

tives is even higher). In fact, 33% of affiliates hold no trading assets.[14] 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).

5 Evidence on Fixed-Income Trading Assets

5.1 Case Study

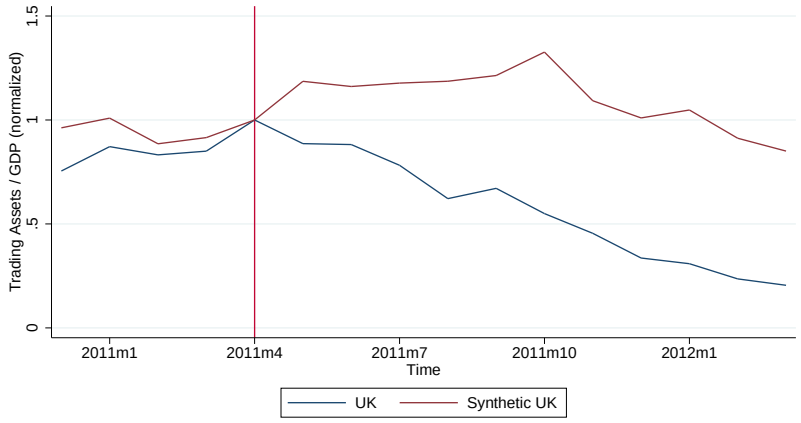
We first consider some illustrative evidence from the United Kingdom. The United Kingdom started a series of annual corporate tax rate cuts in 2011. In a first step, it cut the corporate tax rate from 28% to 26% in April 2011, and already announced further cuts (BBC, 2011). As the United Kingdom is the largest foreign country in which German banks hold trading assets (see Table 1), these tax rates 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 to other countries.

To investigate how proprietary trading in German bank affiliates in the United Kingdom responded to the tax rate cut, we evaluate the time trend in total fixed income trading assets relative to GDP held by German banks in the United Kingdom. As a counterfactual we construct a synthetic control country for the United Kingdom as suggested by Abadie, Diamond, and Hainmueller (2010), based on trading assets/GDP in the pre-treatment period. In the donor pool there are all countries in which at least three German multinational banks have affiliates.[15] Figure 3 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.

[14] If we exclude these affiliates from our analysis, we obtain similar results.

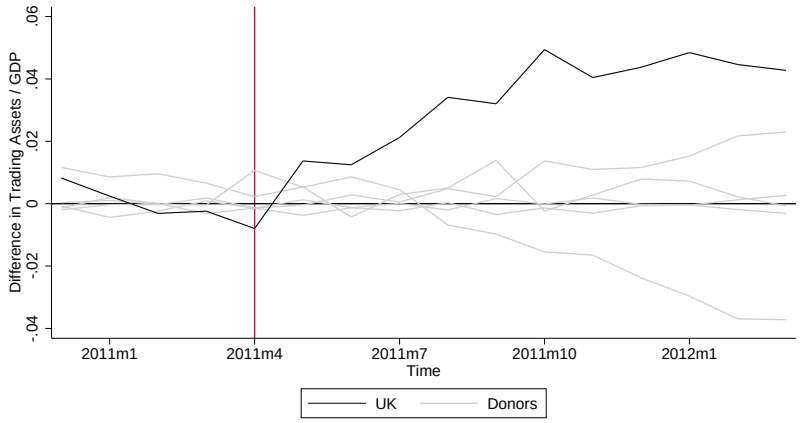
[15] The resulting synthetic control country for the United Kingdom consists of 96% Hong Kong and 4% Singapore.

FIGURE 3: Trading assets/GDP in the UK and in a synthetic UK



The red line shows the time trend in fixed-income trading assets / GDP of German bank affiliates in the United Kingdom. The blue line shows the time trend of the same variable of a synthetic control for the United Kingdom. Series are normalized (04/2011 = 1) due to confidentiality requirements. Source: Bundesbank (2015a).

FIGURE 4: Impact on trading assets/GDP relative to synthetic controls



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: Bundesbank (2015a).

In Figure 4, 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. Due to the confidentiality restrictions of the Bundesbank, we can carry out this analysis only for countries in which more than three German bank groups have

subsidiaries or branches. The dark line in Figure 4 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 British corporate tax rate cut 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.

5.2 Empirical Strategy

5.2.1 Test of Hypothesis 1

In our first hypothesis, we proposed 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:

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

The dependent variable, $IHS(\text{Trading Assets}_{ijkt})$ 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).[16] 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. δ_k are bank-group fixed effects, γ_t are monthly time fixed effects, and ϕ_j are country fixed effects. If Hypothesis 1 holds, we should observe $\beta_1 < 0$, as banks prefer low-tax countries to conduct their proprietary trading.

A potential threat to identifying a causal effect in cross-country regressions is that country characteristics other than the tax rate determine a country's attractiveness for

[16]The inverse hyperbolic sine transformation is $IHS(y) = \ln\left(y_i + \left(y_i^2 + 1\right)^{0.5}\right)$, 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 (MacKinnon and Magee, 1990; Burbidge, Magee, and Robb, 1988).

proprietary trading. To address this concern, we use two 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.[17] Second, we use a selection model, which explicitly estimates the attractiveness of each country for proprietary trading (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.[18] We also include an index on the regulation of securities activities based on the World Bank survey on bank regulation in 2011 (World Bank, 2011). It measures the extent to which banks may engage 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. Appendix 2 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. Moreover, we control for the inverse hyperbolic sine of the bank group's overall total assets. This variable absorbs time-variant 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)

Our second strategy to control for the attractiveness of countries is to estimate a selection model using a two-stage estimator. We use the estimator proposed by

[17] 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.

[18] 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% in the United Kingdom and 13% in Singapore, compared to 4% in Germany and 4% in France.

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.[19] This estimation strategy explicitly controls for banks strategically locating their subsidiaries in low-tax jurisdictions.[20] In more detail, wer proceed as follows: In the first step, we estimate the selection model using a probit specification. As additional variables in the first stage we use the inverse hyperbolic sines of the total assets of the parent and the population of the host country. In the second step, we use the predictions 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 with these additional explanatory variables.

5.2.2 Test of Hypothesis 2

Next, we test whether the relocation of proprietary trading is mostly a shifting of book profits or the result of the relocation of real activities. As an indicator for real activity we use employment in the affiliate.

Our second hypothesis predicts that an increase in trading activities in response to a tax rate decrease takes place without additional employees. To test this hypothesis, we use the following model:

$$IHS\left(\text{Employees}_{ijkt}\right) = \beta_0 + \beta_1 IHS(\text{Trading}_{ijkt}) + \beta_2 X_{ijkt} + \delta_k + \gamma_t + \phi_j + u_{ijkt}. \quad (2)$$

The dependent variable is now $IHS\left(\text{Employees}_{ijkt}\right)$, the inverse hyperbolic sine of the number of employees in bank affiliate i of bank group k in country j in year t. The other variables are as defined above. As we observe employees in a different dataset with annual frequency, we can test Hypothesis 2 only at the year level (thus γ_t are now year dummies). As we use country fixed effects, we only use variation in trading assets over time for identification, and not variation over subsidiaries. This ensures that we indeed look at potential relocations of trading assets. If Hypothesis 2 is true, we expect an

[19]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, Voget, and Wagner (2014) are an exception, they employ a Heckman selection model to estimate banks' pre-tax profit response to corporate tax rates.

[20]Huizinga and Voget (2009) show that international tax liabilities matter for M&A and thus for the structure of multinational firms.

insignificant coefficient for β_1. This would imply that rather than shifting real traders, banks shift only the bare execution of buying and selling to tax haven affiliates. 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 may also indicate insufficient variation over time.

As more employees can also manage more proprietary trading assets, there may be a reverse causality problem. To address this, we use two instrumental variable estimators. First, we instrument $IHS\left(\text{Trading}_{ijkt}\right)$ with the statutory corporate tax rate. This allows us to isolate the variation in trading assets that comes from changes in corporate tax rates. While this instrument fits well with our tests of Hypothesis 1, one may worry that the corporate tax rate could also directly influence the number of employees. This issue is likely small, as hiring and firing employees takes time. Nevertheless, we also provide evidence with an alternative instrument, namely the sum of trading assets in the headquarter of affiliate i. Trading assets in the headquarter 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.

Changes in country characteristics that correlate with employment and trading assets are again another threat to identification. As before, we use several country-level controls to address this threat. We thus again control for the inverse hyperbolic sine of GDP, for the inflation rate, GDP growth, the share of the financial sector and an index on the regulation of securities activities.

5.3 Regression Results

In this section we present the regression results. Table 3 reports the test of the first hypothesis, where we regress trading assets on the tax rate. Table 4 shows the results regarding the second hypothesis, testing whether banks relocate employees along with proprietary trading. 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).

5.3.1 Relocation of Proprietary Trading

In Table 3, we test the effect of statutory tax rates on fixed-income trading assets. In column (1) we report results for the specification without country fixed effects to use the full variation present in the sample. We find a significantly negative coefficient of -3.747. This coefficient indicates that a one percentage point lower corporate tax rate implies on average 3.747% more fixed-income assets held for proprietary trading.

TABLE 3: Effect of tax rates on fixed-income trading assets

	(1)	(2)	(3)
Wooldridge (1995) selection model			x
Corporate tax rate	-3.747***	-3.997*	-3.658***
	(-8.64)	(-1.68)	(-9.19)
IHS(Total assets)	0.547***	0.520***	0.525***
	(36.38)	(35.99)	(33.70)
IHS(Bank group total assets)	0.804***	0.605***	0.849***
	(9.06)	(7.54)	(9.82)
IHS(GDP)	0.248***	-1.275***	0.330***
	(6.82)	(-3.02)	(8.88)
Inflation rate	0.241***	-0.087***	0.225***
	(7.98)	(-5.80)	(7.03)
GDP growth	0.130***	0.068***	0.119***
	(9.59)	(4.82)	(7.75)
Financial sector share	1.328**	4.812	2.892***
	(2.12)	(1.03)	(4.36)
Regulation	0.983***		0.967***
	(15.13)		(15.68)
Subsidiary dummy	-0.208**	-0.135	-0.214**
	(-2.11)	(-1.06)	(-2.25)
Monthly time FE	Yes	Yes	Yes
Bank group FE	Yes	Yes	Yes
Country FE	No	Yes	No
Observations	16,793	16,793	16,793
R^2	0.425	0.547	0.426

Data from External Positions of Banks database of Bundesbank (2015a). The dependent variable is the inverse hyperbolic sine of fixed-income securities held for trading. Appendix 2 defines all variables. Monthly bank data for 12/2010-12/2015. t-statistics in parentheses, based on bootstrapped standard errors clustered by bank group and by country-month-year.

Our main specification (column 2) includes country fixed effects to control for unobserved time-constant country characteristics. We find a similar coefficient (-3.997), significant at the 10% level. Column (3) reports the results of the selection model. We find a tax semi-elasticity of -3.658 for fixed-income trading assets. The inverse Mills ratios are significant on a 10% level for 32 of the 49 months in this sample, implying

that there are selection effects.

In all, while the implied tax semi-elasticities are large, similar magnitudes have been found in other profit shifting contexts, e.g. a tax semi-elasticity for patents of -3.8 (Karkinsky and Riedel, 2012).

5.3.2 Profit Shifting or Shifting of Real Activity?

In Table 4, we test whether the strategic relocation of trading assets is due to the shifting of real activities, or a "profit shifting" strategy where the actual activities continue to take place in high-tax countries. As described in Section 5.2.2, we now use the number of employees as the dependent variable. As this variable is only available at an annual basis, the number of observations in Table 4 is lower than in Table 3.

As we are interested in the employment effects of tax induced variation in trading assets, we use the corporate tax rate as an instrument for trading assets in columns (1) and (2). We first test the relationship in a specification without country fixed effects in column (1). Here, we find a weakly significant and positive coefficient for trading assets. As we use within bank group variation over different affiliates here, this confirms that generally more trading assets imply more employees are needed to conduct this trading. However, to determine whether a tax-induced relocation of trading assets accompanies a shifting of the trading personnel, we include country fixed effects in column (2). We then use variation in trading assets induced by tax rate changes for identification. We now find an insignificant coefficient for trading assets, which would support Hypothesis 2. However, the first stage F-statistic indicates a weak instrument problem in regression (2). Likely, this is the case as we can use only annual data for this test. As only few countries changed their tax rates in the sample period, there is insufficient variation over time.

To address the weak instrument problem, we use an alternative instrument in columns (3) to (6).[21] This instrument is the inverse hyperbolic sine of total trading assets in the German headquarter of the bank group. Columns (3) and (4) present these results with and without country fixed effects. In both specifications, we now find an insignificant estimate for the effect of trading assets on employment. Moreover, with country fixed effects the estimated coefficient reduces by about half. These estimates

[21] Another concern with the regressions in columns (1) and (2) may be that the corporate tax rate is not a valid instrument as it could be correlated with the error term. To test for this problem, we have estimated a reduced form regression of employees on the corporate tax rate and have not found a significant effect.

indicate that an increase in trading assets does not necessarily induce an increase in the number of traders.

In columns (5) and (6) we further analyse the relationship between trading assets and employment by splitting the sample into low-tax and high-tax countries. 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. Hence, more trading assets imply more traders in high-tax countries, but in not in low-tax countries.

TABLE 4: Effects on real activity (IHS of employees)

	IV: Corporate tax rate		IV: Trading of the headquarter			
	All	All	All	All	Low-tax	High-tax
	(1)	(2)	(3)	(4)	(5)	(6)
IHS(Trading)	0.177*	0.212	0.128	0.067	0.080	0.171**
	(1.69)	(0.02)	(1.09)	(0.56)	(0.66)	(2.02)
IHS(GDP)	0.303***	-0.205	0.338***	-0.139	0.266**	0.750***
	(4.00)	(-0.03)	(3.65)	(-0.22)	(2.54)	(8.40)
Inflation rate	0.037	0.002	0.067	0.002	0.045	0.160**
	(0.53)	(0.00)	(0.84)	(0.05)	(0.55)	(2.44)
GDP growth	-0.042*	-0.000	-0.036*	-0.004	-0.027	-0.045
	(-1.93)	(-0.00)	(-1.71)	(-0.22)	(-1.38)	(-0.79)
Financial sector share	-2.984**	6.304	-2.494*	5.997	-4.237***	-22.454
	(-2.45)	(0.02)	(-1.80)	(0.58)	(-2.65)	(-1.62)
Regulation	-0.313**		-0.274**		-0.022*	-0.623**
	(-2.39)		(-2.24)		(-1.87)	(-2.24)
Subsidiary dummy	1.076***	1.038	1.099***	1.148***	1.207***	0.172
	(5.96)	(0.18)	(6.15)	(5.00)	(6.95)	(0.43)
Year & Bank group FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	Yes	No	No
First stage F	10.611	0.236	15.373	12.822	9.825	9.185
Observations	1,065	1,064	1,065	1,064	743	320
Centered R^2	0.386	0.514	0.422	0.578	0.458	0.466

Data from External Positions of Banks database of Bundesbank (2015a,b). 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 headquarter (30%) and *High-tax* refers to the other entities. *IHS(Trading assets)* is the inverse hyperbolic sine of fixed-income trading assets; in columns (1) and (2) it is instrumented by the statutory corporate tax rate and in columns (3) to (6) it is instrumented by the inverse hyperbolic sine of trading assets in the German headquarter. Yearly data from 2010 to 2015. t-statistics in parentheses, based on standard errors clustered by bank group and by country-year.

Taken together these results are in line with our second hypothesis and suggest that a shifting of trading assets does not lead to more employees, neither in high-tax countries nor in low-tax countries. As a robustness test, we also confirm these results using the international Bankscope data set.

5.3.3 Robustness Test with Bankscope Data

As a robustness test, we also re-estimate our regressions using the Bankscope data set (see Appendix 3 for details). Using this data set, we find tax semi-elasticities of trading assets between -6.7 and -8.2 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 as there is little variation over time. The lower quality of the data set may also explain why we loose significance.

We also test in the Bankscope sample whether real activities are relocated together with proprietary trading assets. Regressing a bank affiliate's personnel expenses on trading assets and using trading in all other affiliates of the bank group as the instrument, we find no significant effects for low-tax countries. For high-tax countries the effect is significant. These results again indicate that the relocation of proprietary trading should be interpreted as a profit shifting strategy.

In sum, the results using Bankscope data confirm our main results, even though the Bankscope data set does not include information on branches, which hold a large share of trading assets. Appendix 3 discusses these results in more detail.

6 Descriptive Evidence on Trading Derivatives

So far we have considered fixed-income trading assets. From December 2013 onwards, the Bundesbank data also includes 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 is only available for December 2013 to December 2015, and there were only very few tax rate changes during this period. We thus cannot use country fixed effects. Instead, we present in Table 5 descriptive evidence using the cross-country variation (column 1) and the selection model (column 2).[22]

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

TABLE 5: Effect of tax rates on trading derivatives

	(1)	(2)
Wooldridge (1995) selection model		x
Corporate tax rate	-8.986***	-8.654***
	(-18.65)	(-15.88)
IHS(Total assets)	0.738***	0.735***
	(24.47)	(20.01)
IHS(Bank group total assets)	-0.315	-0.542***
	(-1.34)	(-5.62)
IHS(GDP)	0.641***	0.775***
	(11.85)	(13.39)
Inflation rate	0.162***	0.125***
	(5.04)	(3.98)
GDP growth	0.106***	0.099***
	(4.52)	(3.41)
Financial sector share	-6.626***	-4.149***
	(-7.05)	(-3.23)
Regulation	0.990***	0.957***
	(12.94)	(12.01)
Subsidiary dummy	-1.631***	-1.615***
	(-10.90)	(-9.38)
Monthly time FE	Yes	Yes
Bank group FE	Yes	Yes
R^2	0.565	0.568
Observations	6,460	6,460

Data from External Positions of Banks database of Bundesbank (2015a). The dependent variable is the inverse hyperbolic sine of derivatives held for trading. Appendix 2 defines all variables. Monthly bank data for 12/2013-12/2015. t-statistics in parentheses, based on bootstrapped standard errors clustered by bank group and by country-month-year.

In both specifications, the estimated coefficient for the corporate tax rate is significant and negative. The results indicate tax semi-elasticities between -8.654 and -8.986. 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.

7 Importance of Proprietary Trading as a Profit Shifting Channel

The estimated semi-elasticities in Section 5.3.1 and 6 imply substantial tax effects on trading assets. How much money do banks save through the relocation of trading assets? To answer this question, we conduct a back-of-the-envelope calculation of potential tax savings and apply the estimated elasticities on the observed data of trading assets. While such a back-of-the-envelope calculation has to rely on many assumptions and can deliver only a rough estimate, it allows us to get a feeling 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) in both Table 3 and Table 5 and estimate the percentage change in trading assets if the affiliate had paid a tax of 30% (like the German headquarter).[23] We then multiply this percentage change with the actual level of trading assets in each affiliate.[24] 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 actual tax rate differential to the German headquarter's 30% to arrive at an estimate for the tax savings from the relocated trading assets. Summing up over all affiliates that are taxed at lower rates than the German headquarter gives an estimate of the taxes a bank saves via this profit shifting channel.

There are several potential problems with this approach. First, we apply our estimated semi-elasticities to non-marginal increases in the tax rate. 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 headquarter. Third, we do not know how profitable the proprietary trading activities are. To address this last point, we carry out the estimation with different assumed rates of return.

Table 6 summarizes the results of this back-of-the-envelope calculation. Assuming a constant profitability of 1% (a relatively conservative estimate), our calculations suggest tax savings for 2015 of €450 million from the relocation of fixed-income trading assets

[23]For better comparability, we use the estimated coefficient from the specification without country fixed effects also for fixed-income trading assets. As the coefficient is very similar, the results differ only slightly if we use the coefficient from the estimation with country fixed effects. Using the smaller coefficient from the regression without country fixed effects yields a slightly more conservative estimate.

[24]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.

and trading derivatives.[25]

TABLE 6: Implied tax savings in million EUR

	Exogenous 1% profitability		MSCI World growth rate	
Year	Fixed-income trading assets	Trading derivatives	Fixed-income trading assets	Trading derivatives
2011	29.543		-2.576	
2012	27.928		31.727	
2013	23.579		39.269	
2014	25.486	262.952	40.148	429.510
2015	30.214	420.768	29.242	339.345

Calculated potential annual tax savings of German multinational banks by relocation of proprietary trading activities, assuming an exogenous profitability of trading assets of 1% on the left and a profitability corresponding to the monthly growth rate of the MSCI World Index on the right.

The profitability of proprietary trading in the real world is certainly not constant over time. To approximate changes in profitability over time, we re-estimate the tax savings assuming that profitability equals the growth rate of the MSCI World Index. The right-hand part of Table 6 reports these results. As the return on the MSCI World Index was negative in 2011, we obtain a negative value for implied tax savings in 2011 (due to the missed deduction possibilities of trading losses in higher-taxed affiliates). For 2015, these calculations imply a total tax saving of about €368 million, or 4% of banks' tax payments (€8.4 billion; see Bundesbank, 2016).

Several factors affect the development of these tax savings over time: First, the location of trading assets changes over time. Second, tax rate differentials change. Figure 5 illustrates how the implied potential tax savings per month evolve over time, assuming a constant 1% return. As data on trading derivatives begins only in 12/2013, the second panel captures a shorter time period. While the tax savings due to the relocation of fixed-income trading assets have remained relatively constant over time, the strategic location of trading derivatives has gained importance as tax avoidance channel: Between the start of 2014 and the end of 2015, the tax savings achieved by strategically locating derivatives held for trading in low-tax countries approximately doubled.

[25] With a 2% return on proprietary trading, the tax savings double.

FIGURE 5: Implied monthly tax savings from...

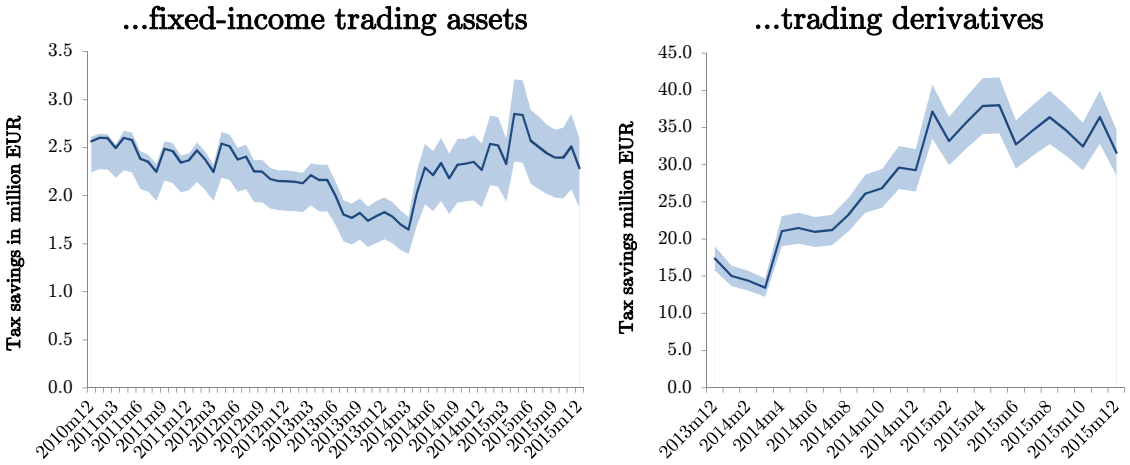


Illustration of implied monthly tax savings: if all lower taxed affiliates were taxed by 30%, our estimated semi-elasticities imply a decline in fixed-income trading assets and in trading derivatives in these affiliates. We calculate the implied tax savings assuming that these trading assets were held in the German headquarter instead and that they yield a constant rate of return of 1%. The shaded area illustrates the implied tax savings using the lower and upper bounds of the 95% confidence interval of the semi-elasticities estimated in Table 3.

Tax rate cuts in other countries also contributed to the tax savings of German banks. For example, tax rate cuts in the United Kingdom in April in each year in the sample result in visible increases of the tax savings of German banks.

How much tax revenue does the German government forego due to banks' relocation of proprietary trading assets? To answer this question, we multiply the estimated trading gains with the average German tax rate of 30% (instead of the tax rate differential between Germany and the country where the trading assets are held). With a 1% average return on trading assets, the German government lost €1.3 billion in tax revenues in 2015, or about 16% of the total taxes paid by German banks. If the return to proprietary trading was 2%, these numbers double.

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.[26]

[26]Note that we can only calculate tax savings for two specific asset types. As banks can also use other asset types for proprietary trading (e.g. shares), total tax savings are likely higher.

8 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 one percentage point lower corporate tax rate increases fixed-income trading assets held in an affiliate in that country by about 4.0%, and trading derivatives by about 9.0%. Our results are qualitatively robust to estimation with more international data from Bankscope. Moreover, we find 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 is very mobile. It responds very strongly to tax rate differentials. Thus, it is likely also 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 may 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 provides 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.

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Appendix 1: Corporate Tax Rates on Bank Profits

TABLE A1: Corporate tax rates (CTR) affecting banks' trading gains in %

Country	2011		2014	
	CTR general	CTR banks	CTR general	CTR banks
Argentina	35	35	35	35
Australia	30	30	30	30
Austria	25	25	25	25
Belgium	34	34	34	34
Brazil	34	40	34	40
Bulgaria	10	10	10	10
Canada	28	28	26.5	26.5
Cayman Islands	0	0	0	0
Chile	20	20	20	20
China	25	25	25	25
Curaçao	34.5	34.5	27.5	27.5
Czech Republic	19	19	19	19
Denmark	25	25	24.5	24.5
Finland	26	26	20	20
France	34.43	34.43	34.43	34.43
Germany	30	30	30	30
Greece	20	20	26	26
Hong Kong	16.5	0*	16.5	0*
Hungary	19	19	19	19
India	32.44	32.44	33.99	33.99
Indonesia	25	25	25	25
Iran	25	25	25	25
Ireland	12.5	12.5	12.5	12.5
Italy	31.4	32.15	31	31.7
Japan	40.69	40.69	35.64	35.64
Jersey	0	10	0	10
Korea	24.2	24.2	24.2	24.2
Luxembourg	28.8	28.8	29.22	29.22
Malaysia	25	25	25	25
Malta	35	35	35	35
Mauritius	15	15	15	15
Mexico	30	30	30	30
Netherlands	25	25	25	25
New Zealand	28	28	28	28
Norway	28	28	27	27
Pakistan	35	35	33	33
Peru	30	30	30	30
Philippines	30	30	30	30
Poland	19	19	19	19
Portugal	25	25	23	23
Qatar	10	10	10	10
Russian Federation	20	20	20	20

TABLE A1: Corporate tax rates (CTR) affecting banks' trading gains, continued

Country	2011		2014	
	CTR general	CTR banks	CTR general	CTR banks
Saudi Arabia	20	20	20	20
Singapore	17	0*	17	0*
Slovakia	19	19	22	22
South Africa	34.55	34.55	28	28
Spain	30	30	30	30
Sri Lanka	28	0*	28	0*
Sweden	26.3	26.3	22	22
Switzerland	21.17	21.17	21.15	21.15
Taiwan	17	17	17	17
Thailand	30	30	20	20
Turkey	20	20	20	20
Ukraine	23	23	18	18
United Arab Emirates	0	20	0	20
United Kingdom	26	26	21	21
United States	39.19	39.19	39.08	39.08
Vietnam	25	25	22	22

Tax rate data from Ernst & Young (2011, 2014) and KPMG (2016). CTR denotes statutory corporate tax rates. * indicates special tax rates applying to corporate capital gains such as gains from proprietary trading, not only to banks. Countries listed are all countries in which German banks have affiliates.

Appendix 2: Variable Definitions

TABLE A2: Variable definitions and sources

Variable	Definition	Source
Bundesbank Data		
Fixed-income trading assets	Bonds and debt securities held for trading	Bundesbank (2015a)
Trading derivatives	Absolute sum of derivatives with positive and negative fair value that are held for trading	Bundesbank (2015a)
Total assets	Total external assets held in the affiliate	Bundesbank (2015a)
Bank group total assets	Total assets in all affiliates and in the headquarter of a bank group	Bundesbank (2015a)
Employees	Number of employees in the affiliate	Bundesbank (2015b)
Subsidiary dummy	=1 if foreign affiliate is a separate legal entity	Bundesbank (2015a)
Bankscope Data		
Trading assets	Total trading assets at fair value	Bankscope
Total assets	Total assets of the affiliate	Bankscope
Personnel expenses	Annual personnel expenses	Bankscope
Country-level variables		
Corporate tax rate	Statutory tax rate applicable to bank profits in the form of corporate capital gains	Ernst & Young (2011, 2014)
GDP	Nminal gross domestic product, interpolated from quarterly to monthly values using the proportional Denton method (Bloem, Dippelsman, and Mæhle, 2001)	IMF, OECD*
Inflation rate	Consumer price inflation rate	IMF*
GDP growth	Annual growth rate of real GDP	IMF*
Financial sector share	Share of the banking and insurance sector in a country's gross value added, monthly values interpolated using cubic spline interpolation	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	Barth, Caprio, and Levine (2013)
Country average wage	Average wage in current prices	OECD*

Data sources marked with a * are complemented by data from national statistical offices available online.

Appendix 3: Analysis with Bankscope Data

To show that our results also hold in a more international sample, we also test both hypotheses using Bureau van Dijk's Bankscope data. As noted in Section 4, Bankscope has several problems regarding its coverage. A major disadvantage is that it does not cover branches.

We use Bankscope data from 2002 to 2014.[27] We consider a bank a subsidiary if the parent bank owns more than 50% 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, 3,744 firm-year observations remain. The sample covers 971 subsidiaries, which belong to 667 bank groups. Table A3 presents the basic descriptives for this dataset.

Table A3: Descriptive statistics for Bankscope data

Variable	Obs.	Mean	Std. Dev.	p1	p50	p99
Trading assets (million USD)	3,744	1,500	15,490	0	4	28,390
Total assets (million USD)	3,744	21,490	105,400	37	2,425	310,000
Corporate tax rate	3,744	0.324	0.093	0.000	0.373	0.400
Nominal GDP (billion USD)	3,744	7,896	7,222	16	3,545	17,351
Inflation rate (%)	3,744	2.259	2.169	-0.666	1.957	9.297
GDP growth (%)	3,744	1.882	2.960	-2.861	1.787	10.169
Regulation	3,744	2.060	0.956	1	2	3
Financial sector share	3,744	0.065	0.022	0.031	0.067	0.110
Personnel expenses (million USD)	3,480	211	1,325	1	28	3,510
Country average wage (USD)	3,480	46,774	21,139	2,509	52,438	94,881

Data from Bankscope database of Bureau van Dijk (2014). All variables on annual frequency for 2002 to 2014.

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.

[27] 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 A4 presents the estimation results, testing Hypothesis 1 in Panel A and Hypothesis 2 in Panel B. In Panel A, we regress the inverse hyperbolic sine of overall trading assets on the corporate tax rate and a set of control variables. Columns (1) and (2) show the results for sample I, and columns (3) and (4) for the smaller sample II. We find that a 1%-point decrease in the tax rate increases trading assets by 8.2% in sample I, and by 6.7% in sample II.[28] In columns (2) and (4), we report results including country fixed effects. The point estimates are negative 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.[29]

Due to the lack of sufficient variation in tax rates, we also cannot use the corporate tax rate as an instrument for trading assets when testing Hypothesis 2. The corporate tax rate is a weak instrument in all settings. Thus, we instrument the trading assets of an affiliate by the total volume of trading assets in all other affiliates of the same bank group. These results are reported in Panel B of Table A4.[30] The dependent variable in these regressions is the inverse hyperbolic sine of personnel expenses. As we now observe only personnel expenses, not the number of employees, we additionally control for the average wage in the country. We find that the volume of trading assets does not significantly affect personnel expenses in low-tax countries (countries with a lower tax rate than the headquarter of the affiliate). By contrast, in high-tax countries we find again significantly positive effects of trading assets on personnel expenses both with and without country fixed effects. In total, these results again confirm Hypothesis 2.[31]

[28]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.

[29]Only for 379 (out of 3744) observations the tax rate changes, and most of those are in Italy (131), the United Kingdom (76) and Bulgaria (24); in tax havens, there is only one observation with a tax rate change (in Curaçao).

[30]Panel B shows results only for sample I. Using sample II, we find very similar results.

[31]Unfortunately, the first stage F-statistics indicate a weak instrument problem in the regressions for low-tax countries. As we have no other plausible instrument available, we nevertheless report these results and acknowledge that the instrumental variable estimations are likely biased.

TABLE A4: Regressions with Bankscope data

Panel A: Effects on proprietary trading

	Sample I		Sample II	
	(1)	(2)	(3)	(4)
Corporate tax rate	-8.182***	-3.900	-6.731**	-10.641
	(-3.18)	(-0.49)	(-2.23)	(-1.21)
Controls and Year FE?	Yes	Yes	Yes	Yes
Bank group FE	Yes	No	Yes	No
Country FE	No	Yes	No	Yes
R^2	0.847	0.596	0.621	0.420
Observations	3,744	3,744	1,393	1,393

Panel B: Effects on real activity (sample I only)

	IV: Trading others			
	Low-tax	High-tax	Low-tax	High-tax
	(1)	(2)	(3)	(4)
IHS(Trading)	-0.051	0.305***	-0.021	0.294***
	(-0.01)	(5.46)	(-0.00)	(5.49)
Controls	Yes	Yes	Yes	Yes
Year & Bank group FE	Yes	Yes	Yes	Yes
Country FE	No	No	Yes	Yes
First stage F	2.051	167.781	2.621	182.044
Observations	976	2,428	973	2,428
Centered R^2	0.783	0.548	0.867	0.573

Data from Bankscope database of Bureau van Dijk (2014). The dependent variable in Panel A is IHS(Trading assets), and in Panel B IHS(Personnel expenses). Control variables are IHS(Total assets), IHS(GDP), inflation, GDP growth, financial sector share and regulation in Panel A and IHS(GDP), inflation, GDP growth, financial sector share, subsidiary dummy, IHS(country average wage) and regulation in Panel B. Sample I includes all banks, sample II is a sub-sample of banks that have at least one foreign subsidiary within the Bankscope data set. Yearly bank data for 2002-2014. t-statistics in parentheses, based on bootstrapped standard errors clustered by bank group and by country-year.