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Real Responses to Anti-Tax Avoidance: Evidence from the UK Worldwide Debt Cap

Abstract

We analyze how multinational firms reallocate real operations and debt across their affiliates in response to anti-tax avoidance policies. The UK introduced a worldwide debt cap in 2010, generating a quasi-natural experiment that limited interest deductibility for a group of multinational firms. We find that multinationals affected by the reform reduced the amount of debt held in the UK and increased debt held abroad. Affected multinationals reallocated a share of their real operations away from the UK. Our findings provide causal evidence for tax-motivated debt and real activity reallocation within multinationals and show how multinationals can circumvent tax avoidance regulations.

JEL-Codes: H250, H260.

Keywords: debt shifting, multinational companies, capital reallocation.

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1 Introduction

Multinational tax avoidance has been a subject of political discussion in recent years, as there is growing evidence that multinational corporations (MNCs) pay little tax (Bilicka, 2019; Torslov et al., 2018). The political pressure has been exacerbated by the revelations from Panama and Paradise papers that exposed details of some of the tax avoidance schemes to the public. Despite efforts to curb such practices, with countries around the world adopting various anti-tax avoidance measures, the extent of profit shifting has been increasing over time (Clausing, 2016). Therefore, it remains empirically unclear how effective these measures are. Even less is known about how anti-tax avoidance measures affect real business activities of multinational firms.

Allocating debt across different tax jurisdictions is a particularly popular method that MNCs use to lower their worldwide tax burden. Relative to a domestic firm, an MNC can easily shift debt across affiliates via its internal capital market. In this paper, we examine a new anti-tax avoidance measure that aims to tackle debt shifting by MNCs. In 2010, the UK pioneered implementing a worldwide anti-avoidance approach by introducing the Worldwide Debt Cap rule (WDC), which benchmarks the operation of MNCs in a single country against their worldwide activities. Such measures are becoming more prominent policy tools, with countries like the United States implementing similar restrictions in December 2017.[2] In its Action Plan for limiting Base Erosion involving interest deductions, the OECD suggests using the worldwide approach to complement the existing anti-debt shifting rules (OECD, 2015). In this paper, we provide the very first empirical investigation of the impact of this new anti-tax avoidance regulation.

We rely on the difference-in-differences (DID) methodology to draw a causal inference. The key feature of the UK's WDC is that it set up a maximum ratio of debt to be held in the UK relative to the overall debt for each MNC. Debt above the maximum ratio, the "gateway ratio", was disallowed for a tax deduction. Therefore, only MNCs that failed the gateway test were affected by the WDC. This feature allows us to use the DID approach to control for concurrent confounding effects, such as the UK's territorial tax system reform which applied to all UK firms, and provide causal estimates for the incremental effect of the

[2]The US rule put a 30% limit on net business interest expense (the excess of business interest expense over business interest income) as a fraction of a taxpayer's "adjusted taxable income." For tax years beginning after December 31, 2017, and before January 1, 2022, "adjusted taxable income" is similar to EBITDA. For tax years beginning after December 31, 2021, adjusted taxable income is similar to EBIT. For more details see https://www.cbh.com/guide/articles/planning-for-the-new-business-interest-expense-deduction-limitation.

WDC.

We compile a unique dataset that matches MNCs with their subsidiaries around the world. This dataset allows us to trace over a decade of financing and real business activities of the ultimate parents of MNCs and their subsidiaries. We use this novel data to investigate how MNCs adjust their debt, operations, and organizational structures across different jurisdictions in response to the WDC. Our key findings are as follows.

First, we find that the WDC effectively curbed MNCs' excessive borrowing in the UK. Affected MNCs reduced their gateway ratios by 29%, on average. This was achieved by a combination of decreasing the UK net debt and increasing MNCs' worldwide gross debt. The WDC also caused affected MNCs to increase debt in the non-UK subsidiaries, particularly in those located in countries with statutory tax rates higher than that in the UK. This indicates that MNCs shift debt across borders to minimize the impact of the WDC.

Second, we show that tax-motivated debt shifting did not significantly change real operations for affected MNCs at the group level. However, it resulted in *reallocation* of real operations across subsidiaries. On average, over the period 2010-2014, affected MNCs reduced total assets, fixed assets, and employment in the UK by 7.5%, 11.4%, and 3.9% respectively. At the same time, they substantially increased real operations in their non-UK subsidiaries. We find that MNCs moved real operations towards countries with higher tax rates, similar to debt. We complement this finding by showing that MNCs also adjust their organizational structures to offset the impact of the WDC. In particular, affected MNCs reduced the percentage of relevant UK subsidiaries that were included in the calculation of UK net debt. They also increased the percentage of subsidiaries in countries with a higher tax rate than that in the UK, while reduced that in countries with a lower tax rate. Taken together, these results suggest that the WDC affected MNCs beyond their financing patterns, yielding real reallocation of assets, employment, and subsidiaries across borders.

Third, we find that foreign MNCs have more flexibility than domestic MNCs in circumventing the WDC. MNCs can reduce the gateway ratio by either decreasing the UK net debt (*i.e.*, the numerator of gateway ratio) and/or increasing the worldwide debt (*i.e.*, the denominator of gateway ratio). We find that foreign MNCs adjusted both margins significantly more than domestic MNCs. The effect of the WDC on the reallocation of business activities is also stronger for foreign MNCs than for domestic MNCs. In particular, only foreign MNCs reduced the size of their UK operations significantly, while expanding the size of their non-UK operations more than domestic MNCs. We show that this is likely due to a stronger home bias for the latter.

We find that the WDC helped the UK tax authority to increase tax payments from affected domestic MNCs. As affected foreign MNCs significantly reduced the size of their UK real operations, the WDC failed to collect more tax revenue from them even with their lower level of UK net debt. Although affected MNCs shift debt abroad, we do not find that their foreign tax payments significantly changed. Note that affected MNCs also shifted their real business activities overseas which should have enlarged the pre-interest tax base in those locations. Thus, while other countries did not suffer from revenue losses due to debt shifting, they did not enjoy more revenue due to increased business activities either.

In the last part of the paper, we address three potential threats to our identification strategy coming from contemporary events: the 2007-2008 financial crisis, UK corporate tax rate cuts, and its territorial tax system reform in 2009. Our DID setting partially addresses these concerns, because these events would affect all firms, while the WDC only affects MNCs that failed the gateway ratio test. However, if these events affected the debt policies of our treated and control firms differently, our results may be confounded. We find no evidence of systematically different exposures to confounding events between our treated and control MNCs. We also implement a set of empirical tests to examine whether different exposures to these confounding events led to heterogeneous responses for our treated firms. We find that the estimated impact of the WDC is similar between treated MNCs that were affected by the confounding events to different extents. These results alleviate the concern that our findings are biased by these concurrent events.

Our paper contributes to the literature as follows. First, we provide the very first comprehensive examination of the impact of the effectiveness of the "worldwide approach" as a new anti-tax avoidance measure. While many countries have adopted the stand-alone rules that consider debt-to-equity or debt-to-asset ratios of each subsidiary of MNC separately (notably, the thin-capitalization rules) to curb debt-shifting by MNCs, evidence on their effectiveness is mixed. Many have recommended using the worldwide approach, which is more difficult to circumvent, to complement the thin-capitalization rules. Apart from the UK, in December 2017 the US passed the Tax Cuts and Jobs Act in which similar limits on net interest expense deductions of MNCs were put into effect. A paper concurrent to ours (Carrizosa et al., 2020) examines the effects of the US tax reform, focusing on debt reallocation of US firms. In 2019, European Commission recommended the implementation of the Anti-Tax Avoidance Directive that sets similar interest deductibility limitations.[3] As more

[3]For more details see: https://ec.europa.eu/taxation$_c$*ustoms/business/company* $-$ *tax/anti* $-$ *tax* $-$ *avoidance* $-$ *package/anti* $-$ *tax* $-$ *avoidance* $-$ *directive*$_e$*n*.

countries are implementing similar restrictions, our findings have important implications for the current policy debate.

We also add to the ongoing research on the impact of anti-tax avoidance measures on real economic activities. The paper closest to our analysis of real effects is Serrato (2018), who shows that the repeal of a tax code that allowed US MNCs to exclude income from Puerto Rico from US corporate taxes led them to shift investment and employment away from the US. Our paper is different from Serrato (2018) in three aspects. First, our study relates to a more general anti-tax avoidance measure that has been adopted more widely across countries. Second, Serrato (2018) uses consolidated group-level and geographic segment data from Compustat, which does not provide disaggregated information at the country or at the subsidiary level. With the detailed subsidiary-level data, we are able to pin down the direction of the real activity reallocation across home and subsidiary countries with different tax features, and also examine potential spillover effects of the WDC outside of the UK. Third, we find that most of the reallocation triggered by the WDC was done by foreign MNCs, with no significant reallocation coming from domestic MNCs. We show that this is driven by a relatively strong home bias of domestic MNCs. In fact, affected UK MNCs with a weaker home bias significantly reduced their UK operations, while those with a stronger home bias did not. Given existing evidence on the home bias for investment by MNCs (Belderbos et al.; Dischinger et al., 2014; Mayer et al., 2010; Resmini and Vittucci Marzetti, 2020), our paper offers more relevant policy implications for a broader set of countries whose MNCs exhibit a stronger home bias than US MNCs.

More broadly, our study extends the literature on MNCs' tax-motivated debt-shifting (Blouin et al., 2014; Buettner et al., 2012; Desai et al., 2004; Huizinga and Laeven, 2008; Huizinga et al., 2008; Mintz and Weichenrieder, 2010), utilizing a quasi-natural policy reform and exploring the impact on debt and real business activities. We also add to a growing literature that examines how MNCs reallocate real operations in response to economic and policy shocks, and how such reallocation affects the local and global economy (Almedia et al., 2015; Biermann, 2019; Boutin et al., 2013; Desai et al., 2007; Giroud and Mueller, 2015, 2016; Huber, 2018; Kalemli-Ozcan et al., 2016; Santioni et al., 2017). We bridge these two strands of literature by adding evidence on how *anti-tax avoidance* policies affect the reallocation of MNCs' real operations across countries and subsidiaries.

2 Policy background

Many countries have attempted to curb the extent of debt shifting of MNCs by implementing anti-tax avoidance policies such as the thin-capitalization rules. The thin-capitalization rules usually set up a fixed ratio, such as the debt-to-equity ratio or the interest coverage ratio, and interest expense associated with debt exceeding the ratio is often disallowed for a tax deduction. The thin-capitalization rules are *stand-alone rules* in the sense that they consider each subsidiary of the MNC as a separate entity. Despite some evidence that the thin-capitalization rules reduce MNCs' incentives to use internal debt for tax planning purposes (Blouin et al., 2014; Buettner et al., 2012), the limitation of these rules has also become apparent over the years. For example, the financing policies of MNCs are likely to be highly centralized and the thin-capitalization rules can be easily circumvented.[4]

More recently, the OECD has recommended using the "worldwide approach" to supplement the thin-capitalization rules.[5] The worldwide approach evaluates the MNCs' allocation of debt across affiliates by comparing the amount of debt located in each host country to some worldwide consolidated benchmark, such as the MNCs' worldwide debt or earnings before interest, tax, depreciation, and amortization (EBITDA). Arguably, it may be more difficult or costly to circumvent the worldwide anti-tax avoidance measures since doing so requires MNCs to manipulate the group-level consolidated debt or EBITDA. To circumvent thin-capitalization rules, by contrast, MNCs only need to adjust the financing policies of a single subsidiary, which can be easily achieved via their internal capital market. Consequently, it has been advocated that the worldwide approach should be more effective than the thin-capitalization rules in addressing earning stripping and debt shifting by MNCs (Desai and Dharmapala, 2015; Dharmapala, 2014).

In January 2010, the UK tax authority (the HMRC) introduced the "worldwide debt cap" (WDC) to restrict the generous tax deductions for financing expenses enjoyed by MNCs. The rule was an outcome of a long consultation that started in June 2007. The HMRC's aim was that the UK should not bear interest expenses that, in aggregate, exceed the amount of interest borne by an MNC as a whole. After the territorial tax system reform, the HMRC needed to compensate tax revenue losses, as it no longer taxed dividends repatriated by

[4]For example, multinationals can inject equity to subsidiaries with a high debt-equity ratio to avoid exceeding the fixed ratio. Webber (2010) provides the survey on the thin-capitalization and interest deductibility rules around the world.

[5]See, OECD (2015)'s BEPS 2015 final report, Action 4.

MNCs under the new territorial tax regime.[6] Raising tax revenue by implementing the WDC is one such measure. The WDC was also implemented to complement existing debt-related thin-capitalization rules, which proved not to be that effective.[7]

The WDC was applicable for periods beginning on or after January 1, 2010 and up until April 1, 2017. The WDC applied to qualifying MNCs that have a corporate tax residence in the UK[8], except those in the financial sector. A qualifying MNC has more than 250 employees, above €50m turnover and/or above €43m balance sheet total assets. To apply the rule, each MNC first needs to calculate its UK net debt, which is aggregated across all UK relevant subsidiaries. Next, a gateway test based on the ratio of the MNC's UK net debt to its worldwide gross debt is conducted. If the gateway ratio exceeds 75%, the interest deduction is disallowed for the exceeding level of interest expenses. The WDC is not optional. On April 1st, 2017 the UK modified the WDC: the worldwide debt denominator was replaced by EBITDA. This change likely reflects the concern that the original WDC may lead to an increase in MNCs' worldwide debt and as a result, default risk. Our result shows that this concern was valid.

The UK net debt held by each UK subsidiary is the difference between relevant liabilities and relevant assets. The type of borrowings that were treated as relevant liabilities includes short-term loans, overdrafts, and long-term debt. Trade credit and liabilities in the form of share capital, such as preference shares, are not treated as relevant liabilities for the gateway test, even if they are accounted for in financial liabilities. Relevant assets include cash and cash equivalents, lending, investment in government or company securities, and net investment in financial leases. To calculate the numerator of the gateway ratio, the MNC needs to aggregate the UK net debt across all relevant UK subsidiaries, which are 75% or more owned by the MNC. The denominator of the gateway ratio, the MNC's worldwide gross debt, is the consolidated liabilities of the worldwide group. While the UK net debt includes both external and internal debt, the worldwide gross debt only considers the MNC's external debt.[9]

It is worth noting that the UK experienced other tax policy changes during the same

[6]Miller (2017) estimates that the anti-tax avoidance measures, especially the restriction on relief for interest, have been the main way UK tax revenues have been raised since 2010.

[7]Unlike thin-capitalization rules in other countries, the UK rule is conducted on a case by case basis and hence, is considerably more discretionary.

[8]This means either a UK company or a UK permanent establishment of a non-UK company.

[9]See the HMRC's website. The regulatory burden of calculating these numbers is small, as they come from financial statements of companies and can easily be obtained from public records stored in Companies House.

period. First, the UK moved from the worldwide tax system to the territorial tax system in 2009, and thereafter it exempts dividend repatriation by MNCs from being taxed in the UK. Studies show that the territorial tax system reform led to more dividend repatriation (Egger et al., 2015), higher payouts to shareholders (Arena and Kutner, 2015) and shifting profits to low tax countries (Langenmayr and Liu, 2020). Second, the UK government gradually lowered the statutory corporate income tax rate from 28% in 2010 to 20% by 2015. The reduction in the statutory rate is a byproduct of the territorial tax system reform and it is a measure to increase UK's competitiveness. These two tax changes could have induced MNCs to reduce the amount of debt financing in the UK. However, the territorial tax system reform and the tax rate reduction apply to all UK companies and are not specific to a certain group of MNCs. In contrast, the 2010 worldwide debt cap targets MNCs with excessive debt holdings in the UK alone. Nevertheless, we examine the potential confounding effects of these other tax changes in Section 7. There were also other, smaller, tax policy changes in the UK, such as the Annual Investment Allowances to stimulate business investment, and the corporate tax surcharge on banks. However, these other tax changes should have little impact on MNCs' debt policies.

3 Conceptual framework

To understand the potential impact of the WDC on MNCs' debt policy, we first compare the cost of debt in the UK with that elsewhere. With full interest deductibility for tax purposes, the cost of debt is the net-of-tax interest rate, $i(1-\tau)$, where i is the nominal interest rate and τ is the statutory corporate income tax rate. Under the WDC, for firms that failed the gateway test, the net-of-tax UK interest rate for one additional pound of debt is simply i. This is higher than the net-of-tax UK interest rate for firms that did not fail the gateway test. Also, it is likely to be substantially larger than the net-of-tax interest rate in other countries without interest deduction limitation, especially those countries with a high statutory corporate income tax rate. Therefore, all else equal, the direct effect of the WDC is that affected MNCs should lower their UK borrowing. If debt shifting imposes little cost, to offset the impact of the WDC on tax payments in the UK, MNCs could reallocate debt elsewhere through its internal capital market so that the overall tax payment of the group would be little affected. Since MNCs prefer to hold debt in high-tax countries, the reallocation would likely flow in that direction.

The WDC can also lead to a reallocation of real business activities. Assume the marginal

cost of capital is the weighted average of the cost of debt and the cost of equity. If the WDC did not affect MNCs' business risks, the marginal cost of capital for affected MNCs' UK operations should increase for two reasons. First, the restriction on interest deductibility directly increases the net-of-tax cost of debt, because a fraction of interest expenses is no longer tax-deductible. Second, the lower level of UK debt reduces the weight of debt relative to equity capital for investment financing.[10] In contrast, as the level of debt increases in non-UK subsidiaries due to debt shifting, the marginal cost of capital should decrease in those locations. This relative change in the cost of capital implies that capital should flow from MNCs' UK subsidiaries to non-UK ones until the marginal return equals the marginal cost of capital in both types of subsidiaries. If labor is complementary to capital, we should also observe a flow of employment in the same direction.[11]

Further, with restrictions on interest deductibility, the sensitivity of investment towards corporate tax rate would be substantially magnified.[12] Hence, debt shifting induced by the WDC may additionally negatively affect the investment and employment of MNCs in the UK, even though the UK government lowered the statutory corporate income tax rate after the implementation of the WDC. Regulations such as the thin-capitalization rules (TCRs), which exist in many countries, may further reinforce the reallocation of real business activities induced by the WDC. For example, if a country implements a fixed debt-to-equity or debt-to-asset ratio TCR, debt shifting to subsidiaries located in this country needs to be accompanied by an increase in equity or total assets.

To offset the impact of the WDC, MNCs are especially likely to shift debt into subsidiaries located in countries with a high corporate income tax rate. Whether capital and employment would also flow to those high tax rate jurisdictions is worth further discussion. On one hand, the lower net-of-tax cost of debt financing should induce capital and employment to flow to those locations. On the other hand, the high corporate income tax rate implies a high user cost of equity capital, which may offset the attractiveness of these jurisdictions as destinations for capital and labor. However, we consider this offsetting effect to be of second-order importance for two reasons. First, when investment at the margin is financed

[10]The decline in leverage also lowers the cost of equity, but its overall effect on the weighted average cost of capital is positive.

[11]Here, we assume that MNCs rationally allocate resources to maximize firm value. A stream of finance literature argues that MNCs may allocate resources among their establishments in an irrational manner. For example, Krüger et al. (2015) suggest that firms use a single discount rate to evaluate all investment projects across establishments.

[12]Buettner et al. (2012) consider the impact of thin-capitalization rules on foreign direct investment, and they show that the tax-rate sensitivity of FDI is about twice as large with limitation on interest deductibility.

mainly by debt, a smaller part of investment return is subject to corporate tax, and hence, the corporate tax rate would have a smaller impact on investment (Buettner et al., 2012). Second, if MNCs can shift profits across jurisdictions with different corporate tax rates to minimize their tax burden, the income-shifting adjusted user cost of equity capital would be much lower than the unadjusted one (Grubert and Slemrod, 1998; Mintz and Smart, 2004; Serrato, 2018). This, in turn, should moderate the negative impact of the high corporate tax rate on investment and employment. For these reasons, we expect to observe the reallocation of capital and employment to be more prominent among MNCs' non-UK subsidiaries facing a higher corporate income tax rate.

In Appendix A, we calculate the tax component of the user cost of capital for MNCs' UK subsidiaries. For simplicity, we assume that a treated MNC financed its investment at the margin mainly by debt before the WDC, and had to switch to financing marginal investment by retained earnings after the reform. We assume that a control MNC financed its marginal investment mainly by retained earnings.[13] In Table A.1, we list parameters necessary for this exercise for three types of assets: machinery, buildings, and intangibles, which are provided by the Oxford University Centre for Business Taxation. These include the present value of capital allowances, the corporate tax rate, the tax and economic depreciation rates, and the interest rate, during the period 2008-2014. We first calculate the tax component of the user cost of capital for the three types of assets, $UC_i, (i = 1, 2, 3)$, under the assumption of equity and debt financing separately, according to Equations A.1 and A.2. The tax component of the user cost for one dollar of new investment is calculated as $\sum_{i=1}^{3} w_i \times UC_i$, where w_i is the weight of each type of asset in the marginal investment.[14] In Table A.2, we show that the WDC increased the tax component of the user cost for treated MNCs' UK investment from 0.166 to 0.186 in 2010. Note that this 11.1% increase in the cost of capital is also the relative difference between the treated and control MNCs, under our assumptions. This increase in the cost of capital is large in magnitude, implying that WDC may have a large effect on

[13]Both the treated and control MNC were likely to use a combination of debt and equity to finance marginal investment in reality, but the cost of capital was likely to be more influenced by that of equity for the control MNCs since they used more equity than debt.

[14]For the weights, we use data from CBT 2011 Tax Ranking: https://core.ac.uk/download/pdf/288286506.pdf.

MNCs' investment in the UK.[15]

4 Data and Empirical Strategy

4.1 Sample construction

To examine the effects of the WDC on MNCs' debt and real activity allocations, we collect data for a large sample of multinational parent companies matched with their subsidiaries. Several data sources are utilized. First, we use Osiris by the Bureau van Dijk (BvD) to extract a sample of MNCs with operations in the UK. The WDC only applies to "worldwide groups" that own a relevant UK subsidiary. Thus, using ownership information from the 2010 Osiris, we require each MNC to own 75% or more shares of at least one UK subsidiary in 2010, when the WDC became effective. We exclude MNCs in the financial services industries and firms with below €43m balance sheet total assets because the WDC did not apply to them. We then use the 2005-2014 CDs of Osiris to extract subsidiaries of those MNCs year by year. We focus only on subsidiaries that are 50% or more owned and thus effectively controlled, as they are more likely to be utilized for debt shifting purposes by MNCs. As ownership structures of MNCs change frequently, our unique data allows us to have a more precise picture of MNCs' organizational structures during the period 2005-2014.

We obtain consolidated financial data for the MNC groups from Osiris. This allows us to construct group-level variables such as consolidated worldwide gross debt, total assets, fixed assets, and employment. We obtain unconsolidated and detailed financial data for MNCs' UK subsidiaries from the second database FAME. FAME allows us to construct MNCs' UK net debt following the HMRC definition, but the data that we have access to starts in 2008. This reduces our ability to analyze longer pre-reform trends. The benchmark sample that we use to analyze the effect of WDC on group-level performances and UK operations covers the period 2008 – 2014, both at the group level and the UK subsidiary level.

Since FAME only covers MNCs' UK subsidiaries, we use the third database, Orbis, to obtain financial data for the MNCs' non-UK subsidiaries. The Orbis sample we have access to covers the period 2005 - 2014. Note that FAME has more detailed coverage of UK firms

[15]In rows 2 and 3 in Table A.2, we use two alternative methods of computing the change in the tax component of the user cost of capital. In row 2, we average the tax component of the user cost of capital under equity and debt financing across all years during 2010 - 2014 and then compute the difference in the averages. In row 3, we compute the change in the tax component comparing a firm using debt financing in 2010 with a firm using equity financing in 2014. These differences are similar to the one reported in the first row.

than Orbis, and Orbis does not contain variables that allow us to calculate the gateway ratio close to the HMRC's definition. This is why we use FAME for the analysis of MNCs' UK operations.

We follow exactly the HMRC's guidance for calculating MNCs' gateway ratios. Note that both the numerator and the denominator in the gateway ratio are calculated using two-year averages of related variables. Hence, the 2010 gateway ratio takes into account the 2009 financial data for the MNC. An MNC failed the gateway test if its gateway ratio exceeded 75% in 2010. These MNCs form our treatment group. In total, 197 MNCs in our sample failed the gateway test, 148 of which are headquartered in the UK, and the rest are headquartered elsewhere. MNCs that never failed the gateway test form our control group. For the 197 treated MNCs, we observe 1,176 unique subsidiaries in the UK and 668 subsidiaries abroad for which we have financial data in Orbis. Almost 50% of MNCs' foreign affiliates in our sample are located in European countries, such as France, Germany, Belgium, Italy, Spain, Norway, and Sweden.

To account for the different characteristics of MNCs, we perform propensity score matching. The reason why matching is important is that we want to compare the evolution of debt and real business operations for a set of MNCs with the most comparable characteristics in 2010. If firms in treatment and control groups are very different from each other, we would expect them to react to other concurrent events in different ways that may confound our estimations. In the robustness section, we provide results using the unmatched sample, different matching methods, and different matching variables.

Before matching, the control group MNCs are much smaller and are located in a different set of headquarter countries. Thus, we match MNCs by industries and locations of their global ultimate owners' (GUO), as well as group size. We apply the one-to-one nearest neighbor matching algorithm without replacement. After matching, we obtain 188 MNCs that failed the gateway test in 2010 and 188 MNCs that did not fail the gateway test.[16] In Table 1, we provide descriptive statistics for key variables for the treated and control groups before and after matching, measured in 2009. We show that matching significantly reduces differences in group size, gross debt, and group-level effective tax rate (ETR). Matching also makes the two groups more comparable in terms of their UK assets, fixed assets, employment, profitability, and ETR. Nonetheless, treated MNCs, on average, held more UK net debt, less gross debt, and had a significantly higher gateway ratio than the control group, both before

[16]We do not find a match for every affected MNCs in our sample. For some MNCs, one or more matching variables are missing. We also failed to find any comparable matches for some treated MNCs.

and after matching.

4.2 Who are the failed MNCs?

The 188 MNCs in the matched sample that failed the gateway test constitute about 12% of all MNCs in the UK, and they own 13% of all UK subsidiaries in 2009. Before matching, treated MNCs were smaller and less profitable in the UK compared with untreated MNCs.[17] However, on average, treated MNCs held more assets and employed more people in the UK. Specifically, they held 21% of total assets and 17% of total employees in the UK among all MNCs in our sample. Treated MNCs, on average, held $13.8 million in total assets and employed 4,886 people in the UK (Table 1). Given the large size of their UK operation, the WDC was likely to generate a significant impact on the UK economy, if it affected treated MNCs' real business activities in the UK.

Table 1 indicates that treated MNCs, on average, had less worldwide gross debt, around $510 ($580) million dollars, relative to $900 ($2,700) million that the control group had in the matched (unmatched) sample. In contrast, before matching, treated MNCs had almost twice the amount of log UK net debt relative to those in the control group. While we cannot differentiate between external and internal debt for the majority of UK subsidiaries, the average ratio of internal debt in relevant UK assets is around 61% for a sub-sample of treated UK subsidiaries with available information (around 50% of the original sample). This suggests that treated MNCs were very active in using their internal capital market, especially through debt, to finance their subsidiaries.

Treated MNCs had a lower UK ETR, on average, than the control group before matching. After matching, this difference is no longer statistically significant (Table 1). In Table B.1 we show the average non-UK statutory CIT rate faced by treated MNCs was 26.0% in 2009, while that faced by the control group was 25.4%. This suggests that the treated MNCs were exposed to a similar overall corporate tax burden to those in the control group. Within the treatment group, the average non-UK CIT rate faced by domestic MNCs is 25.8%, while that faced by foreign MNCs is 26.3%.

MNC groups that failed the gateway test represent all industries. 121 of them are service firms, 37 are in manufacturing, 18 are in wholesale, and the remainder is in miscellaneous industries. The most represented industries are the drug manufacturing industry with 16 MNC groups and the computer programming and data processing services industry with

[17] Since profitability is defined as total UK profit and loss before taxes divided by total assets, lower values for treated firms may simply be related to higher debt that they hold.

15 MNC groups. There is also some geographical clustering in that the majority of the subsidiaries of the treated MNCs are located in London (135 subsidiaries) with smaller clustering in other major industrial cities in the UK, such as Wolverhampton (32), Leeds (12), Aberdeen (11), Maidenhead (11) and Manchester (10).

4.3 Distribution of the gateway ratio

To examine whether the WDC was binding, Figure 1 compares the distribution of MNCs' gateway ratios during 2010-2014. Panels A-D show that for treated MNCs, the distribution of the gateway ratio gradually shifted towards the left after the WDC: 62% of treated MNCs lowered their gateway ratios below the 75% threshold by 2014. In contrast, the distribution of the gateway ratio for MNCs in the control group remained largely unchanged (Panel E). This provides the first evidence that the WDC had a material impact on treated MNCs' gateway ratios. There might be a couple of reasons for some treated MNCs to stay above the gateway ratio post the WDC. First, it may take time to adjust both internal and external borrowing, depending on the nature of the debt contract. Second, firms may borrow for real financial instead of pure tax planning considerations. For example, firms may borrow simply as they do not have sufficient internal funds to finance investment. In this case, firms would continue to hold debt in the UK, even if the WDC made debt financing more expensive. Despite the downward adjustment, Panel F indicates that the treated MNCs still had a much higher gateway ratio, on average, than the control group by 2014.

We find no significant difference between treated MNCs that reduced their gateway ratios below 75% and those that did not, in terms of firm size, the amount of UK net debt, and the average non-UK CIT rates that these MNCs faced in 2010. However, MNCs that did not adjust their gateway ratios below 75% tend to be domestic MNCs. We later show that domestic MNCs were more likely to invest in the UK due to a stronger home bias. Thus, these MNCs were also more likely to borrow in the UK to finance real business operations, instead of merely minimizing their tax bills. Consequently, these MNCs may reduce their gateway ratios to a lesser extent, even though the WDC made borrowing more expensive for them.

Some treated MNCs reduced their gateway ratios far below the 75% threshold. This larger than expected drop is likely due to adjustment costs.[18] It is also worth noting that even before 2010, the UK CIT rate was not the highest among European countries. France

[18]In unreported exercises, we find that affected firms with smaller adjustment costs tend to locate closer to the threshold after the WDC.

and Germany, for example, both had higher CIT rates, but stricter anti-debt shifting rules (Blouin et al., 2014). Thus, it was the combination of a relatively high CIT rate and generous treatment of interest deductions that attracted MNCs to locate debt in the UK before the WDC. The debt cap may incentivize some MNCs to shift most of their UK debt out of the UK to where the combination of tax rate and anti-avoidance rules is more beneficial. For MNCs with such options, their gateway ratios could drop substantially below the threshold. We find that MNCs reduced the gateway ratio more below 75%, if they were larger, had higher average non-UK CIT rates, or if they were headquartered in non-UK countries. These are likely to be firms with more options for debt reallocation outside of the UK.

4.4 Empirical strategy

We use the difference-in-differences (DID) approach to investigate the responses of MNCs to the 2010 UK worldwide debt cap. MNCs that failed the gateway test in 2010 form our treated group, while those that passed the test are in the control group. We adopt the DID approach instead of the regression discontinuity design (RDD) because the reform disallows the excess interest deductions above the 75% threshold. This means that firms just above the gateway threshold are less affected by the WDC rule than those further away. Thus, this is not a discontinuity, but rather a kink.

More specifically, to investigate the effects of the WDC on debt policies and business activities of MNCs as a group, we use the following general specification:

$$Y_{i,t}^{UK} = \alpha + \beta \times Failed_i \times Post_t + \eta_t + \psi_i + \epsilon_{i,t} \tag{1}$$

where $Y_{i,t}^{UK}$ is the outcome variable at the group level, including the gateway ratio with and without taking the log form,[19] UK net debt, worldwide gross debt, total assets, fixed assets, employment, and tax payment, all in logs. $Failed_i$ is a dummy variable that equals one, if MNC i failed the gateway test in 2010, and zero otherwise; $Post_t$ is a dummy variable that equals one from 2010 onwards; η_t is the time fixed effect, ψ_i is the group-specific fixed effect, and $\epsilon_{i,t}$ is the error term. The parameter of interest is β, which captures the effect of the WDC on MNCs' debt policy and real activities.

We also use this framework to study the effects of the WDC on MNCs' tax payments and real activities in the UK. We use three proxies for MNCs' UK operations: total assets, fixed assets, and employment (number of employees), all aggregated across UK subsidiaries

[19] Observations with negative or zero gateway ratios were discarded.

and expressed in logs. The reason why we do not analyze investment directly is that that information is not reported in either Fame or Orbis.[20] To examine changes in total UK tax payment, we use the natural logarithm of total tax paid to the UK tax authority, which is obtained by aggregating tax payment across MNCs' UK subsidiaries, as the dependent variable.

To understand the pattern of debt and real activity reallocation outside of the UK, we use subsidiary-level data from Orbis and estimate Equation 2:

$$Y_{i,j,s,t}^{nonUK} = \alpha + \beta \times Failed_i \times Post_t + \delta \times X_{i,j,s,t}^{'} + \eta_t + \kappa_j + \epsilon_{i,j,s,t} \tag{2}$$

where $Y_{i,j,s,t}^{nonUK}$ is the outcome variable for non-UK subsidiary j that belongs to multinational i, located in host country s in year t; $X_{i,j,s,t}^{'}$ is a set of subsidiary and group-level control variables, such as group size, subsidiary size and subsidiary profitability; η_t is the year fixed effect, κ_j is the subsidiary-specific fixed effect, and $\epsilon_{i,j,s,t}$ is the error term. In some of the specifications, we also control for country-specific fixed effects. This ensures that we account for country-specific business cycle effects. To investigate debt shifting following the WDC, we use non-UK subsidiaries' net-of-cash leverage ratio as the outcome variable in Equation 2. In this specification, a positive estimate for β would be consistent with debt-shifting induced by the WDC. To understand whether debt shifting is tax-sensitive, we interact $Failed_i \times Post_t$ with CIT_{jst}, which is the statutory corporate income tax rate that the non-UK subsidiary j faces in country s in year t . We expect the estimated coefficient on the interaction between CIT_{jst} and $Failed_i \times Post_t$ to be positive. To examine the effects of the WDC on non-UK subsidiaries' tax burden and real activities, we use additional outcome variables in Equation 2, including non-UK subsidiaries' tax payment, the level of total assets, fixed assets, and the number of employees (all in logs).

5 Group-level evidence

5.1 Gateway ratio, UK net debt and worldwide gross debt

Table 2 reports the estimated effects of the WDC on MNCs' gateway ratio, UK net debt, and worldwide gross debt based on Equation 1, using the matched sample. In Column 1, we find that treated MNCs lowered their gateway ratio by around 1.69, on average. To

[20]The growth rate of fixed assets based on these data would only be a proxy for the true investment, as BvD reports fixed assets net of depreciation and asset disposal.

understand this point estimate, note that a median treated MNC has a 2.19 gateway ratio in 2010. Thus, it needs to reduce its gateway ratio by 1.44 to be below 75%. This is broadly in line with our average estimation result in Column 1. In Column 2, we instead use the natural logarithm of the gateway ratio as the dependent variable. The point estimate is -0.345. Translating the log changes into marginal effects, this implies that the gateway ratio dropped by around 29 percent ($-0.29 = exp(-0.345) - 1$), for the treated MNCs after the WDC relative to the control group.

We focus on changes in the treated MNCs' UK net debt (in logs) in Column 3 and worldwide gross debt (in logs) in Column 4. Column 3 indicates that treated MNCs' UK net debt dropped by 64% (-0.64=exp(-1.008)-1) relative to the control group. To better understand the magnitude of this result, we consider the median firm again. That firm reported having total UK net debt of 12,060.5 and gross debt of 5,513 in 2010, both in thousand pounds. Hence, it can only claim interest deductions on $0.75 \times 5,513 = 4,134.75$ of its UK net debt, assuming no adjustment on its gross debt. It loses interest deduction on the rest of its UK net debt ($12,060.5 - 4,135.75 = 7,925.75$). Suppose this firm cut its UK net debt to reduce its gateway ratio to be just 75%. This implies a reduction in the log of the UK net debt of around 1.[21] This is close to the point estimate in Column 3.[22] In columns 1 and 2 of Table B.2 in the Appendix, we show that the reduction in UK net debt was mainly achieved by lowering relevant liabilities rather than increasing relevant assets. Column 4 of Table 2 shows that after the WDC, treated MNCs increased their gross debt by 39% (0.39=exp(0.327)-1), on average. Using a smaller sample where we can distinguish between private and public borrowing, columns 3 - 5 of Table B.2 indicate that the increase in gross debt was mainly achieved by raising private borrowing. This result lends some support to the criticism that the WDC could encourage MNCs to increase external borrowing, possibly exacerbating their default risk.

In Figure 2, we examine responses of the treated MNCs with different gateway ratios. We estimate a triple DID specification, where we interact $Failed_i \times Post_t$ with a dummy $I_i(Gateway \geq X\%)$, indicating that firm $i's$ gateway ratio was above $X\%$ in 2010. In Figure 2, we plot the estimated triple DID coefficients. We find that the decline in the gateway ratio for treated firms becomes larger when the firm is further above the 75% threshold.[23] This suggests that treated MNCs with gateway ratios far above 75% responded more to

[21] $ln(4,134.75) - ln(12,060.5) = -1.070$.

[22] Incorporating the adjustment in the gross debt, this median firm would reduce the log of the UK net debt by around 0.75.

[23] Table 1 in the Online Appendix reports the corresponding estimation results.

the WDC. One implication of this result is that the DID is a more suitable approach than alternative methods, like the RDD, to evaluate the impact of the WDC.

We report the estimated treatment effects in Table 3 for domestic (Panel A) and foreign MNCs (Panel B), separately. We find a stronger response for foreign MNCs. Affected domestic MNCs reduced their UK net debt by 59% (Column 3) and increased their worldwide gross debt by 25% (Column 4).[24] Foreign MNCs reduced their UK net debt by 78% (Column 3) but increased their worldwide gross debt by 97% (Column 4). The differences between the domestic and foreign multinationals are also statistically significant with p-values of 0.000 in all cases.

What may explain this heterogeneity? Note that the worldwide debt consists of external borrowing from third parties. Companies tend to borrow externally using the headquarter rather than their affiliates (Kolasinski, 2009).[25] This is because headquarters usually have higher credit ratings than affiliates and hence, are more able to obtain financing with the most favorable terms. Hence, a foreign MNC can complement the reduction of its UK net debt by increasing external debt elsewhere, especially in headquarter countries with a lower level of adjustment costs.[26] In contrast, domestic MNCs are relatively limited in reducing their gateway ratios by borrowing more externally in the UK, since doing so would increase their UK net debt. While domestic MNCs can borrow externally via foreign subsidiaries, the cost of doing so is likely to be higher.

Dynamic effects of the reform In Figure 3, we examine how the key debt-related variables evolve during our sample period (2008-2014) in more detail. For each outcome variable, we plot the estimated difference between each year and the reference year, which we set to be 2010, for the treated and control groups separately. The dependent variables are the MNCs' gateway ratio, the UK net debt (in logs), and the worldwide gross debt (in logs).[27] Each dot represents the point estimate and the vertical line represents the associated 95% confidence intervals. In all estimations, we control for MNC-level fixed effects. Note that the WDC was implemented in January 2010 and for the majority of UK firms, the fiscal year 2010 ended in April that year. Thus, we expect to see little change within 2010 as firms had a rather

[24] All these are log transformations.

[25] Kolasinski (2009) documents that subsidiary debt issuance accounts for only around 13% of total US non-financial corporate debt proceeds.

[26] 15% of foreign MNCs' non-UK subsidiaries in our sample are located in the headquarter countries. We find that such subsidiaries increased leverage more after the WDC, consistent with this conjecture. This result is provided in Table 7 in the Online Appendix.

[27] To construct the gateway ratio in Figure 3, we use one-year data instead of two-year averages, which allows us to have an additional pre-reform year to evaluate the parallel trends assumption.

short window to adjust their behavior. Setting the reference year to be 2010 also allows us to have two pre-treatment years to evaluate the parallel trends assumption.

Figure 3 shows that the parallel trends assumption largely holds for all three debt-related variables. We do not observe statistically significant differences between treated and control groups in the years 2008 and 2009. As expected, we find little adjustment in the fiscal year 2010. Starting from 2011, we observe that treated MNCs reduced their gateway ratios significantly, relative to the control group (Figure 3a). The reduction in the gateway ratio continued for most of the post-WDC period, indicating a gradual adjustment. Figures 3b and 3c confirm that the gradual reduction in the gateway ratio of the treated MNCs was achieved by a combination of lowering the UK net debt and raising the worldwide gross debt. These figures also highlight that the estimated changes in debt after WDC were driven purely by treated firms. Control group firms did not significantly adjust their gateway test ratios or their components.

In Figure 4, we show the evolution of the UK net debt and the worldwide gross debt for domestic and foreign MNCs, separately. Figures 4a and 4b present the dynamic estimation results for domestic MNCs, while Figures 4c and 4d report those for foreign MNCs. In each of those figures, we compare treatment and control MNCs belonging to the same category. Both types of MNCs that failed the gateway ratio test reduced their UK net debt and increased the worldwide debt relative to the control group. These adjustments, however, are far more prominent for foreign MNCs, consistent with results from Table 3.

5.2 Tax payment and real operations

What is the impact of the WDC on the MNCs' tax payment and real operations as a whole? To answer this question, we utilize group-level consolidated data and estimate the impact of the WDC on four outcome variables: total tax payment, total assets, fixed assets, and employment. We report the DID estimation results in Table 4. We find that at the group level, the WDC did not change these outcome variables significantly. The WDC implies a potentially higher tax liability in the UK for affected MNCs. However, this is not reflected in the consolidated group-level data—treated MNCs' total consolidated tax payment increased but not statistically significantly so (Column 1 of Table 4). We also do not find that the WDC significantly altered treated MNCs' total assets, fixed assets, or employment, based on the group-level consolidated data.

Note that these group-level results cannot reveal any reallocation across subsidiaries. This is important, because the reallocation of the tax burden, assets, and labor across borders,

will have a different impact on host countries' fiscal revenue and economy. For this, we conduct further examinations using the subsidiary-level data.

6 Subsidiary-level evidence

6.1 Reallocation of debt

In this section, we examine whether MNCs reallocate debt across affiliates via their internal capital market to offset the impact of the WDC. First, since only subsidiaries at least 75% owned by the MNC are considered "relevant" in the gateway test, MNCs that failed the gateway test could reallocate debt from the 75% owned UK subsidiaries to UK subsidiaries that are less than 75% owned. In Table B.3, we find weak evidence that the 50%-75% owned UK subsidiaries of the affected MNCs increased leverage, compared with those owned by unaffected MNCs, especially domestic MNCs. However, this effect is not statistically significant, likely because reallocating debt to subsidiaries within the UK may bring smaller benefits to affected MNCs than moving debt to more tax advantageous locations outside of the UK.

Second, affected MNCs could shift debt to non-UK subsidiaries to minimize their overall tax burden. If this is the case, we expect the leverage ratio of the affected MNCs' non-UK subsidiaries to increase, on average. Further, this increase in the leverage ratio should be more substantial in subsidiaries located in countries with higher corporate income tax rates. We test these hypotheses by estimating Equation 2 where the dependent variable is the net-of-cash leverage ratio of each non-UK subsidiary. The results are reported in Table 5. Throughout all columns in Table 5, we control for common business cycle effects and subsidiary-specific fixed effects. We also control for host country-specific year fixed effects in some estimations. In Columns 1-4, we use the sample of all MNCs' subsidiaries. In Column 1, we estimate Equation 2 without adding any control variables. We find that on average the leverage ratio of affected MNCs' non-UK subsidiaries increased by 18.6% after the WDC relative to the control group. Controlling for subsidiaries' size and profitability, group size (Column 2), and host country-year fixed effects (Column 3), we obtain the same result. Column 3 suggests that the leverage ratio of affected MNCs' non-UK subsidiaries increased by around 13.6% following the WDC.

Next, we multiply $Failed_i \times Post_t$ by each host country's statutory corporate income tax rate and include this term on the right-hand side of Equation 2. The result based on this

specification is reported in Column 4. The point estimate for $Failed_i \times Post_t \times CIT_{jst}$ is positive and statistically significant at the 1 percent level. This suggests that affected MNCs shift more debt into non-UK subsidiaries facing a higher corporate income tax rate. The coefficient of 0.522 means that leverage increased by 22 percent in non-UK subsidiaries with a tax rate of 40 percent.

We repeat the estimations based on the specifications in Columns 3-4 using the subsample of subsidiaries that belong to domestic MNCs (Columns 5-6), and foreign MNCs (Columns 7-8). We find that both types of MNCs shift debt to their non-UK subsidiaries following the WDC, in particular, to host countries with a higher tax rate. Similar to results from Table 3, the estimated extent of debt shifting is much larger for foreign MNCs. For domestic MNCs, while we also find evidence of debt shifting, the extent is roughly half of that of foreign MNCs.

6.2 Reallocation of real activities

UK operations Next, we examine whether anti-tax avoidance measures trigger reallocation of real business operations. First, we explore whether the WDC prompted MNCs to adjust their operations in the UK, due to an increased cost of capital as our conceptual framework indicates. The estimation results based on Equation 1, using MNCs' UK total assets, fixed assets, and employment (all in logs) as the dependant variables, are reported in Table 6. We find that on average, affected MNCs shrank their UK operations (Columns 1-3), controlling for MNCs' group size. However, this is mainly driven by foreign MNCs. Affected foreign MNCs reduced their total assets by more than a third (Column 7). While changes in total assets may include the change in debt, we find a similar reduction in foreign MNCs' UK fixed assets. There is also an 11.3 percent reduction in UK employment by affected foreign MNCs, which is statistically significant at the 1 percent level. While we find a negative impact of the WDC on affected domestic MNCs' UK operation, the point estimates are not statistically significant.

Figure 5 illustrates the movement of real business activities after the WDC reform for both treatment and control groups. While there is no difference between the treated and control groups by 2010, the two groups began to diverge since 2011 in terms of total assets and fixed assets. Treated MNCs also reduced their UK employment relative to the control group, but this adjustment comes with a slight lag–the decline only became significant since 2012, possibly due to a higher adjustment cost for labor. The timing of the adjustments in real business activities is consistent with that in UK debt presented in Figure 3.

Next, we calculate the implied user cost elasticity. A typical treated MNC reduced their UK fixed assets by 11.4%. Table A.2 indicates an 11.1% increase in the tax component of the cost of capital for the treated MNCs relative to the control group. Thus, the implied elasticity of capital stocks with respect to the changes in the tax component for an average treated MNC in our sample is around 1 (=11.4%/11.1%). These are in line with the range of estimates from the literature. For example, Bond and Xing (2015) find this elasticity to be close to 1, while Zwick and Mahon (2017) summarize previous elasticity estimates which mostly range from 0.5 to 1, with some recent studies presenting estimates larger than 1. There is, nonetheless, a considerable difference between domestic and foreign MNCs. While the implied user cost elasticity is around 0.59 for treated domestic MNCs (not statistically significant), it is as high as 3.2 for foreign MNCs. Comparing these estimates with the literature is tricky, as existing literature seldom distinguishes between domestic and foreign firms. However, as foreign MNCs tend to have a weaker home bias than domestic MNCs, it is unsurprising to obtain a much larger elasticity for them.

We also calculate the implied elasticity of employment with respect to changes in the tax component of the user cost of capital. Using the point estimate from Column 3 in Table 6, this is around 0.35 (=3.9%/11%). Using consolidated US data, Serrato (2018) finds a semi-elasticity of employment with respect to effective tax rates of around 1.2-1.44. If converted, our elasticity estimate implies a 2.4 semi-elasticity for a typical affected MNC.[28] Note that affected UK MNCs did not reduce total or fixed assets in the UK possibly due to a strong home bias, which could explain the insignificant adjustment in labor in the UK. The lack of home bias, on the contrary, may explain the high sensitivity of foreign MNCs' real operations towards the WDC.

Non-UK operations In Table 7, we examine changes in MNCs' non-UK operations. Panel A considers the effects averaged across all non-UK subsidiaries. We do not control for group size in Table 7 since we find strong collinearity between group size and non-UK operation size for foreign MNCs. In Panel A, for both domestic and foreign MNCs, we find a significant expansion of their non-UK operations. This is consistent with the hypothesis that debt shifting into non-UK subsidiaries lowered the cost of capital there. Note that the WDC may have discouraged domestic MNCs from expanding in the UK, and instead

[28] An increase in tax payments of 10.9% from column 1 in Table 8 will convert to a similar increase in effective tax rates (ETRs), if we assume that income does not change. Taking ETR of 15% from Table 1, this suggests a 1.635 percentage point change in ETR. Dividing the 3.9% reduction in employment from Table 6 by this percentage change, we obtain a semi-elasticity of 2.4.

they are doing that abroad. This can explain the increase in their real business operations abroad without significant changes to their UK operations. The percent increases in non-UK total and fixed assets of domestic MNCs are marginally smaller than that of foreign MNCs. However, the differences are not statistically significant. The effect of WDC on employment is significantly larger for foreign MNCs than for domestic ones.

In Panel B of Table 7, we interact $Failed_i \times Post_t$ with host countries' statutory corporate income tax rate. Consistent with our theoretical argument, we find that more capital and employment were reallocated to countries with a higher tax rate, as the estimated coefficient on the interaction term is positive and statistically significant.[29] These results suggest that the reallocation of real business activities in response to the WDC was in the same direction as that of debt.

Aggregate Magnitudes Our estimates of the effects of WDC on real operations can be converted into aggregate magnitudes. Using our average estimates and back-of-the-envelope calculations, we show the extent to which the reform affected the overall business activities of MNCs in the UK and in foreign countries. Affected foreign MNCs held $32.1 billion in total assets, $15.1 billion in fixed assets, and employed 35,966 people in the UK during the pre-reform years (Panel A, Table B.1). Based on the estimates in Columns 7-9 in Table 6, the WDC led affected foreign MNCs to cut $10.7 billion total assets, $5.5 billion fixed assets, and hired 4,064 fewer employees in the UK by 2014. Affected foreign MNCs held a total of $54.6 billion total assets, $39.4 billion fixed assets, and employed 56,062 people in their non-UK subsidiaries during the pre-reform years (Panel B, Table B.1). Based on estimates in Table 7, affected foreign MNCs increased total assets by $12.5 billion, fixed assets by $6.9 billion, and hired 8,577 more people in their non-UK subsidiaries by 2014.[30]

We find that domestic MNCs did not significantly change the size of their UK operations, but expanded outside of the UK. Affected domestic MNCs held $279 billion total assets, $214 billion fixed assets, and employed 175,195 people in their non-UK subsidiaries in 2009 (Panel B, Table B.1). Based on the estimates in Table 7, affected domestic MNCs increased their non-UK total assets by $59 billion, fixed assets by $29.5 billion, and they also hired 15,767

[29] We can aggregate the subsidiary-level data by each foreign country and year and re-estimate. Results from this aggregation show the same pattern as observed in Table 7.

[30] Note that the loss in total assets and fixed assets in the UK matches the increase in assets in foreign countries. The decline in employment in the UK is smaller than the increase in employment in foreign countries. This is possibly because for the sample of MNCs for which we observe employment and assets in the UK, we find a set of their foreign subsidiaries with full information on assets, but with some missing observations on employment.

more people overseas by 2014.

According to our triple DID estimation results, reallocation of assets and employment is more prominent in high-tax countries. As most of the non-UK subsidiaries in our sample are located in Europe, our result suggests that high-tax European countries, such as France, Germany, and Italy, are most likely to benefit from MNCs' reallocation of business activities.

Home Bias Our analysis indicates unintended consequences of anti-tax avoidance measures on real business activities, which have not been widely discussed in the literature before. Unlike Serrato (2018), who finds that anti-tax avoidance measures led to business activity reallocation away from the US by US MNCs, we do not find that the WDC significantly reduced domestic MNCs' home operations.

One possible explanation for this difference may be that US MNCs have a weaker home bias than UK domestic MNCs. Using aggregate BEA statistics, we find that US MNCs held about 57% of their total assets in the US in 2017, while UK MNCs in our sample held close to 81% of their total assets in the UK in 2010. Figure B.1 indicates a much stronger bias for holding assets in the UK for domestic MNCs, compared with foreign MNCs in our sample. Thus, the home bias can potentially explain the different responses to the WDC by the two types of MNCs.

To examine whether domestic MNCs with different degrees of home bias responded differently to the WDC, we conduct a triple DID estimation in Table B.4, where we interact $Failed_i \times Post_t$ with a dummy indicating strong home bias. We show that even among domestic MNCs, those with a stronger home bias tend to experience a smaller reallocation of real business operations from the UK to foreign countries. This is true for both moving operations from the UK (Panel A) and into foreign countries (Panel B). This provides further support to our claim that a stronger home bias amongst UK MNCs could explain the difference between Serrato (2018) and our study.

6.3 Organizational structures

MNCs may also adjust their organizational structures as a more aggressive response to offset the impact of the WDC. The gateway test requires calculating the UK net debt ratio using relevant UK subsidiaries. Hence, if a relevant subsidiary had a high level of UK net debt, an MNC can reduce share holdings of this UK subsidiary to exclude it from the gateway test. A more extreme response would be to completely sell or shut down this UK subsidiary and perhaps to acquire new affiliates elsewhere. If we assume that debt shifting to existing

non-UK subsidiaries may violate thin-capitalization rules in the host countries, setting up new subsidiaries there may also be a way to circumvent these regulations.

There is not much evidence on changes in organizational structure in the previous literature for two reasons. First, organizational structure adjustment is more costly than simple debt and real business activity reallocation across existing subsidiaries. Hence, it has been considered to be less likely to occur in response to tax reforms. Second, time-varying ownership structures of the MNCs are required to conduct such an analysis. Our unique data permits us to do this novel test. We estimate the effect of the reform on the time-varying percentage of relevant UK subsidiaries that belong to the MNC group in the group's total number of subsidiaries.[31] To facilitate debt shifting, a group may also increase the number of subsidiaries located in high tax countries, which is reasonable considering thin-capitalization rules imposed on each subsidiary. Thus, we use the percentage of subsidiaries in high (low) tax countries as the dependent variable to examine organizational changes in this dimension.

We use all MNCs with at least one relevant subsidiary in the UK in 2010 and trace their ownership structures during 2005 – 2014.[32] We calculate the ratio of controlled UK subsidiaries relative to all of MNC's controlled subsidiaries (%UK 50+) and use this as the dependent variable in Column 1 of Table 8. In this DID estimation, we do not find that affected MNCs reduced the percentage of UK subsidiaries that are at least 50% owned. In Column 2, we use the percentage of "relevant" UK subsidiaries relative to MNC's total number of subsidiaries as the dependent variable (%UK 75+). We find weak evidence that MNCs reduced the share of relevant UK subsidiaries, suggesting some adjustment at this margin. In Columns 3 and 4, we consider the ratio of non-UK subsidiaries located in countries with a higher or lower statutory corporate tax rate than that in the UK. We show that treated MNCs increased the fraction of their subsidiaries located in higher tax regimes by 4.2 percent and reduced the fraction of subsidiaries located in lower tax regimes by 3.7 percent. These changes are statistically significant at the 1 percent level. Taken together, these results suggest that affected MNCs restructured their subsidiaries in response to the WDC, in addition to the intensive margin adjustments in real business activities.

[31] We do not analyze the absolute number of multinational subsidiaries as there has been a change in the way that Orbis records subsidiaries during our sample period.

[32] Using the much smaller matched sample yields qualitatively similar but insignificant point estimates.

6.4 Tax burden

Given that the purpose of the WDC was to raise tax revenue in the UK, we investigate whether the WDC increased MNCs' tax payments to the UK tax authority. We report the estimated results in Panel A in Table 9. We find that following the WDC, the UK tax payments of domestic MNCs increased by 21.3% (Column 2).[33] In contrast, the UK tax payments of foreign MNCs did not significantly change (Column 3). This result is in line with our findings that domestic MNCs did not significantly change their UK operation size but foreign MNCs shrank their tax base in the UK. Thus, the WDC only succeeded in raising tax revenue from affected domestic MNCs.

Our results are consistent with Miller (2017) who shows that anti-tax avoidance policies, especially those related to interest deductibility restrictions, are the only recent UK tax policy leading to positive revenues to the HMRC. In our sample, domestic MNCs in 2009 had around 2.3 billion pounds of positive tax liability in the UK. A 21.3% increase in tax liability for the affected domestic MNCs would lead to a 499 million pounds increase in tax liability.[34] Miller (2017) suggests that the UK has gained 1.2 billion pounds from all of the anti-avoidance measures announced between 2010 and 2015. Our estimates are well within the range of her calculations.

Further, the WDC could have a spillover effect on other countries' tax revenue due to the reallocation of debt and real business activities. The direction of such an effect is ambiguous. On the one hand, debt shifting into non-UK subsidiaries could lower MNCs' tax payments outside of the UK. On the other hand, the reallocation of real business operations enlarged the pre-interest deductions tax base in these locations. In Panel B in Table 9, we find that the foreign tax payment of treated MNCs' did not change post the WDC. This indicates the effect of increased leverage was more or less offset by that of real operation reallocation. Thus, while foreign countries benefit from UK's WDC by receiving more assets and employees, they did not enjoy any increase in tax revenue.

As treated domestic MNCs increased tax payments in the UK significantly, we would

[33]The UK corporate tax revenues as reported by the HMRC have increased from GBP 30.8 billion in 2009/10 to GBP 35.3 billion in 2010/2011 (excluding revenues from North Sea oil companies). The HMRC does not report the breakdown of corporate tax receipts by ownership type of companies. Evidence from Bilicka (2019) suggests that net tax payments of multinational firms have increased between the two tax years.

[34]The additional tax revenue for the period 2010- 2014 should equal to (total UK net debt in 2009 held by domestic MNCs) x (average interest rate in 2009-2014) x (percent reduction UK net debt from column 4 Table 2) x (average tax rate in 2009 -2014). These are 42 billion, 0.052, -64%, 0.25, respectively, which gives 343 million. These results are in line with the regression estimates, especially since here we assume the short-term interest rate is the same for everyone, which would not be true in reality.

expect an increase in the overall tax liability of those MNCs. In Table 5 of the Online Appendix, we find a 12.1% increase in domestic MNCs' consolidated group-level tax liability. This point estimate, however, is not statistically significant possibly due to small sample size. Differences in accounting methods used for consolidated group-level and unconsolidated subsidiary-level financial statements may also create discrepancies. Another possible explanation is that affected domestic MNCs managed to offset some of the increase in the UK tax liability somewhere we do not observe, as Orbis and Fame may fail to collect tax payment information from all of MNCs' subsidiaries.[35]

For foreign MNCs, results in Table 9 suggest that the WDC did not significantly affect their tax bills either in the UK or elsewhere. These results are not surprising, since we find that foreign MNCs reallocated real activities away from the UK, which shrank their pre-interest tax bases in the UK and created larger pre-interest tax bases in other countries. This, however, indicates that foreign governments did not enjoy higher revenues, as the larger tax base was offset by more interest deductions.

7 Confounding events

Several factors may challenge our identification strategy, including the financial crisis, the territorial tax system reform, and the UK corporate tax rate cuts. Our difference-in-differences research design helps alleviate these concerns to some extent, because each of those events, in principle, affects all MNCs in the UK. However, if these events had a differential impact on our treated group, our estimates may be biased. We address these confounding events in this section.

7.1 Exposure to the financial crisis

Firms in our treated group may have been affected differently by the 2008 subprime mortgage and 2009 Euro-debt crises. These financial crises were negative shocks to the supply of external finance for non-financial firms (Acharya et al., 2018), which can have larger effects on firms lacking sufficient financial slack and/or depending more on external financing (Campello et al., 2010; Chodorow-Reich, 2014; Duchin et al., 2010). One concern about our identification strategy is that the high level of debt of the treated MNCs may be associated with high default risk and/or strong financial constraint. Hence, it is possible

[35]In Table 6 in the Online Appendix, we show that treated MNCs did not use 50-75% owned UK subsidiaries for this offsetting.

that treated MNCs reduced their debt more than control group firms because the financial crisis had a more negative impact on their access to external finance. Two issues are worth noting: 1) much of the treated MNCs' UK borrowing was in the form of internal debt which may be less affected by the reduced supply of external finance, and 2) the level of debt is different from default risk and financing constraint in the sense that a firm with a high level of debt might maintain sufficient financial slack that would reduce its exposure to a shock. With these in mind, we examine whether treated and control MNCs were exposed to the financial crisis to different extents, and conduct triple DID estimations to test whether the effect of the WDC differs across treated MNCs with different degrees of default risk or financial constraints.

We measure default risks by the expected distance to default (DD) (Bharath and Shumway, 2008), and we measure financial constraint using the KZ index (Kaplan and Zingales, 1997). The DD is a measure of default risk derived using the structural credit risk model of Merton (1974), in which the equity of the firm is a call option on the underlying value of the firm with a strike price equal to the face value of the firm's debt. The implied probability of default is the standard normal cumulative distribution function of negative DD. Hence, a higher value of DD means that a firm has a lower probability of default.[36] The KZ index measures how reliant the firm is on external financing.[37] A higher value of the KZ index suggests that a firm is more reliant on external financing. Because changes in firms' financial positions as the crisis unfolded may be related to unobserved firm characteristics, we follow Duchin et al. (2010) and measure firms' financial positions based on financial data one year before the crisis. Specifically, we use firms' financial statement information in 2007 to construct these measures.

Table B.5 compares the default risks and financial constraints faced by treated and control MNCs before the WDC. We do not find that treated MNCs faced higher default risks than control MNCs. This is consistent with the fact that the treated MNCs actually had a lower level of gross debt than the control group, on average (Table 1). Although treated MNCs were much more indebted in the UK than the control MNCs, much of their UK net debt was internal debt that is less likely to impose any default risk. There is also no systematic evidence suggesting that the treated MNCs were more financially constrained

[36]The DD is defined as: $= \frac{ln(\frac{equity+debt}{debt}) + (return - \frac{\sigma^2}{2}) \times T}{\sigma \times \sqrt{T}}$, where $return$ is stock return, σ is the volatility of firm value, and T indicates time.

[37]We follow Lamont et al. (2001) to estimate the KZ index: $KZ - index = -1.002 \times cashflow + 0.283 \times Q + 3.319 \times debt - 39.368 \times dividends - 1.315 \times cash$.

than the control MNCs. In fact, we find that treated MNCs, on average, had a higher liquidity ratio than the control group.

Next, we differentiate between treated MNCs with different default risks and financial constraints, and report the triple DID estimation results in Table 10. We show that the estimated effects of the WDC on the gateway ratio, the UK net debt, and the worldwide gross debt do not significantly vary in magnitude between treated MNCs with different degrees of default risk, or between firms that were more or less financially constrained. In Table 10, we measure financial constraint using the KZ index. We obtain similar conclusions when we use alternative measures for firms' financial constraints, including liquidity ratio, payout ratio, and an indicator of whether the firm pays out dividends.[38] Taken together, these results indicate that our benchmark results are unlikely to be confounded by the financial crisis.

7.2 Territorial tax reform

Another potential confounding factor for our results is the UK's transition from the worldwide to the territorial tax system in 2009. Arguably, the territorial tax reform should have had a smaller impact on foreign MNCs. The fact that we see stronger responses by foreign MNCs suggests that our results are unlikely to be confounded by the territorial tax reform. Nonetheless, we empirically test two channels through which that reform could have potentially affected our treated MNCs differentially from the control group firms.

First, the territorial tax reform encouraged MNCs to repatriate dividends from overseas. If MNCs with more UK debt faced more frictions before the territorial system reform (that is, it was more costly for them to repatriate profits before 2009), they would repatriate more foreign profits following the territorial tax system reform. This may imply a greater substitution between repatriated profits and debt after the territorial tax system reform. Hence, we compare the dividend repatriation patterns between the treated and control groups in Table 11. Since the territorial reform should mainly affect domestic MNCs, we use this sub-sample for the comparison. In Column 1 of Table 11, the dependent variable is total dividends received by UK subsidiaries. In Column 2, the dependent variable is dividends paid out by the MNCs' non-UK subsidiaries. In these columns, we find no difference between affected and non-affected MNCs. Therefore, any substitution between debt and repatriated profits as a way to finance investment projects should be similar between the treated and the control groups.

[38] We report the results in Figure 8 in the Online Appendix.

Second, the territorial tax system reform may incentivize MNCs to shift profit into low-tax regions, as foreign profits are no longer taxed in the UK upon repatriation (Langenmayr and Liu, 2020). Note that, if firms shift after-interest profit (EBT) rather than pre-interest profit (EBIT), they may initiate lending from the non-UK part of the group to the UK. If treated MNCs were more able to shift profit in this way than the control group, we should see a relative *increase* in their UK net debt. This runs against our finding that treated MNCs actually reduced their UK debt and increased foreign borrowing.

We also consider an alternative scenario in which firms first decide where to locate pre-interest profit (EBIT) using non-debt methods (e.g., transfer pricing) and then choose their debt policy accordingly. If EBIT in the UK declined, the MNC may want to reduce debt in the UK as there is less EBIT to deduct the interests against. In Table B.6, we show that there is no difference between the treated and control groups in terms of their UK or non-UK EBIT (scaled by total assets) after the WDC. This implies that the territorial tax reform should have affected EBIT of the two groups similarly and hence, should have a similar impact on the debt policies of the two groups. Consequently, the differential responses in debt policies between the treated and control groups are unlikely to be driven by the territorial tax system reform.

7.3 UK corporate tax rate cuts

The third potential confounding factor is the declining corporate income tax rate in the UK, which reduces the attractiveness of debt financing, all else equal. The initial UK corporate tax cuts package was announced in 2007 to reduce the tax rate from 30% to 28% effective in April 2008. In 2009 the UK has announced an additional tax cut to lower the rate to 20% by 2015. These tax cuts have later been extended. To understand whether these tax cuts affected treated and control groups differently, we calculate the average non-UK statutory corporate income tax rate for MNCs in our sample. We find that the average non-UK CIT rate was 26.0% and 25.4% in 2009 for treated and control MNCs, respectively (Table B1). Therefore, the UK should have been an equally attractive destination for debt for both types of MNCs before the WDC, and the UK tax rate cut should have a similar impact on debt financing of the two types of MNCs.

A related concern is that the treated and control MNCs could be different in terms of their effective tax rates and profits they held in the UK. If this is the case, they may react differently to the corporate tax rate cuts in the UK. For example, if treated MNCs had higher profits in the UK than the control group, the cut in the UK statutory rate may generate

more tax savings for them. If MNCs use tax savings to substitute for debt financing, we should observe treated MNCs reducing debt more than the control group. For our matched sample, the UK ETR in 2009 was 15% for treated MNCs and 14.4% for those in the control group. These figures were not statistically significantly different from each other. Also, the treated and control groups in the matched sample had similar levels of UK profitability (see, Table 1). This suggests that the treated and control MNCs should not, in principle, differ in terms of their response to corporate tax rate cuts.

As a formal check, we construct a dummy indicating whether the MNC's UK profitability is above the sample median in 2010. We define UK profitability as a ratio of UK profits before taxes to UK total assets for each MNC. We interact this dummy with $Failed_i \times Post_t$ in a triple DID estimation. In Table 12, we show that the effect of WDC on treated MNC's gateway ratio, net UK debt, and gross debt does not differ across firms with different levels of UK profitability.

8 Additional tests

We conduct a host of robustness tests to examine whether our results are sensitive to the matching method, matching set of variables, or control variables included in the specifications. First, we compare results with and without matching. In Panel A of Table B.7, we provide baseline results analogous to those in Table 2 when we use the full sample. In Panel B, we exclude industries from the full sample where the treated MNCs were not present. Using these alternative samples, we obtain broadly similar results to our benchmark ones.

We next examine whether our benchmark estimation results are sensitive to different matching methods. We use the one-to-one nearest neighborhood matching method in the benchmark estimations. In Table B.8, we report results based on a sample matched by the kernel matching technique. It shows that our benchmark findings are not sensitive to the choice of the matching technique.

In Table B.9, we consider whether using a different set of matching variables changes our main result. We use the benchmark one-to-one nearest neighborhood matching method for this table. In all specifications, we include MNCs' GUO industry, GUO location, and group size in 2010 in the set of matching variables, as we did in the benchmark estimations. Here, we extend the set of matching variables to include MNCs' UK profitability (Column 1), UK effective tax rate (UK ETRs, Column 2), the ratio of UK total assets to the group total assets (Column 3), the difference in UK total assets between 2008 and 2009 (Column

4), the difference in MNCs assets between 2008 and 2009 (Column 5) and finally, all of these additional variables together (Column 6). Matching on UK profitability and ETRs helps us address concerns that our treatment and control groups may be different in terms of tax aggressiveness, and consequently may have been affected by the UK corporate tax cuts differently. Matching on the relative size of MNCs' UK operations addresses the concern that the treated and control groups may have different exposures to the UK and hence, may respond differently to the UK's anti-tax avoidance measure. Further, matching on the difference in UK and MNC total assets between 2008 – 2009 allows us to address concerns about differential pre-trends between treatment and control groups. Results from Table B.9 suggest that expanding the set of matching variables does not significantly affect either the magnitude or the statistical significance of our benchmark results.

Finally, in Section 2 in the Online Appendix, we include Table 2 with a set of results where we control for firm-level observable characteristics. In Panel A, we control for group size, UK size, and UK profitability of MNCs and in Panels B - D, we include additional controls in line with some prior studies examining debt policies of MNCs, such as dividend payments, effective tax rates, and average non-UK CIT tax rates (Faulkender and Smith, 2016). The inclusion of these controls does not change the results substantially. While additional controls limit the sample size, the majority of our results still hold, especially regarding the effect of the WDC on MNCs' UK debt holdings.

9 Conclusions

Tackling debt shifting for tax avoidance purposes by multinational firms is high on the agenda of many national governments. In this paper, we analyze how a new form of debt-related anti-tax avoidance policy affects multinationals' debt and real activities allocations. We use the UK worldwide debt cap reform in 2010 as a quasi-natural experiment, which restricted the MNC's interest expense deductions for tax purposes in the UK to be below a fixed ratio relative to the MNC's worldwide debt holdings. Unlike the widely adopted thin-capitalization rule, the worldwide approach should be more difficult to circumvent and thus, should have a more binding effect on earning stripping by MNCs. We provide causal evidence for a significant effect of the UK worldwide debt cap on MNCs' debt allocation across subsidiaries. While the anti-tax avoidance policy was effective in curbing excessive borrowing in the UK, one unintended consequence is an increase in multinational groups' external debt. This could possibly affect firms' credit risk, which we leave for future research.

The worldwide debt cap also led to the reallocation of real activities among affected foreign MNCs. We show that affected multinationals shrank their business operation in the UK while expanding it elsewhere. This offset the amount of tax revenue that could have been raised from MNCs as a result of the WDC, especially from foreign MNCs with a weak home bias. Foreign countries, on the other hand, benefit from such reallocation as investment and employment shift there. However, the reallocation of business activities did not bring more tax revenue to foreign countries due to debt shifting occurring at the same time. Our findings contribute to the growing literature on how anti-tax avoidance measures affect real economic activities and fiscal conditions, both at home and abroad.

Finally, our analysis has broad implications for implementing anti-tax avoidance measures without international cooperation. We show that such unilateral move may have unintended consequences and significant spillover effects. The WDC also likely imposed an additional tax burden on domestic MNCs relative to foreign MNCs for their UK operation, which may create competitive disadvantages for the former. International cooperation in matters of anti-tax avoidance policies is thus crucial to avoid such unintended consequences.

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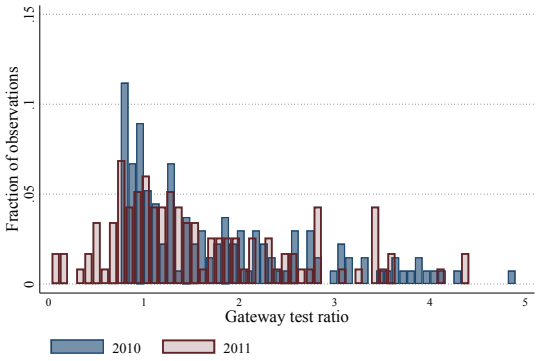
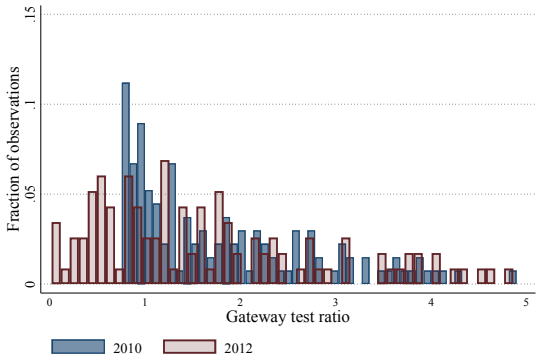
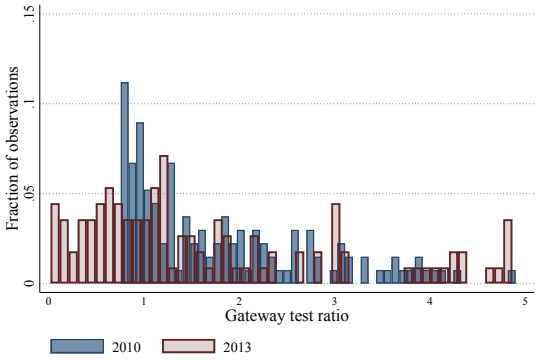
Figure 1: Distributions of the gateway test ratio



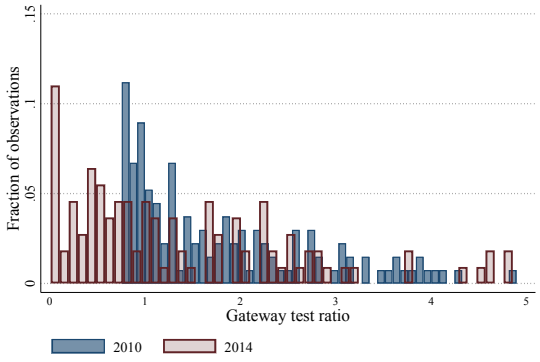
a Treatment group 2010 vs 2011.



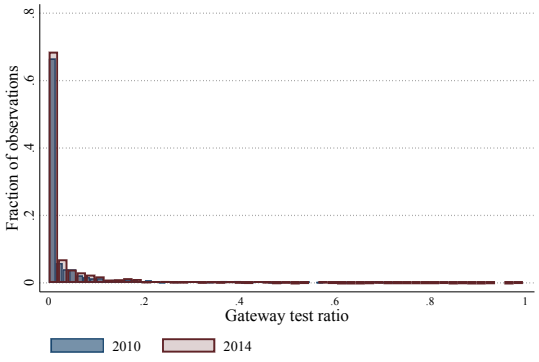
b Treatment group 2010 vs 2012.



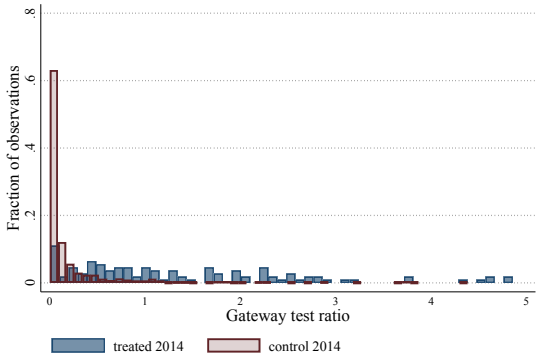
c Treatment group 2010 vs 2013



d Treatment group 2010 vs 2014



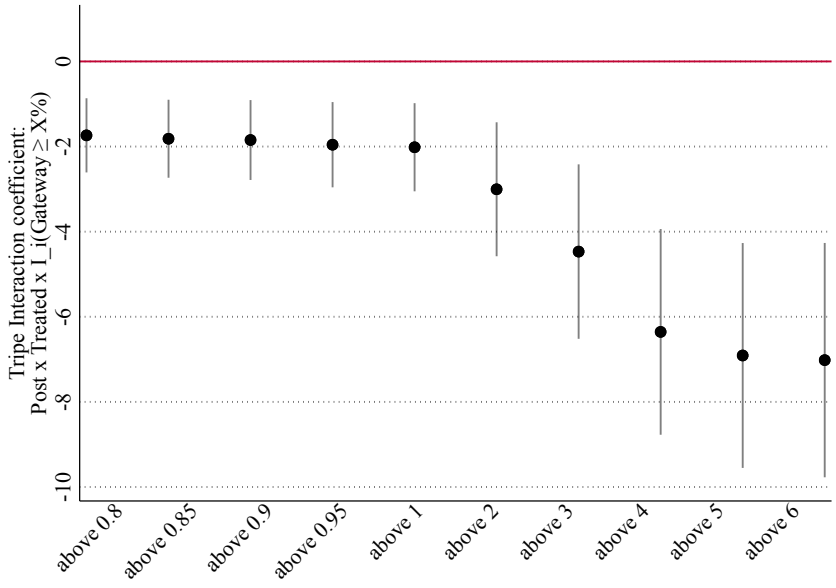
e Control group



f Treated vs control group 2014

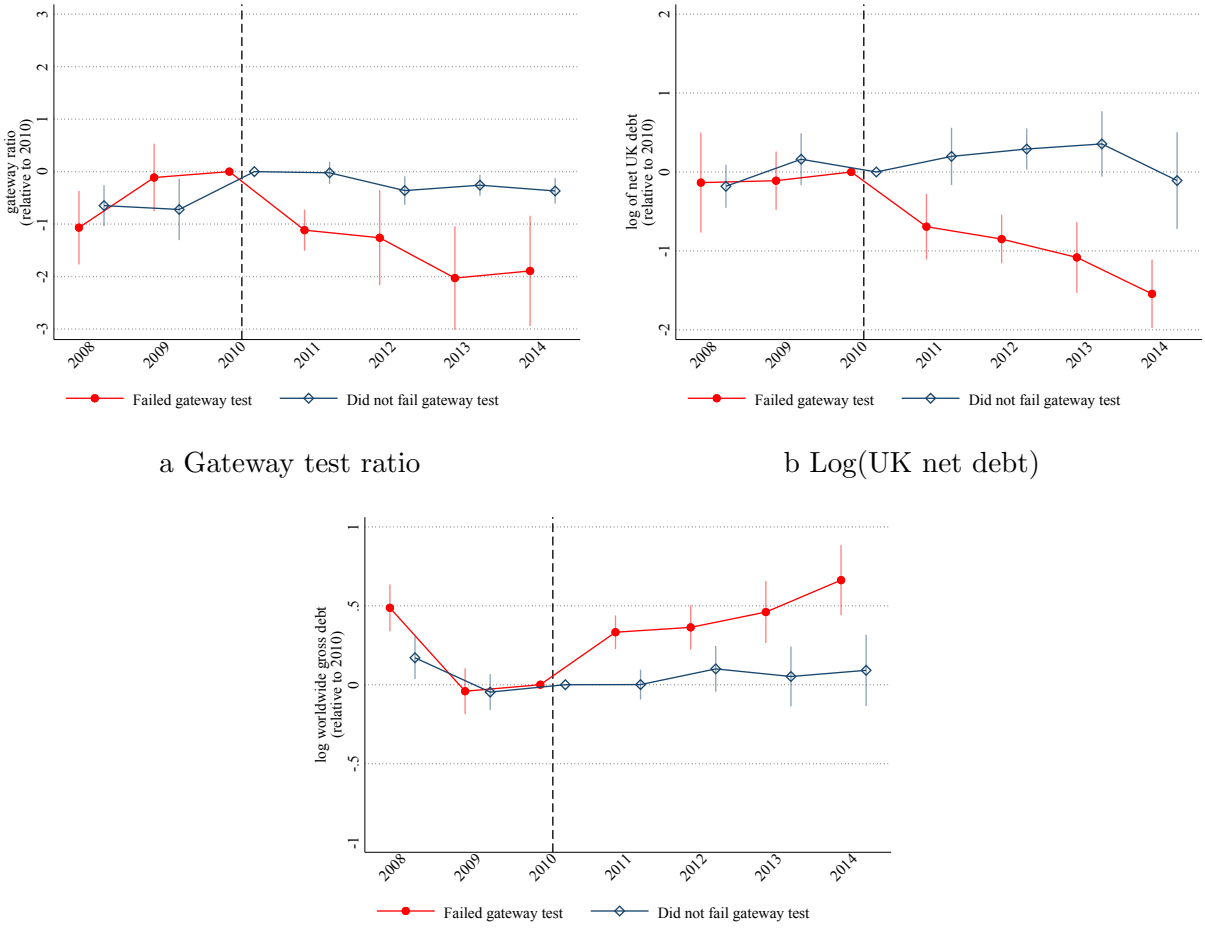
Note: These graphs plot histograms of the gateway ratio, which is the ratio of MNCs' UK net debt to worldwide gross debt. Panels A - D plot the distributions for treated MNCs during 2010-2014. Panel E plots the distribution for the control group. In Panel F, we compare the distributions between the treated and control groups in 2014. There were 30 treated MNCs with a gateway test ratio above 5 in 2010, which we exclude from these graphs for a better presentation. There was no more MNC with a gateway ratio above 5 by 2014.

Figure 2: Heterogeneous responses to the WDC: Treated MNCs with different gateway ratios



Note: We plot triple DID estimation results where we interact $Failed_i \times post_i$ with a dummy $I_i(Gateway \geq X\%)$, indicating that firm $i's$ gateway ratio was above $X\%$ in 2010. Each black dot represents the point estimate, while the vertical bars represent the 95% confidence intervals. Gateway test ratio is the ratio of UK net debt to worldwide gross debt. The regression coefficients plotted here can be found in Table 1 in the Online Appendix. The treated group includes MNCs that failed the gateway ratio test in 2010. The control group contains MNCs that never failed the gateway ratio. We match the two groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement.

Figure 3: Dynamic effects of the WDC on debt



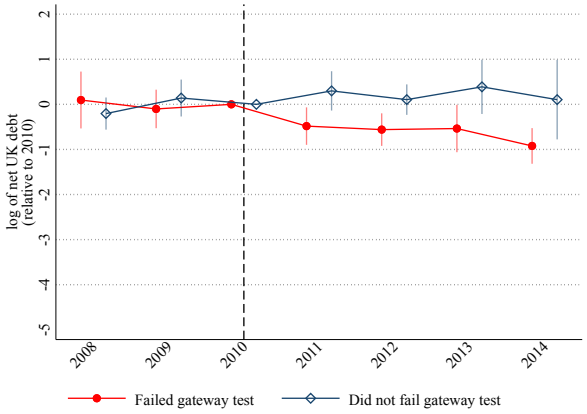
a Gateway test ratio

b Log(UK net debt)

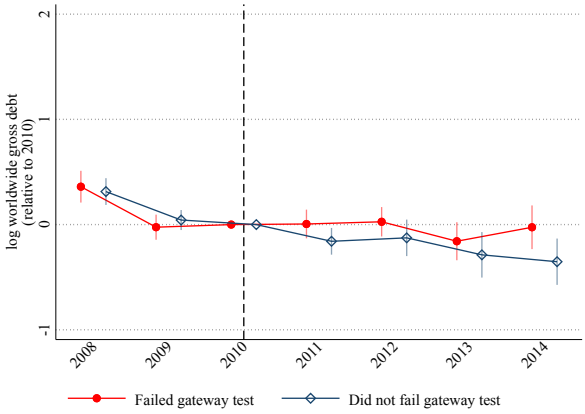
c Log(Worldwide gross debt)

Note: These figures plot DID estimation results based on Equation 1, where we include firm fixed effects. The dependent variables are the gateway test ratios with and without taking the log, the logarithm of UK net debt, and the logarithm of worldwide gross debt. Gateway test ratio is the ratio of UK net debt to worldwide gross debt. Each variable is calculated on the annual basis. For each outcome variable, we plot the estimated difference between each year and the reference year, which we set to be 2010, for the treatment (red dots) and control (blue hollow diamonds) groups. The vertical bars represent the 95% confidence intervals. The treated group includes MNCs that failed the gateway ratio test in 2010. The control group contains MNCs that never failed the gateway ratio. We match the two groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement.

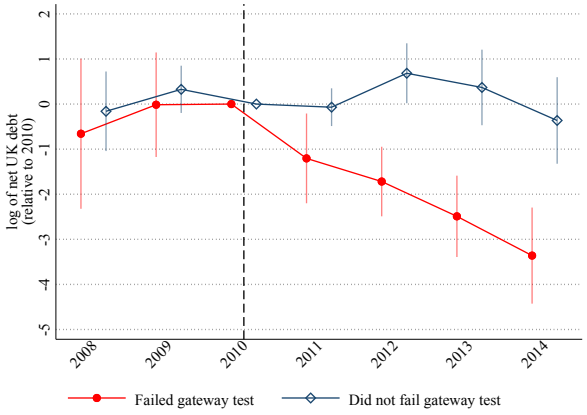
Figure 4: Dynamic effects of WDC on debt –comparing domestic and foreign MNCs



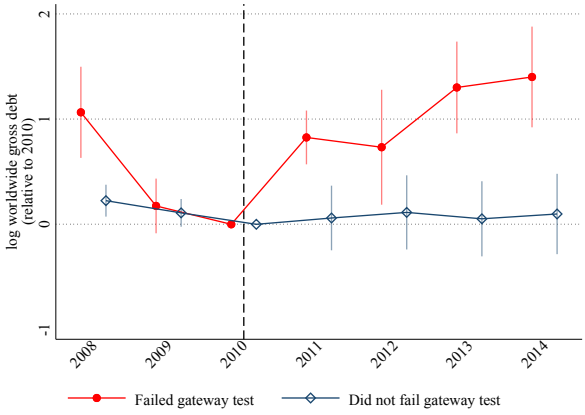
a Log(UK net debt): domestic MNCs



b Log(Worldwide gross debt): domestic MNCs



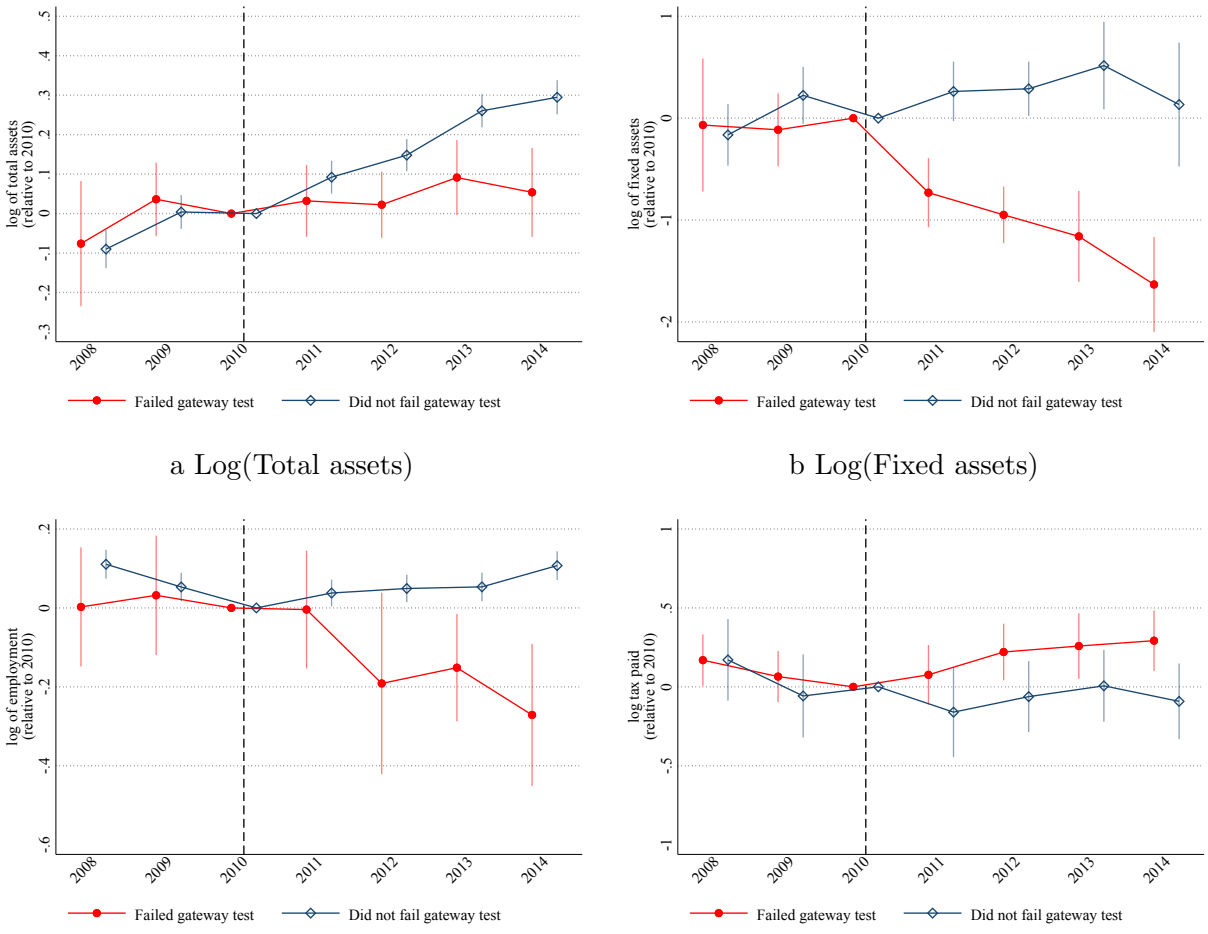
c Log(UK net debt): foreign MNCs



d Log(Worldwide gross debt): foreign MNCs

Note: These figures plot DID estimation results based on Equation 1, where we include firm fixed effects. The dependent variables are the logarithm of UK net debt and the logarithm of worldwide gross debt. Each variable is calculated on the annual basis. For each outcome variable, we plot the estimated difference between each year and the reference year, which we set to be 2010, for the treatment (red dots) and control (blue hollow diamonds) groups. The vertical bars represent the 95% confidence intervals. Domestic MNCs are MNCs headquartered in the UK and foreign MNCs are MNCs headquartered elsewhere. The treated group includes MNCs that failed the gateway ratio test in 2010. The control group contains MNCs that never failed the gateway ratio. We match the two groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement.

Figure 5: Dynamic effects of the WDC on business operations in the UK



a Log(Total assets)

b Log(Fixed assets)

c Log(Employees)

d Log(Total tax paid in the UK)

Note: These figures plot DID estimation results based on Equation 1, where we include firm fixed effects. The dependent variables include MNCs' UK total assets, fixed assets, employees, and tax paid in the UK, all in logs. For each outcome variable, we plot the estimated difference between each year and the reference year, which we set to be 2010, for the treatment (red dots) and control (blue hollow diamonds) groups. The vertical bars represent the 95% confidence intervals. The treated group includes MNCs that failed the gateway ratio test in 2010. The control group contains MNCs that never failed the gateway ratio. We match the two groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement.

Table 1: Matching properties: Means of key variables for treatment and control groups in 2009

Variable		Mean Treated	Mean Control	T-statistics	% bias	% bias reduction
Group-level statistics						
MNC log(total assets)	Unmatched	12.32	13.68	-19.73	-57.4	
	Matched	12.27	12.38	-0.47	-4.7	91.9
MNC log(gross debt)	Unmatched	9.4	11.45	-17.25	-54.7	
	Matched	9.23	10.33	-3.55	-30.2	44.8
MNC ETR	Unmatched	.064	.043	0.97	8.5	
	Matched	.064	0.050	0.46	5.8	31.7
UK statistics						
log(UK net debt)	Unmatched	10.03	5.09	31.03	110.9	
	Matched	10.70	4.41	14.51	141.6	-27.7
log(gateway ratio)	Unmatched	0.92	-1.56	37.63	134.3	
	Matched	1.29	-0.92	15.30	120.1	10.5
log(UK total assets)	Unmatched	13.8	4.36	6.35	8.3	
	Matched	13.7	6.5	0.62	6.4	23.5
log(UK fixed assets)	Unmatched	9.64	2.62	6.76	8.4	
	Matched	9.95	3.90	0.69	7.3	13.8
UK employment	Unmatched	4,886	1,444	5.33	6.4	
	Matched	4,987	5,710	-0.30	-1.3	79.0
UK profitability	Unmatched	-0.07	0.003	-8.03	-19.7	
	Matched	-0.05	-0.04	-0.37	-4.0	79.5
UK ETR	Unmatched	0.128	0.167	-5.6	-0.68	
	Matched	0.15	0.14	1.0	0.09	82.9

Note: This table reports the means of key financial variables for the treated and control MNCs in 2009, before and after matching, based on Fame. We also report the T statistics for the test of equal means. The treated group includes firms that failed the gateway ratio test in 2010. The control group contains MNCs that never failed the gateway ratio. We match the two groups of firms based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. % bias reduction is calculated as (% bias of unmatched sample-% bias of matched sample)/(% bias of unmatched sample). MNC total assets, MNC gross debt, UK total assets and fixed assets are averages reported in $ millions. UK employment is the number of people employed. UK profitability is total UK profit and loss before taxes divided by total assets held by each MNC. UK ETR is total UK tax liability divided by total profit and loss before taxes held by each MNC.

Table 2: Impact of the worldwide debt cap on MNCs' gateway ratios and group-level debt holdings

Dep. Var	Gateway Ratio	Log Gateway Ratio	Log UK Net Debt	Log Gross Debt
	(1)	(2)	(3)	(4)
$Failed_i \times Post_t$	-1.691***	-0.345***	-1.008***	0.327***
	(0.431)	(0.081)	(0.223)	(0.088)
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
No. of groups	376	376	376	376
Observations	2,055	2,055	2,055	2,055

Note: This table reports the estimated effects of the WDC on MNCs' gateway ratio, UK net debt and worldwide gross debt. *UK Net Debt* is UK relevant liability minus UK relevant assets, aggregated across the MNCs' UK subsidiaries; *Gross Debt* is the worldwide gross debt of the multinational group; and *Gateway Ratio* is *UK Net Debt* divided by *Gross Debt*. We match the treated and control groups based on GUO industry, GUO headquarter location and group size, using the one-to-one nearest neighbor matching technique without replacement. We include both year and MNC group-level fixed effects. No control variables are included. Standard errors are robust and two-way clustered over MNC group and year.

Table 3: Impact of the worldwide debt cap on MNCs' group-level debt holdings–headquarter heterogeneities.

Dep. Var	Gateway Ratio (1)	Log Gateway Ratio (2)	Log UK Net Debt (3)	Log Gross Debt (4)
Panel A: Domestic MNCs				
$Failed_i \times Post_t$	-1.341***	-0.267***	-0.894***	0.227**
	(0.475)	(0.086)	(0.253)	(0.097)
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
No. of groups	278	278	278	278
Observations	1,531	1,531	1,531	1,531
Panel B: Foreign MNCs				
$Failed_i \times Post_t$	-3.083***	-0.642***	-1.537***	0.682***
	(1.032)	(0.195)	(0.465)	(0.201)
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
No. of groups	98	98	98	98
Observations	523	523	523	523

Note: This table reports the estimated effects of the WDC on gateway ratio, UK net debt and worldwide gross debt for domestic and foreign MNCs, respectively. Panel A includes MNCs headquartered in the UK only, while panel B includes MNCs that are headquartered outside of the UK. *UK Net Debt* is UK relevant liability minus UK relevant assets, aggregated across the MNCs' UK subsidiaries; *Gross Debt* is the worldwide gross debt of the multinational group; and *Gateway Ratio* is *UK Net Debt* divided by *Gross Debt*. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. We include both year and MNC group-level fixed effects. No control variables are included. Standard errors are robust and two-way clustered over MNC group and year.

Table 4: Impact of the worldwide debt cap on MNCs' group-level operations: evidence from consolidated data

Dep. Var	log tax	log total assets	log fixed assets	log employment
	(1)	(2)	(3)	(4)
$Failed_i \times Post_t$	0.075	0.008	0.027	-0.047
	(0.123)	(0.046)	(0.053)	(0.047)
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
No. of groups	376	376	376	376
Observations	2,054	2,054	2,054	2,054

Note: This table reports the estimated effects of the WDC on MNCs' tax payments, total assets, fixed assets and total employees using consolidated group-level data. We include the logarithm of MNC total assets as a control in column 1, and include no controls in columns 2-4. We match the treated and control groups based on GUO industry, GUO headquarter location and group size, using the one-to-one nearest neighbor matching technique without replacement. We include both year and MNC group-level fixed effects. Standard errors are robust and two-way clustered over MNC group and year.

Table 5: Impact of the worldwide debt cap on non-UK subsidiaries' leverage ratio

Dep. Var.	All MNC				Domestic MNC		Foreign MNC	
Lev_{ijst}	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Failed_i \times Post_t$	0.186***	0.152***	0.136***		0.074**		0.160**	
	(0.030)	(0.029)	(0.030)		(0.035)		(0.068)	
$Failed_i \times Post_t \times CIT_{st}$				0.522***		0.248**		0.576***
				(0.103)		(0.121)		(0.218)
Controls		✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
Host country-year FE			✓		✓		✓	
Subsidiary FE	✓	✓	✓	✓	✓	✓	✓	✓
No of groups	1,926	1,754	1,754	1,753	1,022	1,021	733	733
Observations	11,827	9,359	9,359	9,354	5,607	5,605	3,752	3,749

Note: This table reports the estimated effect of the WDC on the leverage ratio of MNCs' non-UK subsidiaries. Lev_{ijst} is the net-of-cash leverage ratio of subsidiary j, which belongs to MNC i and is located in country s in year t. CIT_{st} is the statutory corporate income tax rate in country s in year t. Columns 1-4 consider all MNCs, Columns 5-6 consider domestic MNCs, and Columns 7-8 consider foreign MNCs. Where indicated we control for group size, subsidiary size and profitability. *Group Size* is the logarithm of total assets for the whole group, *Subsidiary Size* is logarithm of total asset for each subsidiary, and *Subsidiary Profitability* is the ratio of profit and loss before tax to total assets for each subsidiary. We match the the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. Standard errors are robust and two-way clustered over subsidiary and year.

Table 6: Impact of the worldwide debt cap on MNCs' UK operations

	All MNCs			Domestic MNCs			Foreign MNCs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. Var.	assets	fx assets	emp	assets	fx assets	emp	assets	fx assets	emp
$Failed_i \times Post_t$	-0.075**	-0.114**	-0.039*	-0.006	-0.066	-0.012	-0.344***	-0.363**	-0.113***
	(0.037)	(0.057)	(0.021)	(0.033)	(0.058)	(0.025)	(0.113)	(0.152)	(0.039)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Group FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
No. of groups	376	371	230	278	277	171	98	94	59
Observations	2,054	2,009	1,259	1,531	1,521	942	523	488	317

Note: This table reports the estimated effects of the WDC on MNCs' UK operation, proxied by their UK total assets (asstes), fixed assets (fx assets), and employment (emp) aggregated across all UK subsidiaries (all in natural logarithm). Columns 1-3 consider all MNCs, Columns 4-6 consider domestic MNCs, and Columns 7-9 consider foreign MNCs. We match the treated and the control groups on the MNCs' GUO industry, GUO location and group size. In all specifications, we control for *Group Size*, which is the logarithm of total assets for the whole group. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. Standard errors are robust and two-way clustered over MNC group and year.

Table 7: Impact of the worldwide debt cap on MNCs' non-UK operations

Panel A: Average Effects

	All MNCs			Domestic MNCs			Foreign MNCs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. Var.	assets	fx assets	emp	assets	fx assets	emp	assets	fx assets	emp
$Failed_i \times Post_t$	0.165***	0.113***	0.106***	0.211***	0.138***	0.090***	0.229***	0.175*	0.153**
	(0.027)	(0.039)	(0.026)	(0.032)	(0.046)	(0.030)	(0.062)	(0.092)	(0.062)
No. of groups	2,026	1,924	1,725	1,184	1,135	1,012	845	792	715
Observations	12,820	12,056	9,613	7,598	7,169	5,695	5,222	4,887	3,918

Panel B: Interacting with corporate tax rate

	All MNCs			Domestic MNCs			Foreign MNCs		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. Var.	assets	fx assets	emp	assets	fx assets	emp	assets	fx assets	emp
$Failed_i \times Post_t \times CIT_{st}$	0.593***	0.376**	0.360***	0.815***	0.452**	0.310***	0.733***	0.555*	0.477*
	(0.104)	(0.149)	(0.100)	(0.125)	(0.179)	(0.116)	(0.241)	(0.336)	(0.244)
No. of groups	2,025	1,923	1,725	1,183	1,134	1,012	845	792	715
Observations	12,815	12,051	9,613	7,596	7,167	5,695	5,219	4,884	3,918
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subsidiary FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Country-year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓

Note: This table reports the estimated effects of the WDC on MNCs' non-UK operations, proxied by non-UK subsidiary j's total assets (assets), fixed assets (fx assets), and employment (emp), all in natural logarithm. Columns 1-3 consider all MNCs, Columns 4-6 consider domestic MNCs, and Columns 7-9 consider foreign MNCs. CIT_{st} is the statutory corporate income tax rate in country s in year t. No controls are included in any of the specifications. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. Standard errors are robust and two-way clustered over subsidiary and year.

Table 8: Impact of the worldwide debt cap on MNCs' organizational structures

Dep. Var.	(1) %UK 50+	(2) %UK 75+	(3) %High Tax Subs	(4) %Low Tax Subs
$Failed_i \times Post_t$	-0.002	-0.016*	0.042***	-0.037***
	(0.009)	(0.009)	(0.007)	(0.006)
Year FE	✓	✓	✓	✓
Parent FE	✓	✓	✓	✓
No. of groups	1,306	1,306	1,306	1,306
Observations	11,983	11,983	11,983	11,983

Note: This table reports the estimated effects of the WDC on MNCs' organizational structures. %UK 50+ is the proportion of UK subsidiaries 50% or more controlled by the MNC; %UK 75+ is the proportion of UK subsidiaries 75% or more controlled by the MNC; %High Tax Subs is the proportion of subsidiaries in countries with a statutory corporate income tax rate higher than that in the UK; %Low Tax Subs is the proportion of subsidiaries in countries with a statutory corporate income tax rate lower than that in UK. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No controls are included in any of the specifications. Standard errors are robust and two-way clustered over MNC group and year.

Table 9: Impact of the worldwide debt cap on UK and non-UK tax payments

	All MNC	Domestic MNC	Foreign MNC
	(1)	(2)	(3)
Dep. Var.: $Log(\text{UKtaxpaid})_{ijt}$	**Panel A: UK 75% + subsidiaries**		
$Failed_i \times Post_t$	0.109	0.213**	-0.178
	(0.094)	(0.105)	(0.208)
Year FE	✓	✓	✓
Group FE	✓	✓	✓
No. of groups	317	237	80
Observations	1,338	1,010	328
Dep. Var.: $Log(\text{foreigntaxpaid})_{ijt}$	**Panel B: non-UK subsidiaries**		
$Failed_i \times Post_t$	0.034	0.029	-0.119
	(0.077)	(0.097)	(0.247)
Year	✓	✓	✓
Subsidiary FE	✓	✓	✓
Observations	6,761	3,907	2,853
No. of groups	1321	761	560

Note: This table reports the estimated effects of the WDC on MNCs' tax payment in or outside of the UK. In Panel A we report results for UK tax payments by relevant UK subsidiaries (75% or more owned); in Panel B, we report results for MNCs' non-UK tax payments. Column 1 considers all MNCs, Column 2 considers domestic MNCs, and Column 3 considers foreign MNCs. In Panels A, the dependent variable is the natural logarithm of UK tax payments aggregated across MNCs' UK subsidiaries in year t. In Panel B, the dependent variable is the natural logarithm of tax payments of a non-UK subsidiary j belonging to MNC i in year t. In all DID estimations, we match the the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No control variables are included. Standard errors are robust and two-way clustered over MNC group and year.

Table 10: Exposures to the financial crisis

Dep. Var	Gateway Ratio (1)	Log Gateway Ratio (2)	Log UK Net Debt (3)	Log Gross Debt (4)
Panel A: Expected default risk				
$Failed_i \times Post_t$	-1.004*	-0.485***	-0.958**	0.530***
	(0.595)	(0.138)	(0.386)	(0.149)
$Failed_i \times Post_t \times High_d$	-1.359	0.232	0.633	-0.235
	(1.158)	(0.175)	(0.493)	(0.157)
Observations	1,075	864	864	864
No. of groups	203	154	154	154
Panel B: Kaplan-Zingales index				
$Failed_i \times Post_t$	-2.463**	-0.478***	-0.941*	0.525***
	(0.972)	(0.157)	(0.484)	(0.165)
$Failed_i \times Post_t \times High_{KZ}$:	0.407	-0.209	-0.536	0.264
	(1.429)	(0.246)	(0.689)	(0.247)
Observations	724	752	752	752
No. of groups	134	134	134	134
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓

Note: This table reports the estimated effects of the WDC on MNCs' with different exposures to the financial crisis. The dependent variables are the gateway ratio (column 1), the log of the gateway ratio (column 2), the log of the UK net debt (column 3), and the log of the worldwide gross debt (column 4). We measure exposure to financial crisis using distance to default and we measure financial constraint using the KZ index. The distance to default is $DD = \frac{ln(\frac{equity+debt}{debt}) + (return - \frac{\sigma^2}{2}) \times T}{\sigma \times \sqrt{T}}$, where σ is volatility of firm value. A higher value of DD indicates a small probability of default. The Kaplan-Zingales index is measured as a combination of cash flow, Q, debt to total capital, dividends and cash to capital ratios and measures how reliant the firm is on external financing; $KZ - index = -1.002 \times cashflow + 0.283 \times Q + 3.319 \times debt - 39.368 \times dividends - 1.315 \times cash$. $High_{KZ}$ dummy in 2007 suggests high reliance on external financing. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No controls are included. Standard errors are robust and two-way clustered over subsidiary and year.

Table 11: Territorial tax system reform and dividend repatriation

Dep. Var.	(1) Dividend received by UK subsidiaries	(2) Dividend paid by non-UK subsidiaries
$Failed_i \times Post_t$	0.242	0.135
	(0.163)	(0.145)
Year FE	✓	✓
Subsidiary FE	✓	✓
No. of groups	1,425	988
Observations	6,230	5,710

Note: This table compares dividend repatriations of treated and control groups belonging to domestic MNCs. In Column 1, the dependent variable is the natural logarithm of one plus dividends that are received by the MNCs' UK subsidiaries, where dividends are defined as the difference between 2008 and 2009 shareholder funds available for distribution (equity) calculated after current profits. If dividends calculated in this way are negative, we set them to zero. In Column 2, the dependent variable is the natural logarithm of one plus dividends payout by MNCs' non-UK subsidiaries. We match the the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No controls are included. Standard errors are robust and two-way clustered over subsidiary and year.

Table 12: Impact of the worldwide debt cap on MNCs' group-level debt holdings: heterogeneity by the ability and incentive to shift profits

Dep. var.	(1) Gateway test	(2) Log Gateway test	(3) log UK net debt	(4) Log Gross debt
$Failed_i \times Post_t$	-1.164	-0.238**	-0.634***	0.223*
	(0.774)	(0.101)	(0.160)	(0.126)
$Failed_i \times Post_t \times$	-0.251	-0.003	0.010	0.006
— $High\ profitability_i$	(0.877)	(0.109)	(0.120)	(0.133)
Observations	1,462	1,462	672	1,532
No. of groups	277	277	161	278
Year FE	✓	✓	✓	✓
Parent FE	✓	✓	✓	✓

Note: This table reports the estimated effects of the WDC on MNCs' gateway ratio (column 1), log gateway ratio (column 2), UK net debt (column 3), and worldwide gross debt (column 4). We run triple DID estimations interacting $Treated_i \times post_t$ with a dummy, $High\ profitability_i$, which equals 1 if the treated MNC's UK profitability in 2010 was above the sample median. We measure UK profitability by the ratio of UK profits before taxes to UK assets for each MNC. We match the the treated and control groups based on GUO industry, GUO location and groupK, size, using the one-to-one nearest neighbor matching technique without replacement. No controls are included. Standard errors are robust and two-way clustered over MNC group and year.

Appendices

A Cost of capital calculations

In this Appendix, we outline the formulas used for the calculation of the tax component of the user cost of capital. Following Devereux and Griffith (2003), the tax component of the user cost of capital, assuming the marginal investment is financed by retained earnings, can be specified as:

$$Tax_E = \frac{(1-A)}{(1-\tau)}(r+\delta) \tag{A.1}$$

where A is the present value of depreciation allowances and r is the interest rate(for example, if the investment only lasts for 1 year and is allowed to depreciate 50% in year 1 with a corporate tax rate of 25%, then A=(50% $\times$25%)/(1 + r)).τ is the statutory corporate tax rate. δ is the economic depreciation rate.

The tax component of the user cost of capital, assuming the marginal investment is financed by debt, can be written down as:

$$Tax_D = \frac{(1-A)}{(1-\tau)}(r+\delta) - \frac{r\tau(1-\phi\tau)}{(1-\tau)} \tag{A.2}$$

where ϕ is the percent of first-year depreciation allowance (so that $(1-\phi\tau)$ is how much cash the firm will pay to buy 1 unit value of investment goods). Note, Devereux and Griffith (2003) makes several strong assumptions to derive this expression. One needs to assume that the inflation rate is 0, and that the shareholder discount rate, the real interest rate and the nominal interest rate are all the same (the latter two are the same without inflation).

Table A.1 provides the list of parameters, based on the tax base of the Oxford University Centre for Business Taxation, which we use to calculate the tax component of the user cost for marginal investment financed by debt and equity, respectively. We then assume the following weights to calculate the weighted average tax component of the user cost for one additional unit of investment: 41.3% for buildings, 44.2% for machinery, and 14.5% for intangibles.[39] Table A.2 provides the estimated average tax component of the user cost under equity and debt financing.

[39]Weights come from the CBT 2011 tax report.

Table A.1: Tax component of the user cost of capital: by asset types

	A	τ	ϕ	r	δ	Tax component	
						Equity	Debt
Panel A: Machinery							
2008	0.247	0.300	0.250	0.064	0.175	0.257	0.232
2009	0.218	0.280	0.200	0.052	0.175	0.246	0.227
2010	0.218	0.280	0.200	0.052	0.175	0.247	0.227
2011	0.218	0.280	0.200	0.053	0.175	0.248	0.228
2012	0.203	0.260	0.200	0.053	0.175	0.246	0.228
2013	0.181	0.240	0.180	0.053	0.175	0.245	0.229
2014	0.174	0.230	0.180	0.052	0.175	0.244	0.229
Panel B: Buildings							
2008	0.142	0.300	0.040	0.064	0.031	0.117	0.089
2009	0.108	0.280	0.030	0.052	0.031	0.102	0.082
2010	0.077	0.280	0.020	0.052	0.031	0.107	0.086
2011	0.039	0.280	0.010	0.053	0.031	0.112	0.092
2012	0	0.260	0	0.053	0.031	0.113	0.095
2013	0	0.240	0	0.053	0.031	0.110	0.094
2014	0	0.230	0	0.052	0.031	0.108	0.093
Panel C: Intangibles							
2008	0.247	0.300	0.250	0.064	0.154	0.234	0.209
2009	0.231	0.280	0.250	0.052	0.154	0.219	0.200
2010	0.231	0.280	0.250	0.052	0.154	0.220	0.201
2011	0.231	0.280	0.250	0.053	0.154	0.221	0.201
2012	0.214	0.260	0.250	0.053	0.154	0.219	0.202
2013	0.198	0.240	0.250	0.053	0.154	0.218	0.202
2014	0.082	0.230	0.250	0.052	0.154	0.245	0.231

Note: This table summarizes data we use in the calculation of the tax component of the user cost of capital. The present value of capital allowances (A), corporate tax rate (τ), tax depreciation (ϕ) and economic depreciation (δ) are provided by Oxford University Center for Business Taxation Tax Database. r is the borrowing interest rate, which comes from Bank of England, "Monthly average of UK resident monetary financial institutions' (excl. Central Bank) sterling weighted average interest rate - other loans with an initial fixation > 5yrs to private non-financial corporations (in percent) not seasonally adjusted". The tax component of the user cost of capital is calculated using Equation (A.1) for equity financing and Equation (A.2) for debt financing, separately.

Table A.2: Tax component of the user cost of capital: averaged across assets

	Equity	Debt	Change
2010	0.186	0.166	11.1%
average across 2010 - 2014	0.188	0.170	10.0%
from 2010 debt to 2014 equity	0.189	0.166	13.0%

Note: This table calculates the tax component of the user cost of capital, averaged across three asset types. We use the following weights for the calculation: 41.3% for buildings, 44.2% for machinery, and 14.5% for intangibles. In row 1, we calculate the change in the tax component if the firm moved from debt to equity financing in 2010. In rows 2 and 3, we use two alternative methods of computing the change in the tax component of user cost of capital. In row 2, we average the tax component of the user cost of capital under equity and debt financing across all years during 2010 - 2014, and then compute the difference in the averages. In row 3, we compute the change in the tax components comparing a firm using debt financing in 2010 with a firm using equity-financing in 2014.

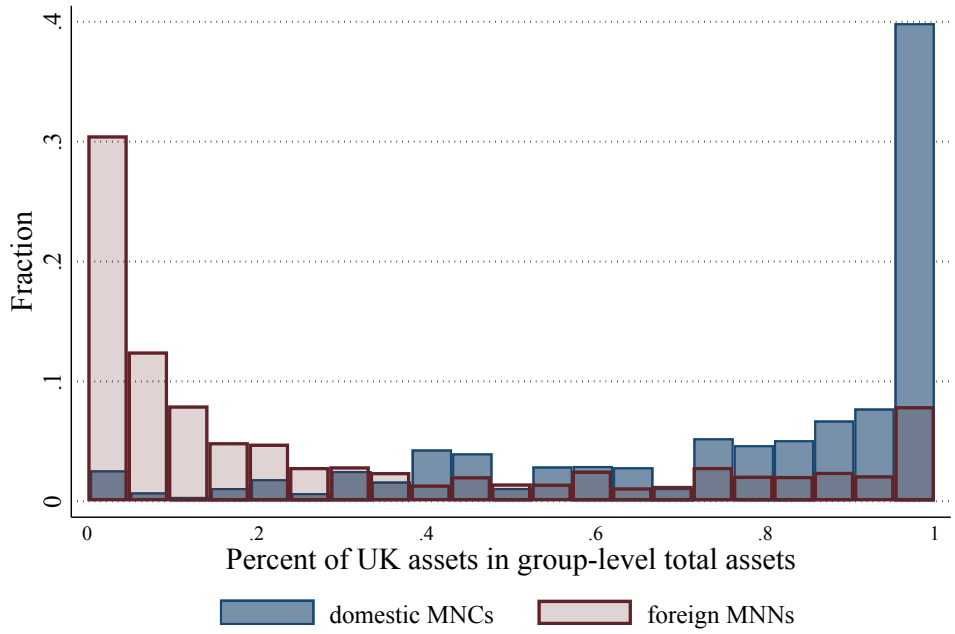
Table A.3: Implied elasticity of fixed assets and employment with respect to the tax component of the user cost of capital

	Fixed assets			**Employment**		
	ϵ_{all}	ϵ_d	ϵ_f	ϵ_{all}	ϵ_d	ϵ_f
2010	1.02	0.59	3.26	0.35	0.11	1.01
average across 2010 - 2014	1.14	0.66	3.63	0.39	0.12	1.13
from 2010 debt to 2014 equity	0.88	0.51	2.80	0.30	0.09	0.87

Note: This table calculates the implied elasticities of fixed assets and employment with respect to changes in the user cost of capital. ϵ_{all} is the elasticity for all treated MMCs, which is calculated by dividing the DID estimates in Table 5 by the percent change in the tax component of user cost of capital moving from debt to equity financing. ϵ_d and ϵ_f are corresponding elasticities for domestic and foreign MNCs calculated using coefficients from Table 6. We use the estimated change in the tax component of the user cost in Table A.2, under three alternative methods, for the elasticity calculations.

B Additional Results

Figure B.1: Distribution of MNCs' UK total assets relative to group level total assets



Note: This figure plots the distribution of the ratio of MNCs' UK total assets to the group level consolidated total assets in 2010. Red bars denote foreign MNCs and blue bars represent domestic MNCs.

Table B.1: Summary statistics of key variables

Variable	All MNCs		domestic MNCs		foreign MNCs	
	treated	control	treated	control	treated	control
Panel A: UK key characteristics: FAME						
Aggregated across MNCs:						
UK total assets	2,514.47	498.82	2,482.37	453.96	32.10	44.87
UK employment	563,466	301,667	527,500	277,035	35,966	24,632
UK fixed assets	1,815.81	314.80	1,800.69	292.65	15.12	22.15
Panel B: non-UK key characteristics: ORBIS						
Aggregated across MNCs:						
Non-UK total assets	333.96	163.53	279.35	46.60	54.62	116.94
Non-UK employment	231,257	226,412	175,195	76,488	56,062	149,924
Non-UK fixed assets	253.22	91.90	213.81	22.19	39.41	69.71
Averaged across MNCs:						
Non-UK ETR	0.171	0.203	0.164	0.200	0.186	0.205
Non-UK CIT	0.26	0.254	0.258	0.249	0.263	0.257
Non-UK leverage	-0.138	-0.233	-0.125	-0.229	-0.168	-0.236
% UK assets	74%	53%	81%	74%	42%	24%

Note: This table reports the summary statistics of selected variables for the matched treated and control groups. The statistics are for 2009 and are in billions of pounds for total assets and fixed assets, in units for employment and are ratios for leverage and ETRs. To obtain UK/non-UK total assets, employment and fixed assets, we sum across all UK (Panel A)/non-UK (Panel B) subsidiaries belonging to the same MNC. The treated group includes MNCs that failed the gateway ratio test in 2010. The control group contains MNCs that did not fail the gateway ratio in 2010. We match the two groups based on GUO industry, GUO location and group-size, using the one-to-one nearest neighbor matching technique without replacement. *ETR* is the effective tax rate, calculated as the ratio of tax expense to profit and loss before taxes. *CIT* is the statutory corporate income tax rate. *Leverage* is the net-of-cash leverage ratio. *% UK assets* is the ratio of assets held in the UK to group level total assets.

Table B.2: Impact of the worldwide debt cap on MNCs' group level debt: additional results

Dep.Var	(1) Log rel assets	(2) Log rel liab	(3) Gross debt	(4) private debt	(5) public debt
$Failed_i \times Post_t$	-0.038	-0.199***	0.105	0.287*	-0.165
	(0.052)	(0.053)	(0.107)	(0.167)	(0.138)
Year FE	✓	✓	✓	✓	✓
Group FE	✓	✓	✓	✓	✓
No. of groups	375	376	179	179	179
Observations	2,050	2,050	798	798	798

Note: This table reports the estimated effects of the WDC on MNCs' relevant assets (column 1) and relevant liabilities (column 2). In column 3 we estimate the effect of the WDC on MNC's gross debt based on a smaller sample where we can distinguish between private and public debt. In column 4, we estimate the effect of the WDC on private debt (bank loans), and we estimate that on public debt (debentures) in column 5. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No control variables are included. Standard errors are robust and two-way clustered over MNC group and year.

Table B.3: Impact of the worldwide debt cap on MNCs' UK leverage of 50-75% controlled subsiadiaries: evidence from Orbis

	All MNCs (1)	domestic MNCs (2)	foregin MNCs (3)
$Failed_i \times Post_t$	0.022	0.042	-0.160
	(0.039)	(0.045)	(0.101)
Year FE	✓	✓	✓
Subsidiary FE	✓	✓	✓
No. of groups	2,866	797	2,080
Observations	9,485	2,665	6,820

Note: This table reports the estimated effects of the WDC on MNCs' UK leverage using ORBIS. We show results for UK subsidiaries that are 50-75% owned. The dependent variable in all columns Lev_{ijt}, the net-of-cash leverage ratio of subsidiary j, which belongs to MNC i in year t. In column 1 we use all MNCs, in column 2 we use the sub-sample of domestic MNCs, and in column 3 we use the sub-sample of foreign MNCs. No controls are included. Standard errors are robust and two-way clustered over MNC group and year.

Table B.4: Impact of the worldwide debt cap on domestic MNCs' real operations: testing the home bias hypothesis

Dep. Var	assets	fx assets	emp
	(1)	(2)	(3)
Panel A: domestic operations			
$Failed_i \times Post_t$	-0.072*	-0.169**	-0.232**
	(0.041)	(0.071)	(0.098)
$Failed_i \times Post_t \times$ *High home bias*	0.010	0.145**	0.255*
	(0.034)	(0.059)	(0.148)
Year FE	✓	✓	✓
Group FE	✓	✓	✓
No. of groups	182	182	182
Observations	1,096	1,096	1,096
Panel B: foreign operations			
$Failed_i \times Post_t$	0.199***	0.127***	0.126***
	(0.034)	(0.047)	(0.034)
$Failed_i \times Post_t \times$ *High home bias*	-0.140***	-0.132*	-0.077*
	(0.051)	(0.074)	(0.044)
Year FE	✓	✓	✓
Subsidiary FE	✓	✓	✓
No. of groups	1,184	1,131	1,011
Observations	7,587	7,136	5,690

Note: This table reports the estimated effects of the WDC on domestic MNCs' real operations, proxied by their UK total assets (assts), fixed assets (fx assets), and employment (emp) (all in natural logarithm). In Panel A we show results for domestic MNCs' UK operations aggregated across all UK subsidiaries. In Panel B we show results for domestic MNCs' foreign operations. Here, we have a smaller sample than in Table 6 because we require a full ORBIS ownership tree to calculate the home bias dummy. *High home bias* is a dummy that equals to 1 when an MNC has larger than median share of real business operations in the UK. In column 1, this is calculated by computing a share of total assets that the MNC holds in the UK in all total assets, in column 2 we use the fraction of fixed assets held in the UK relative to all fixed assets and in column 3 we use the fraction of employment in all employment. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. Standard errors are robust and two-way clustered over MNC group and year.

Table B.5: Measuring exposures to the financial crisis and financial constraints

	mean control	mean treated	diff in means	t-stat	p-value
Default distance	0.39	0.34	0.05	0.75	0.46
Liquidity ratio	0.38	0.47	-0.09	-1.27	0.21
KZ-index	0.43	0.40	0.03	0.38	0.71
Payout ratio	0.47	0.43	0.03	0.33	0.74
Payout dummy	0.63	0.61	0.02	0.25	0.80

Note: In this table we report descriptive statistics for various measures we use to proxy for MNCs' exposures to the financial crisis, and for MNCs' financial constraints. All variables are constructed using the 2007 data. We measure exposure to financial crisis using distance to default and we measure financial constraint using the KZ index, liquidity ratio, payout ratios and a dummy indicating positive payout. Default distance is defined as $DD = ln(\frac{equity + debt}{debt} + return - \frac{sigma^2}{2})/sigma$, where $debt = short - term - debt + 0.5 \times long - term - debt$, and $sigma = equity/(equity + debt) \times std\_return + debt/(equity + debt) \times (0.05 + 0.25 \times std\_return)$. To proxy for std_return we use stock return of each firm. Liquidity ratio is cash and cash equivalent / current liabilities. KZ index is dervied as follows: $KZ - index = -1.002 \times cashflow + 0.283 \times Q + 3.319 \times debt - 39.368 \times dividends - 1.315 \times cash$. Payout ratio is (cash dividends + stock repurchases)/net income and payout dummy equals one for firms that pay out dividends and zero otherwise. We report the means of these variables for the treated and control groups. We also provide the T-statistics and associated p-values for testing the equal means between the two groups

Table B.6: Impact of the worldwide debt cap on MNCs' UK EBIT

Dep. Var.	All MNC	Domestic MNC	Foreign MNC
EBIT/ total assets	(1)	(2)	(3)
Panel A: UK EBIT			
$Failed_i \times Post_t$	-0.002	-0.000	-0.006
	(0.001)	(0.000)	(0.005)
Year FE	✓	✓	✓
Group FE	✓	✓	✓
No. of groups	376	278	98
Observations	2,055	1,532	523
Panel B: low-tax countries foreign EBIT			
$Failed_i \times Post_t$	0.003	-0.010	0.007
	(0.011)	(0.014)	(0.026)
Year FE	✓	✓	✓
Subsidiary FE	✓	✓	✓
No. of groups	912	546	366
Observations	4,898	2,952	1,945

Note: In this table we report DID estimation result with earnings before interest and taxes (EBIT) divided by total assets as a dependent variable. We report results for all MNCs in column 1, for domestic MNCs in column 2 and for foreign MNCs in column 3. In Panel A, we show results for aggregated UK EBIT using FAME, in Panel B we show results for EBIT in foreign low-tax subsidiaries of MNCs in our sample. We match the treated and control groups based on GUO industry, GUO location and group size, using the one-to-one nearest neighbor matching technique without replacement. No control variables are included. Standard errors are robust and two-way clustered over MNC group and year.

Table B.7: Estimation results based on alternative samples

Dep. Var	Gateway Ratio (1)	Log Gateway Ratio (2)	Log UK Net Debt (3)	Log Gross Debt (4)
Panel A: Full sample				
$Failed_i \times Post_t$	-1.435**	-0.755**	-0.988**	0.351**
	(0.438)	(0.190)	(0.270)	(0.110)
No. of groups	1770	1770	1770	1770
Observations	9663	9663	9663	9663
Panel B: Excluding some industries				
$Failed_i \times Post_t$	-1.436**	-0.752**	-0.960**	0.356**
	(0.438)	(0.188)	(0.271)	(0.111)
No. of groups	1589	1589	1589	1589
Observations	8694	2676	8849	8694
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓

Note: This table reports the estimated effects of the WDC on MNCs' gateway ratio, UK net debt, and worldwide gross debt, using alternative samples. In Panel A we use the unmatched full sample and in Panel B we exclude industries in which treated MNCs have no presence from the full sample. No controls are included in any of the specifications. Standard errors are robust and two-way clustered over MNC group and year.

Table B.8: Estimation results based on kernel-matching

Dep. Var	Gateway Ratio	Log Gateway Ratio	Log UK Net Debt	Log Gross Debt
	(1)	(2)	(3)	(4)
$Failed_i \times Post_t$	-1.821***	-0.394***	-1.160***	0.293***
	(0.418)	(0.070)	(0.201)	(0.078)
Year FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
No. of groups	1,371	1,373	1,373	1,373
Observations	7,635	7,786	7,786	7,786

Note: This table reports the estimated effects of the WDC on MNCs' gateway ratio, UK net debt, and worldwide gross debt, based on an alternative matched sample using the kernel-matching technique. We match the two groups of firms based on GUO industry, GUO location and group size, using the kernel matching technique. No controls are included. Standard errors are robust and two-way clustered over MNC group and year.

Table B.9: Robustness tests: alternative matching variables

Matching var.	(1) UK profit.	(2) UK ETR	(3) UK assets to all assets	(4) UK assets diff 09-08	(5) MNC assets diff 09-08	(6) all
Dependent variable: Log Gateway Ratio						
$Failed_i \times Post_t$	-0.292***	-0.339***	-0.286***	-0.365***	-0.399***	-0.403***
	(0.082)	(0.083)	(0.076)	(0.078)	(0.077)	(0.083)
Dependent variable: Log UK Net Debt						
$Failed_i \times Post_t$	-1.622***	-1.294***	-1.177***	-1.257***	-1.098***	-1.456***
	(0.204)	(0.215)	(0.203)	(0.203)	(0.202)	(0.212)
Dependent variable: Log Gross Debt						
$Failed_i \times Post_t$	0.226***	0.139*	0.213***	0.273***	0.272***	0.226***
	(0.082)	(0.083)	(0.082)	(0.083)	(0.079)	(0.085)
Year FE	✓	✓	✓	✓	✓	✓
Group FE	✓	✓	✓	✓	✓	✓
Controls	✓	✓	✓	✓	✓	✓
No. of groups	322	324	372	372	371	318
Observations	1,790	1,796	2,043	2,047	2,043	1,769

Note: This table reports the estimated effects of the WDC on MNCs' gateway ratio, UK net debt, and worldwide gross debt using alternative matching variables. In all specifications we include GUO industry, GUO location and group size in the set of matching variables. In addition, we match on UK profitability in column 1, UK effective tax rates in column 2, the ratio of UK total assets to worldwide total assets in column 3, the difference in MNCs' UK assets between 2008 and 2009 in column 4, the difference in MNCs' total assets between 2008 and 2009 in column 5, and all of these additional matching variables together in column 6. Additional matching variables are indicated at the top of each column. Matching is based on the nearest-neighbor one-on-one matching technique without replacement. Standard errors are robust and two-way clustered over MNC group and year.