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# International Transfer Pricing and Tax Avoidance: Evidence from Linked Trade-Tax Statistics in the UK\*

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## Abstract

This paper employs unique data on export transactions and corporate tax returns of UK multinational firms and finds that firms manipulate their transfer prices to shift profits to lower-taxed destinations. It uncovers three new findings on tax-motivated transfer mispricing in real goods. First, transfer mispricing increases substantially when taxation of foreign profits changes from a worldwide to a territorial approach in the UK, with multinationals shifting more profits into low-tax jurisdictions. Second, transfer mispricing increases with a firm's R&D intensity. Third, tax-motivated transfer mispricing is concentrated in countries that are not tax havens and have low-to-medium-level corporate tax rates.

**Keywords:** transfer pricing, corporate taxation avoidance, multinational firms

**JEL Classification:** F23, H25, H32

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# 1 Introduction

Globalization has led to the concentration of economic activity within a small number of multinational corporations (MNCs). This development has made it more challenging for governments to raise revenue from corporate income tax, as MNCs can shift their profits across borders to reduce their tax bills.<sup>1</sup> In recent years, policy-makers have become increasingly concerned about this issue as the extent of profit shifting has intensified. (Zucman, 2014).

A key instrument that MNCs use to shift profits is manipulating transfer prices they charge on transactions between related parties within the MNC group (transfer mispricing). For example, to reduce its pre-tax profits (and hence corporate taxes), an MNC can charge a lower price when selling to a related party in a low-tax country.<sup>2</sup> Tax-motivated transfer mispricing can take place in trade in real goods as well as in services, and in particular in the form of royalty and licensing payments on intellectual property rights held abroad.<sup>3</sup>

This paper presents new evidence on tax-motivated transfer mispricing in real goods by exploiting a unique data set that combines the tax records of UK MNCs in manufacturing and their international trade transactions over the years of 2005-2011. The empirical strategy identifies the causal effect of the corporate income tax differential between the destination country and the UK on the unit price of exports by UK MNCs. It controls for omitted variable bias by including a full set of firm–market–product fixed effects, product–market–year fixed effects, and firm–product–year fixed effects in a triple-difference regression. Identifying variation comes from the differential change in the price charged by a multinational with a foreign subsidiary relative to the price charged by a MNC without a subsidiary in the same country in response to a change in the tax rate difference between the destination country and the UK.

We find strong evidence for tax-motivated transfer mispricing in manufacturing exports to low-tax destinations. A one percentage point increase in the UK-destination country tax differential reduces related-party export prices relative to arm’s-length export prices

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<sup>1</sup>See, among others, Harris et al. (1993), Hines and Rice (1994), and Desai et al. (2006) for evidence of general profit shifting by MNCs to low-tax countries, including tax havens.

<sup>2</sup>Conversely, it can pay a higher price when buying from a related party in a low-tax country.

<sup>3</sup>See, for example, evidence presented in Dischinger and Riedel (2011).

by three percent. The extent of tax-motivated transfer mispricing is larger following the UK's change from a worldwide to a territorial tax system.<sup>4</sup> After the tax reform, a one percentage point increase in the tax difference reduces related-party export prices relative to arm's-length export prices by another 1.5 percent. Transfer mispricing increases with firm R&D intensity, with the marginal effect of the tax differential rising to 6.4 percent for those undertaking most R&D. Finally, increases (decreases) in transfer mispricing associated with widening (narrowing) tax differences are concentrated in countries that are not classified as tax havens and have low to intermediate tax rates.

These benchmark findings are in line with the large effects of tax savings on transfer prices estimated in Clausing (2003), Bernard et al. (2006), and Flaaen (2016) but are substantially larger than the effects found in Vicard (2015) and Cristea and Nguyen (2016). We show that some of the differences can be attributed to omitted variable bias, as previous studies used smaller sets of fixed effects in the empirical analysis.

Our paper adds to the literature in four distinct ways. First, we show in a simple model that a shift from a worldwide to a territorial system in taxing foreign profits of MNCs leads to stronger transfer mispricing, and we provide empirical evidence that corroborates the theoretical prediction. Second, the results establish that transfer mispricing is concentrated in the most R&D-intensive firms. This finding is robust to controlling for differential effects by firm size and the type of product traded and suggests that R&D investment facilitates transfer mispricing by making goods more specific. Third, in perhaps surprising contrast with research on France by Davies et al. (forthcoming), our evidence indicates that mispricing in tangible goods by UK MNCs is concentrated in non-tax-haven countries.<sup>5</sup> Fourth, thanks to the rich data and the relatively large number of MNCs headquartered in the UK, the regressions in this paper control for more fixed effects than previous studies, allowing for a clean

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<sup>4</sup>This reform fundamentally changed the taxation of foreign earnings from a worldwide regime to a territorial regime in the UK. Under the worldwide regime, foreign earnings of UK MNCs were liable to additional UK taxes when repatriating from countries with a lower statutory tax rate than the UK. In contrast, the territorial regime exempts foreign earnings of UK MNCs from UK taxes altogether. We discuss the reform in more detail in section 2.

<sup>5</sup>The fact that we do not find evidence for mispricing of exports to tax haven countries may in parts be driven by our identification strategy which relies on tax changes over time. However, the robust finding of substantial transfer mispricing to non-haven countries is still striking. We thank Niels Johannesen for this great comment.

identification of tax-motivated transfer mispricing.<sup>6</sup> In addition, the 2009 UK tax reform in the taxation of cross-border corporate income provides us with a quasi-natural experiment that introduced exogenous changes in the tax incentives of profit shifting, corroborating the causal effect of taxes on transfer prices.

Our findings have several implications for tax policy design. First, they show that there is substantial profit shifting through transfer mispricing in tangible goods by UK MNCs. This represents an area of revenue leakage that warrants further attention of the UK tax authority. While the quantitative evidence is UK-specific, the empirical analysis can be extended to other countries with the suitable data in order to help uncovering the extent of tax-motivated transfer mispricing elsewhere. Second, tax-motivated transfer mispricing is not uniform across firms, but concentrated in the most R&D-intensive ones. This pattern provides useful guidance for tax authorities. Third, we find that the shift to the territorial system increased the extent of tax-motivated transfer mispricing, highlighting a relevant revenue cost of moving away from the worldwide system. Finally, the finding that transfer mispricing is concentrated in non-haven countries with low to medium tax rates suggests that policy-makers should be mindful of potential revenue loss not only to tax havens but also to other trading partners that have low statutory corporate income tax rates.

**Literature** Several papers have looked at transfer-pricing behavior of multinational firms. Early literature, including Grubert and Mutti (1991), Harris et al. (1993), Hines and Rice (1994), and Collins et al. (1998), provided indirect evidence for profit shifting, showing that pre-tax profits are systematically correlated with tax differentials across countries.

Clausing (2003) was the first to provide direct evidence on manipulated prices, using U.S. industry-level data. In another seminal paper, Bernard et al. (2006) employed transaction-level data from the U.S. Census to study a wide set of factors that can lead to manipulated transfer prices, including corporate taxes and tariffs. More recently, Flaaen (2016) employs the same data, studying transfer-price manipulation by U.S. multinationals in the context of the 2004 Home Investment Act.

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<sup>6</sup>Bernard et al. (2006) and Flaaen (2016) use U.S. Census data that allow them to directly look at the price wedge within a multinational firm, implicitly taking out much of the time-invariant variation. However, our country-product-year and firm-product-year fixed effects still go beyond their specifications in terms of controlling for time-variant factors. Further details are discussed in section 5.

Closely related to our work are three papers that also use detailed trade data to study transfer-price manipulations for a set of different countries. Davies et al. (forthcoming) and Vicard (2015) exploit information on French firms, whereas Cristea and Nguyen (2016) employ Danish data. Finally, Hebous and Johannesen (2015) analyze firm-level trade data on German MNCs, providing evidence that they shift profits to tax havens through services trade.

The remainder of the paper is structured as follows. Section 2 provides background on transfer pricing and the 2009 tax reform. Section 3 presents a simple framework for illustrating the effect of tax differential on transfer pricing. Section 4 describes the data, Section 5 explains the empirical approach, and Section 6 presents the empirical results. Section 7 concludes with a discussion of policy implications and avenues for future research.

## **2 Institutional Background**

This section provides an overview of transfer pricing, explaining the arm’s length principle that generally guides the setting of transfer prices and several weaknesses of this approach. It then discusses the 2009 tax reform that changed the UK’s taxation of foreign profits from a worldwide to a territorial regime.

### **2.1 Transfer Pricing**

Transfer pricing is the setting of prices for internal (intra-firm) transactions in goods, services, intangibles, and capital flows within an MNC. Transfer pricing affects the pre-tax profits that each party earns from a cross-border transaction and the amount of corporation tax that is due in both countries. Consider a UK pharmaceutical group that buys raw material from a subsidiary in China. How much the UK parent pays its Chinese subsidiary for each unit of the raw material — the transfer price — affects how much profit the Chinese affiliate earns and how much local tax it pays, and the amount of profit and corporation tax faced by the UK parent company.

Most tax authorities, including the HMRC in the UK, use the arm’s length principle to

guide transfer pricing.<sup>7</sup> The arm's length principle requires that a transfer price should be the same as if the two parties involved were two independent companies, that is, the same as a comparable market transaction.<sup>8</sup> Given the nature of related-party transactions, a range of arm's length prices may arise for the same transaction. This leeway is due to challenges in the application of the arm's length principle. For example, a comparable transaction may not exist between independent parties. Comparable transactions may also be costly to observe for the tax authority. If comparable arm's-length prices are not accessible, they may be difficult to infer. As a consequence, there is room for manipulation, through under- or over-pricing, to exploit tax differentials across jurisdictions in order to lower the overall tax burden of the multinational group.

Many countries implement transfer-pricing regulations as a countermeasure to mitigate transfer mispricing. The tightness of these regulations varies from mere acknowledgement of the arm's length principle to requirement of detailed transfer-pricing reports. Rigid regulations increase the cost of transfer mispricing and are found to be somewhat effective in curbing the extent of profit shifting in developed countries.<sup>9</sup> In the UK, transfer-pricing documentation requirements are a part of the domestic tax law, specifying that documentation must be available upon request or submitted with the company's annual tax return.<sup>10</sup>

## 2.2 The 2009 Territorial Tax Reform

The tax treatment of foreign profits in the home country is a key consideration for MNCs when setting their transfer prices, as taxation of foreign earnings at home affects the total

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<sup>7</sup>The arm's length principle is established in Article 9 of the Organization for Economic Co-operation and Development (OECD) and the UN Model Tax Conventions and is the framework for the extensive network of bilateral income tax treaties between OECD countries, and many non-OECD governments.

<sup>8</sup>Setting the transfer price involves the search for a comparable transaction and the application of an appropriate transfer-pricing method. Two transactions are regarded as comparable when either there are no material differences between them or reasonable accurate adjustments can be made to eliminate the effect of such differences (OECD, 2011). The OECD Guidelines also provide a set of criteria to assess comparability between controlled and uncontrolled transactions in terms of characteristics of products or services, functions performed by each party taking account of the assets used and risks assumed, contractual terms, economic circumstances, and business strategies.

<sup>9</sup>For example, Riedel et al. (2015) show that the introduction and tightening of transfer pricing rules raises (lowers) reported operating profits of high-tax (low-tax) affiliates and reduces the sensitivity of affiliates' pre-tax profits to corporate tax rate changes.

<sup>10</sup>Unlike other OECD countries, the UK does not have a prescribed list of documentation requirements, and detailed disclosure are not currently required within tax returns.

profit tax bill. Basically all countries fall into one of two predominant categories: ‘worldwide’ or ‘territorial’. Under ‘worldwide’ taxation, an MNC pays taxes on its domestic and foreign income, though a credit is often given for foreign taxes paid.<sup>11</sup> Under territorial taxation, an MNC only pays taxes on profits in the source country and faces no additional tax when bringing profits home.<sup>12</sup> So, £1 profit earned or reported in a low-tax country  $j$  would imply  $\mathcal{L}(1 - \tau_j)$  after-tax profit, where  $\tau_j$  is the statutory tax rate in the host country.

To capture the aspect that profits located in the low-tax country eventually require costly repatriation, assume that profits located abroad are less valuable to an MNC by a factor of  $\gamma < 1$ . Then, under the worldwide system, a £1 profit earned or reported in a low-tax country  $j$  would be worth  $\mathcal{L}\gamma(1 - \tau_j)$  to the MNC.

The difference in the taxation of foreign profits under the two systems implies larger tax savings for MNCs from shifting profit to lower-taxed jurisdictions under territorial taxation. Specifically, the increase in the additional savings when moving from a worldwide to a territorial system are  $\mathcal{L}(1 - \gamma)(1 - \tau_j)$  for each pound of profit reported in the low-tax country. Assuming that foreign profits accumulated under the worldwide system ultimately return home, there is hence a stronger incentive for profit shifting under the territorial system than under the worldwide system.

In 2009, the UK switched from worldwide to territorial taxation, which, given our discussion, is expected to increase the extent of transfer mispricing by UK MNCs. Note that it is plausible that before 2009, part of the foreign earnings were already brought back to the UK in some other complicated, non-taxable way.<sup>13</sup> To the extent that such activities are costly, it is still the case that the amount of tax savings from profit shifting net of costs is larger under the territorial tax system.<sup>14</sup> Finally, a great feature of the tax reform is

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<sup>11</sup>In the case of the UK, there was a restrictive-form onshore-pooling regime for excess credits, allowing “eligible unrelieved foreign tax” on high-taxed dividends to be credited against the UK tax arising on the pooled low-taxed dividends.

<sup>12</sup>This statement only applies to active income of foreign affiliates, which is essentially income earned through business activity. Passive income is income that derives from activities in which the recipient is not directly involved, such as investment income or royalty income. Unlike with the treatment of active income, taxes on passive income are due when this income is earned; no deferral of taxes is allowed. Anti-deferral rules are defined in the controlled foreign company (CFC) rules to prevent the shifting of income to tax havens.

<sup>13</sup>For example, the UK did not restrict parent companies from borrowing from foreign subsidiaries, contrary to the United States’ treatment of “deemed” dividends under I.R.C. §956.

<sup>14</sup>In addition, the worldwide system could also cause some costly distortion in the allocation of investment



that its exact announcement and implementation dates were not known in advance. We can therefore exploit variation in the tax incentives to shift profits generated by the reform to study transfer mispricing in a quasi-experimental setting.<sup>15</sup>

### 3 Conceptual Framework

This section develops a simple model that shows how tax differences motivate MNCs to manipulate transfer prices. It also shows how a shift from a worldwide tax system to a territorial tax system increases incentives for transfer price manipulation. We start from a modified version of the model in Cristea and Nguyen (2016), which is based on Bernard et al. (2006) and Hyde and Choe (2005).

There are three differences to the setup in Cristea and Nguyen (2016). The most important is a new parameter  $\gamma$ , which captures the aspect that deferred profits abroad may be worth less to an MNC than profits at home — a key innovation to study the difference in incentives to shift profits between worldwide and territorial taxation. Secondly, to focus the analysis, we drop the incentive price  $p_i$ . This change is without loss of generality, as all questions that we are interested in are independent of that variable. Finally, we modify the penalty function for transfer mispricing. The change in the penalty function is not essential but arguably makes the model more realistic.

**Basic setup** There is a multinational firm that sells to another country in two ways. It sells directly to an unrelated party at the arm’s length price  $p_a$ , and it sells through its subsidiary abroad at the final sales price  $p_f$ . For this related-party transaction, the MNC also needs to set an internal transfer price  $p_t$ . We assume that arm’s length sales and related-party sales target independent sets of consumers, so there is no competition across these two modes of

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across countries.

<sup>15</sup>In this paper we focus on the changing incentives of profit shifting accompanying the territorial tax reform. Other studies, for example, Egger et al. (2015) and Liu (2017), examine the effect of the territorial tax reform on dividend repatriation and fixed capital investment by UK multinationals, respectively.

selling abroad.<sup>16</sup> Profits of the parent  $\pi_h$  and subsidiary  $\pi_f$  are given by:

$$\begin{aligned}\pi_h &= (1 - \tau_h)[(p_a - c)q_a + (p_t - c)q_f], \\ \pi_f &= (1 - \tau_f)(p_f - p_t)q_f,\end{aligned}\tag{1}$$

where  $\tau_h$  and  $\tau_f$  are the corporate income tax rates in countries where the headquarters and the subsidiary are located, respectively;  $c$  is marginal cost of production per unit of output; and  $q_a$  and  $q_f$  are quantities sold at arm's length and through the affiliate. Assume that differences between the transfer price and the arm's length price imply a penalty given by:<sup>17</sup>

$$\frac{\lambda}{2}(p_a - p_t)^2 q_f,\tag{2}$$

where  $\lambda$  captures the strength of tax enforcement. The penalty is linear in the trade volume,  $q_f$ , and quadratic in the difference between the arm's length price and the transfer price,  $p_a - p_t$ .

MNCs have to decide where to report their book profits. Importantly, they can only pay out dividends to their equity holders or reinvest at home if profits have been repatriated to the headquarters. Under worldwide taxation, firms pay dividend taxes on any current or deferred after-tax profits that are brought home. To capture this aspect, let  $\gamma \in \{\gamma_W, \gamma_T\}$  be the relative value of a pound of after-tax profit in a low-tax country compared to a pound of after-tax profit at home. In a worldwide system with deferral, after-tax profits abroad are less valuable to the firm, because they are still taxed upon repatriation and therefore  $\gamma_W < 1$ . In a territorial system, there are no additional taxes on foreign repatriations, so  $\gamma_T = 1$ .<sup>18</sup> Assume that penalties are paid at home and are not tax deductible. An MNC

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<sup>16</sup>This assumption greatly simplifies the analysis but does not drive the results. All mechanisms and results should persist when allowing for some degree of competition across modes of exporting.

<sup>17</sup>While Cristea and Nguyen (2016) assume the penalty function is quadratic in  $q_f$ , in our specification the penalty is linear in the quantity sold abroad through the affiliate. In our view, a punishment that is convex in the extent of mispricing ( $p_a - p_t$ ) but proportional to the trade volume is the most intuitive. With this assumption, the model still gives rise to a manipulated arm's length price, as emphasized in Cristea and Nguyen (2016).

<sup>18</sup>Of course, there may still be some costs involved in moving profits back to the headquarters. The key point is that these costs should be strictly smaller under territorial taxation than under worldwide taxation — that is,  $\gamma_W < \gamma_T$ .

therefore maximizes its overall weighted profits:

$$\Pi = (1 - \tau_h)[(p_a - c)q_a + (p_t - c)q_f] - \frac{\lambda}{2}(p_a - p_t)^2 q_f + \gamma(1 - \tau_f)(p_f - p_t)q_f. \quad (3)$$

**The transfer price** Taking the first-order condition with respect to  $p_t$ , we can derive

$$p_t = p_a - \frac{(\gamma - 1 + \tau_h - \gamma\tau_f)}{\lambda}. \quad (4)$$

The optimal transfer price is equal to the arm's length price minus a correction for taxes. The lower the tax rate abroad relative to the home rate, the lower is the optimal transfer price.<sup>19</sup> Leaving profits abroad is costly to the MNC under worldwide taxation and the optimal transfer price is hence less distorted than under territorial taxation. This effect can easily be seen by noting that  $p_t$  decreases in  $\gamma$ .

**Proposition 1 (Transfer Price Manipulation)** *Relative to the arm's length price  $p_a$ ,*

(i) *under a territorial tax system, the optimal transfer price decreases in the tax difference  $\tau_h - \tau_f$ ,*

(ii) *under a worldwide tax system, the optimal transfer price decreases in the adjusted tax difference  $\tau_h - \gamma_W\tau_f$ ,*

(iii) *transfer price manipulation is stronger under a territorial tax system than under a worldwide tax system ( $\partial(p_a - p_t)/\partial\gamma > 0$ ).*

**Proof.** *Follows directly from equation (4) ■*

In equilibrium, the optimal arm's length price  $p_a$  is also a function of the tax rates at home and abroad. As the full model is not solvable in closed form, we show that the results in Proposition 1 on the transfer price (relative to  $p_a$ ) generalize to the absolute transfer price  $p_t$  by simulating the model (Figure 1).

<sup>19</sup>Note that in Cristea and Nguyen (2016), the optimal transfer price also depends on  $q_f$ . Our change to the penalty function makes this non-intuitive result disappear.

**The arm's length price** Now, assume that there is a standard CES demand given by

$$q_a = p_a^{-\sigma} A. \quad (5)$$

Then, we can derive the first-order condition with respect to  $p_a$  and solve for<sup>20</sup>

$$p_a = p_x \frac{1}{1 + \kappa(\Delta\tau)}, \quad (6)$$

$$\text{with } p_x = \frac{\sigma}{\sigma - 1} c, \quad (7)$$

$$\text{and } \kappa(\Delta\tau) = \frac{\gamma - 1 + \tau_h - \gamma\tau_f}{(1 - \tau_h)(\sigma - 1)} \left( \frac{q_f}{q_a} \right). \quad (8)$$

As pointed out by Cristea and Nguyen (2016), multinational firms have an incentive to not only manipulate their transfer price with a related party but also their arm's length prices to unrelated parties. Equation (6) implies that the arm's length price increases with the destination country's tax rate. Arm's length prices and transfer prices hence move in the same direction in response to tax rates, which keeps them closer together and thereby limits the effectiveness of transfer pricing regulation and tax penalty.

Finally, note that in the data we observe whether a firm has a subsidiary in a given country instead of whether a given trade transaction is with a related party. For MNCs with a subsidiary, we hence observe in the data a combination of the arm's length price  $p_a$  and the related party price  $p_f$ :

$$p_s = s_f p_t + (1 - s_f) p_a, \text{ with } s_f = \frac{q_f}{q_f + q_a}. \quad (9)$$

**Simulation results** Figure 1 shows how optimal prices change with the tax difference. While the figure shows results for a specific set of parameters, the patterns in the figure discussed below are general features of the model. First, note that the transfer price,  $p_t$ , strictly decreases in the tax difference, as should be expected. In addition, the firm has an incentive to charge an arm's length price,  $p_a$ , that is strictly below the standard CES price  $p_x$ , as discussed in detail in Cristea and Nguyen (2016). Next, Figure 2 illustrates how the

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<sup>20</sup>For  $\gamma = 1$ , this result is the same as in Cristea and Nguyen (2016), despite the change to the penalty function.

transfer price changes with  $\gamma$ , by plotting the optimal transfer price against the tax difference for  $\gamma = 1$  and  $\gamma = 0.95$ . The optimal transfer price is clearly decreasing in  $\gamma$ , in line with the result in Proposition 1.

## 4 Data

Our data set is constructed by merging three databases. The first database includes transaction-level export data from 2005 to 2011 provided by the HMRC. Specifically, each record includes the firm's trader ID (anonymized), the product code (15-digit HMRC Integrated Trade Tariff Code), the destination country, the export value in British pounds, and the weight in kilograms.<sup>21</sup> The unit of observation in our empirical analysis is a firm-product-destination-year price. We collapse the transaction data to that level, computing total export value, total quantity, number of shipments, and average unit price.

The second database, also provided by the HMRC, consists of firm-level corporation tax records that provide detailed information on the tax position of each company and how it is determined. A lookup table that cross references the trader IDs and taxpayer identifiers allows us to merge the two databases. We therefore know the exact tax position for each trading company, including whether it has positive trading profits.

The third database, the FAME ownership database of Bureau Van Dijk, is also at the firm level and provides information, for each company, on the name and location of its ultimate global parent and subsidiaries, if applicable.<sup>22</sup> Based on the ownership information, we group the population of UK companies into one of the following categories: (1) domestic;<sup>23</sup> (2) parent companies of an MNC group with at least one subsidiary outside the UK; (3) subsidiaries of a UK MNC group; and (4) subsidiaries of a foreign parent company. Figure

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<sup>21</sup>Transactions within the EU only need to be reported by firms whose exports in a given calendar year exceed a certain threshold (for example, £250,000 in 2016). Firms have to report all transactions with countries outside the EU.

<sup>22</sup>The ownership data set is from the FAME website in 2015. We define ultimate parents as shareholders that have more than 50% total shareholding. The total shareholding was calculated by summing up the direct percentage of shares and indirect percentage shares in FAME; see [https://webhelp.bvdep.com/robo/projects/whdotnetownership\\_63\\_en/CalcPerc.htm](https://webhelp.bvdep.com/robo/projects/whdotnetownership_63_en/CalcPerc.htm). The FAME data set provides information on companies' subsidiaries up to 10 levels.

<sup>23</sup>Domestic companies include (a) stand-alone companies, (b) parent companies of a domestic group with all subsidiaries in the UK, and (c) subsidiaries of a domestic group.

3 Panel A shows the number of UK affiliates in each of the 108 countries that had UK exporting partners in 2011.

For a more credible identification, we restrict our comparison to pricing differences between multinationals, focusing primarily on all the UK multinationals in groups (2) and (3), as our data are best suited to study their transfer pricing behavior.<sup>24</sup> We use the location of foreign affiliates as a proxy for related-party trade, similar to Vicard (2015), Hebous and Johannesen (2015), and Cristea and Nguyen (2016). By definition, a UK MNC can only have related-party trade with countries where it has a related party. Of course, it may also trade with unrelated parties in these countries. Therefore, the price we observe for an MNC that has an affiliate in a given country is the weighted average of the prices charged in all intra-firm and arm's length transactions. Importantly, this measurement error biases results against us finding any effects, as it makes it harder to identify systematic differences between pure arm's length prices and our related-party price proxy.<sup>25</sup>

We augment the data set with additional data on destination country characteristics and statutory corporate tax rates.<sup>26</sup> We obtain information on country-level variables from the World Bank (World Databank, World Development Indicators) and the PennWorld Table 8.1.<sup>27</sup> The statutory tax rates are headline corporation tax rates drawn from KPMG Corporate Tax Rate Tables.<sup>28</sup>

Define  $\Delta\tau_{jt} \equiv |\tau_{jt} - \tau_{UK,t}|$  as the absolute value of the difference in the statutory tax rate between the UK ( $\tau_{UK,t}$ ) and the destination country ( $\tau_{jt}$ ). Furthermore, define a country as a low-tax destination if its statutory corporate tax rate is lower than the UK rate ( $\Delta\tau_{jt} < 0$ )

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<sup>24</sup>Domestic firms or groups do not set transfer prices for cross-border transactions. Subsidiaries of foreign parents set transfer prices, but we only observe a small part of the overall activities of these MNC groups. In addition, foreign-owned subsidiaries were not affected by the UK tax reform to the same extent as UK multinationals.

<sup>25</sup>Interestingly, for France, Davies et al. (forthcoming), using data with direct information on related-party trade, found very similar results to Vicard (2015), who proxied related-party trade through affiliate information.

<sup>26</sup>Given that we include an extensive set of fixed effects in our baseline regression, we utilize the firm and destination country characteristics mainly to replicate and compare with specifications in existing studies on transfer pricing in Section 6.

<sup>27</sup>The PennWorld Table 8.1 is constructed by the University of California-Davis and the Groningen Growth Development Centre of the University of Groningen and is available at <http://www.rug.nl/research/ggdc/data/pwt/pwt-8.1>.

<sup>28</sup>The corporate tax rates from 2006 to 2011 are drawn from KPMG Corporate Tax Rate Table (2006 to 2014). The rates for 2005 are from KPMG (2006).

and as a high-tax country if its statutory tax rate is equal to or higher than the UK rate ( $\Delta\tau_{jt} \geq 0$ ). Following this definition, a destination country can switch from a low-tax to a high-tax country when the tax rate in the foreign country or in the UK changes over time. Figure 3 Panel B shows the number of countries classified as low tax and high tax, respectively, over the sample period of 2005 to 2011.

Figure 4 further illustrates variation in the tax rates. Panel A shows the time trend in the statutory tax rate in the UK and in its top five export destination markets in 2005 to 2011. Panel B shows the histogram of the corporate tax differential based on all observations. As these figures show, there is substantial variation in corporate tax rates, both in the time series and the cross section.

The final data set includes 931,773 observations at the firm–product–year level for 1,256 unique companies in manufacturing during 2005 to 2011, capturing over £30 billion per year in exports, or approximately 16 percent of total UK manufacturing exports during the sample period. Figure 5 reports the annual exports and the share of intra-firm trade in total exports between 2005 and 2011. In total, around 39 percent of MNC exports are to countries where they have majority-owned affiliates. Table 1 provides summary statistics for the final data set.

## 5 Empirical Strategy

**Baseline** Our baseline specification estimates transfer pricing behaviors of MNCs in a triple-difference regression. Specifically, we estimate:

$$\ln p_{ijkt} = \alpha_{ijk} + \alpha_{jkt} + \alpha_{ikt} + (\beta_1 \Delta\tau_{jt} \times I_{low,t} + \beta_2 \Delta\tau_{jt} \times I_{high,t}) \times Aff_{ij} + \epsilon_{ijkt}, \quad (10)$$

where  $p_{ijkt}$  is the average unit price of exports of product  $k$  to country  $j$  by firm  $i$  in year  $t$ .  $\Delta\tau_{jt} \equiv |\tau_{jt} - \tau_{UK,t}|$  is the absolute difference in statutory corporate tax rates between the destination country  $j$  and the UK in year  $t$ .  $I_{low,t}$  ( $I_{high,t}$ ) are indicators that take the value of one if the destination country has a lower (higher) statutory tax rate than the UK in year  $t$ , and zero otherwise.  $Aff_{ij}$  is a dummy indicator that takes a value of one if the MNC firm

$i$  has at least one affiliate in country  $j$ , and zero otherwise.  $\alpha_{ijk}$  is a firm–market–product fixed effect,  $\alpha_{jkt}$  is a product–market–year fixed effect, and  $\alpha_{ikt}$  is a firm–product–year fixed effect.<sup>29</sup>

With inclusion of the fixed effects, identification relies on the differential change in the price charged by a multinational on exports to a foreign subsidiary relative to the price charged by a multinational without any subsidiary in the same country in response to a change in the tax rate difference between that country and the UK. To the extent that certain exports only take place between related parties and therefore would not be captured in the above estimation, the estimated response of transfer pricing to tax differentials represents a lower bound of the true extent of transfer mispricing. Taking the full set of fixed effects is crucial for insulating the causal effect of tax differences. More specifically,  $\alpha_{ijk}$  takes out the average price a firm charges for a product in a given market. This fixed effect is essential, as firms often supply goods of different quality to different destination markets.<sup>30</sup> The second fixed effect,  $\alpha_{jkt}$ , controls for the average price of a product in a year across all firms, taking out all shocks to the supply and demand of a product that are common across firms. Finally,  $\alpha_{ikt}$  controls for the average price a firm charges for a product in a given year. This fixed effect controls for all shocks to the supply or demand of a firm’s product that are common across markets. The coefficients we estimate ( $\beta_1$  and  $\beta_2$ ) therefore capture the causal effect of tax differences on transfer prices, controlling for all of the main supply and demand factors that could confound the effect of taxes on prices.

We expect  $\beta_1$  to be negative if MNCs systematically *reduce* the export prices for transactions with their foreign affiliates to shift more profits into low-tax countries in response to an *increase* in  $\Delta\tau_{jt}$ . Similarly, we expect  $\beta_2$  to be positive when MNCs systematically increase the export prices for transactions with their foreign affiliates to shift more profits out of high-tax countries in response to an increase in  $\Delta\tau_{jt}$ . Our baseline regression does not include firm-level or country-level controls, as any variation at that level is absorbed by the fixed effects. To account for possible correlation in export prices among all the UK

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<sup>29</sup>We employ the Stata module, *reghdfe*, as the model includes a large number of fixed effects. The module was developed by Correia (2015), and it efficiently estimates models that include high-dimensional fixed effects.

<sup>30</sup>See, e.g., Hallak (2006), Khandelwal (2010), and Hallak and Schott (2011) on the importance of product quality in international trade.



multinationals trading with the same destination market, we cluster the standard errors by country-year pairs.

**The quasi-natural experiment** We exploit the change in the UK’s tax system in 2009 as a quasi-natural experiment. As discussed in Section 2, the reform from worldwide to territorial taxation created stronger incentives for UK multinationals to shift profits into lower-tax destinations since 2009. To check whether the reform indeed led to more transfer mispricing, we run the following specification:

$$\begin{aligned} \ln p_{ijkt} = & \alpha_{ijk} + \alpha_{jkt} + \alpha_{ikt} + (\beta_1 \Delta\tau_{jt} \times I_{low,t} + \beta_2 \Delta\tau_{jt} \times I_{high,t}) \times Aff_{ij} \\ & + (\beta_3 \Delta\tau_{jt} \times I_{low,t} + \beta_4 \Delta\tau_{jt} \times I_{high,t}) \times Aff_{ij} \times Post_t + \epsilon_{ijkt}, \end{aligned} \quad (11)$$

where  $Post_t$  is an indicator that takes value of one if year  $t$  is after the tax reform and zero otherwise. Given that the reform took place in the second half of the fiscal year, we drop observations in 2009 for cleaner identification.<sup>31</sup> The main coefficients of interest are now  $\beta_3$  and  $\beta_4$ . If the reform increased incentives for transfer price manipulation, we would expect a negative  $\beta_3$  and a positive  $\beta_4$ , conditional on a negative  $\beta_1$  and a positive  $\beta_2$ .

## 6 Evidence on Tax-Motivated Transfer Mispricing

In this section, we provide direct evidence on the extent to which UK multinationals shift profit abroad via the manipulation of their transfer prices for exports.

### 6.1 Main results

**Baseline results** Table 2 presents our main regression results. Column (1) reports the baseline results based on equation (10). The coefficient on the triple interaction for low-tax destinations is negative and highly significant, indicating that MNCs shift profits out of the UK by underpricing related-party exports to low-tax countries. In contrast, the triple interaction for high-tax destinations is insignificant. That is, there is no evidence that MNCs

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<sup>31</sup>That is,  $Post_t$  is equal to zero until 2008 and equal to one from 2010 onward.

shift profits into the UK from higher-tax countries through transfer prices.<sup>32</sup>

Effects for low-tax destinations are large. A one percentage point larger tax difference, on average, reduces related-party export prices relative to arm's length export prices by three percent. This magnitude is in line with estimates by Clausing (2003) but is substantially larger than the effects found in Vicard (2015) and Cristea and Nguyen (2016).<sup>33</sup> Part of the difference could be due to genuine differences in the aggressiveness of transfer pricing by French and Danish firms as compared to U.S. and British firms. However, we show below that parts of the differences can be attributed to omitted variable bias, as previous studies used smaller sets of fixed effects in their empirical analysis.

**The quasi-natural experiment** Column (2) shows regression results from the quasi-natural experiment, by adding interaction terms between the main explanatory variables and a post-reform dummy indicator (as in equation (11)) to capture the effect of the tax reform. The regression shows that the extent of profit shifting through transfer mispricing has increased under the territorial tax system. Before the reform, on average, a one percentage point increase in the tax difference led to a 2.7 percent decrease in the price of related-party exports relative to the price of arm's-length exports. After 2009, the tax effect is more pronounced, reducing the relative export price for low-tax destinations by another 1.5 percent per percentage point of tax rate difference. The increase in the strength of transfer pricing following the UK tax reform is significant at the 5 percent level.<sup>34</sup>

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<sup>32</sup>One reason we might not find transfer mispricing for exports to high-tax countries is that under the worldwide tax system, foreign taxes can be used as credits to reduce overall UK tax liability on foreign earnings. Therefore, the incentive to shift income out of high-tax countries can be much smaller than implied by the tax difference. Another reason is that UK MNCs may shift profits directly from subsidiaries in high-tax countries to subsidiaries in low-tax countries, making profit shifting into the UK through transfer mispricing unnecessary.

<sup>33</sup>Bernard et al. (2006) and Flaaen (2016) also find relatively large effects. Their coefficients are, however, not easily comparable given the differences in data and estimation approaches.

<sup>34</sup>This finding is consistent with existing studies based on OECD countries that establish that firms with worldwide parents tend to shift less income than firms with territorial parents (Markle, 2016). Given that we only have two years of post-reform data, we are unable to examine in-depth the dynamics of transfer mispricing under the territorial tax regime.

## 6.2 Transfer Mispricing and R&D

Do firms that undertake more investment in R&D engage in more transfer price manipulation? A priori, the relation could go either way. On the one hand, R&D increases the intangible capital of a firm, some of which can be allocated to low-tax jurisdictions to facilitate profit shifting. That way, R&D-intensive firms could shift sizable profits through licensing and royalty payments, reducing the need to misprice their goods. In this sense, transfer mispricing of tangible goods and intangibles can be viewed as *substitutes* in shifting profits. On the other hand, R&D can make a firm's products more specialized, which makes finding comparable prices harder and in turn makes it easier to shift profits through transfer mispricing. In this case, transfer mispricing of tangible goods and intangibles are *complements* in shifting profits.<sup>35</sup>

Table 3 Column (1) presents the results from a regression that interacts  $\Delta\tau_{jt} \times I_{low,t} \times AFF_{ij}$  with three indicators of R&D intensity based on the average firm-level R&D spending in the sample.<sup>36</sup> The results are striking. Firms with the highest R&D intensity strongly manipulate their transfer prices. Their coefficient is highly significant and has double the size of the average baseline effect estimated earlier. In contrast, there is no evidence for any systematic transfer price manipulations of firms outside the highest R&D group. The findings are consistent with the view that R&D makes goods more specific, facilitating profit shifting through mispricing. Profit shifting via transfer price manipulation therefore seems to be a complement rather than a substitute to shifting based on intellectual-property rights for R&D-intensive firms.

It is plausible that large companies are more likely to invest in R&D so that indicators of R&D intensity may be highly correlated with firm size. To see whether the findings related to R&D are driven by firm size, the regression in Table 3 Column (2) replaces the R&D intensity indicators with indicators of firm size, defined based on the quartiles of the distribution of firm-level fixed assets in the sample. The results suggest that transfer

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<sup>35</sup>Note that the average extent of profit shifting via transfer mispricing in intangible assets by high R&D-intensive firms is controlled for by the firm-year fixed effects.

<sup>36</sup>Specifically, we compute a time-invariant measure of firm-level R&D intensity as the ratio between total qualifying R&D expenditure and total turnover during the sample period. We then group firms by their R&D intensity into the low, medium, and high categories.

mispricing is concentrated in medium and large firms. Column (3) includes both sets of interaction terms, and shows that, controlling for firm size, companies with the highest R&D intensity strongly manipulate their transfer prices. Column (4) further controls for the type of goods based on the classification in Rauch (1999), by adding an interaction term between a dummy indicator that distinguishes between differentiated and undifferentiated goods and the main variable of interest  $\Delta\tau_{jt} \times I_{low,t} \times AFF_{ij}$  to the regression. Column (5) includes both the firm size and the goods type interactions as controls. The basic finding that the most R&D-intensive firms manipulate their transfer prices more remains unchanged in these alternative specifications.

### 6.3 Heterogeneity in the Location of Transfer Mispricing

A recent study on transfer mispricing, Davies et al. (forthcoming), found that price manipulation by French firms is concentrated in trade with tax havens and very low-tax countries. We test to what extent the same patterns hold for UK MNCs.

We begin by splitting the sample into tax havens and countries that are not tax havens following the classification in Hines (2005). Results are presented in Columns (1) and (2) of Table 4. Interestingly, we find significant effects for non-haven countries but no effects for the tax-haven-only sample. These results remain unchanged when pooling the data and adding an additional interaction term with the tax haven indicator to the regression (Column 3).

One potential explanation for this finding is that there are way fewer tax havens than other countries in the world, so the sample size in Column (1) is much smaller. However, the small number of tax havens did not prevent Davies et al. (forthcoming) from finding an effect concentrated in the former. An additional factor is that our empirical strategy relies on variation in the tax rates over time. The fact that tax rates were already quite low in most tax havens at the beginning of our sample thus further limits the identifying variation available.

An economic reason for not finding effects is that trade volumes with tax havens are not that large (they have declined substantially in our sample period and represent slightly over 10 percent of UK exports in manufacturing since 2008). To the extent that there is sizable profit shifting to tax havens, it must therefore happen through other channels than

transfer price manipulation, e.g., royalty payments on intellectual property rights located there. Columns (4)-(9) verify that this finding is robust to using alternative lists of tax havens as in Dharmapala and Hines (2009) and as suggested in OECD (2000).<sup>37</sup>

In a next step, we study whether transfer price manipulation is concentrated in the lowest-tax destinations. For this analysis, we split the sample into quintiles according to the tax difference between the UK and the destination country. We then replace our main explanatory variable ( $\Delta\tau_{jt} \times I_{low,t}$ ) by its interactions with dummy indicators of each quintile. Results are presented in Figure 6. The results suggest that the extent of transfer price manipulation is roughly proportional to the tax difference. However, for the lowest-tax countries, standard errors are large and coefficients are only significantly different from zero for countries with midrange tax rates.

To summarize, our results show that transfer price manipulation by UK MNCs is concentrated in exports to non-tax-haven countries and is most apparent in exports to countries with low to intermediate corporate income tax rates. As discussed above, this finding is likely due to the fact that MNCs may shift profits to tax havens through other means than transfer mispricing. UK MNCs hence mostly exploit transfer mispricing in exports to non-haven countries with relatively low tax rates.

## 6.4 Effects on the Quantity and Total Value of Exports by UK Multinationals

We now analyze the effect of the tax differential on the quantity and value of exports by UK MNCs. While transfer mispricing should mostly work through prices, the following regressions allow us to quantify the overall effect of transfer pricing on measured trade flows. Interestingly, we find some suggestive evidence that related-party trade flows may be slightly more depressed through tax incentives when taking the quantity response into account. There is also some evidence that the 2009 tax reform led to trade creation for tax purposes, that is, firms shifted exports to markets that they were shifting profits to. Table 5 Columns (1) and (2) show results with the dependent variable being the quantity of exports

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<sup>37</sup>Table A.1 provides the list of tax havens in each publication in the Appendix.

measured by weight, whereas Columns (3)-(4) and (5)-(6) focus on the unit price and the total value of transactions, respectively.

First, note that there is no significant effect of the tax differential on the quantity of transactions, so manipulation of the transfer price is the main channel through which UK multinationals engage in tax-motivated profit shifting. However, there is weak evidence for a quantity effect, which is significant at a 15 percent level with a coefficient of 0.03. As a result, Column (5) predicts a larger effect for export values than Column (3) for the unit price: a one percentage point increase in the tax differential on average depresses the value of intra-firm exports to low-tax countries by around six percent relative to arm's length exports. Finally, there is some evidence for a tax-induced trade creation effect following the territorial tax reform. The tax reform interaction term in the weight regression is positive and significant at the 10 percent level (Column (2)). This result suggests that, after 2009, some exporters increased their exports to countries to which they were shifting profits prior to the reform.

**Quantification of Effects** We discuss the quantitative importance of our findings, computing estimates of shifted profits and foregone tax revenues to the UK based on our estimated coefficient for transfer mispricing. We calculate total shifted profits as

$$\sum_{c=1}^C \beta_1 \times I_{low,c} \times \Delta\tau_c \times exp_c, \quad (12)$$

where  $\beta_1$  is the coefficient estimate from baseline equation (10),  $exp_c$  is the volume of related-party exports to country  $c$ , and  $\Delta\tau_c$  is the tax difference between the UK and country  $c$ . We estimate that in 2010, UK multinationals shifted about 601 million GBP toward low-tax jurisdictions via transfer mispricing, where Ireland ranks the top country to which such transfer mispricing took place. At the 2010 tax rate of 28 percent, this finding implies foregone tax revenues of £168.2 million due to transfer mispricing in exports by UK MNCs in manufacturing. These estimates are relatively small but are in line with Davies et al. (forthcoming), who estimate that French firms would have paid about 1 percent (333 million Euro out of 36 billion Euro) more corporate income tax in the absence of tax-motivated

transfer price manipulation.

## 6.5 Comparison to Previous Studies

Several previous studies estimate the extent of the price wedge between arm’s length and intra-firm trade with respect to the statutory corporate tax in the destination country relative to the home country. These studies all find significant responses of the price wedge to the tax rate differential in a baseline regression of log unit price on a measure of the tax wedge.

A key challenge for the literature to credibly identify the effect of taxes on transfer prices is the large heterogeneity in the sets of fixed effects employed in these studies.<sup>38</sup> The large variation in the sets of fixed effects employed make it difficult to compare results across papers. In the following exercise, we show how our results change when employing the less comprehensive fixed-effect specifications used in some of the previous papers.

Table 6 reports the results based on four specifications of equation (10). Column (1) includes no fixed effects and reports a negative and highly significant coefficient estimate on  $\Delta\tau_{jt} \times I_{low,t} \times Aff_{ij}(\hat{\beta}_1)$  and a positive and statistically insignificant coefficient estimate on  $\Delta\tau_{jt} \times I_{high,t} \times Aff_{ij}(\hat{\beta}_2)$ . Column (2) follows the main specification in Vicard (2015) by including a set of firm-product-year fixed effects and country-product-year fixed effects. Column (3) uses the main specification in Cristea and Nguyen (2016) and includes a set of country-firm-product fixed effects, and year fixed effects interacted with the low-tax country dummy indicator  $I_{low,t}$ . Column (4) adds firm-level and country-level controls, as in Cristea and Nguyen (2016).

Columns (2)-(4) show that results are highly sensitive to the inclusion of different fixed effects, with the coefficient on high-tax countries even having the opposite sign in one specification from that predicted by the theory. To make sure that the varying results in Panel

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<sup>38</sup>These studies also differ in the data employed. They covered different countries and years and had different levels of aggregation. Clausing (2003) uses monthly US data in 1997 to 1999. Bernard et al. (2006) uses annual data on US exports in 1993 to 2000. Davies et al. (forthcoming) uses cross-sectional data for a set of French exporters in 1999, and Vicard (2015) uses French data in 2000, 2007 to 2009, and 2014. Cristea and Nguyen (2016) analyzes trade data by foreign-owned multinationals in Denmark in 1999 to 2006. Finally, Bernard et al. (2006) and Flaaen (2016) both employ U.S. Census data and look at the price wedges within U.S. multinational firms between related-party sales and arm’s-length sales. While this leads to a clean identification of effects in some dimensions, it also leads to an additional endogeneity concern, as discussed by Cristea and Nguyen (2016).

A are not an artifact of using different regression samples, Panel B repeats the analysis by including observations that are used in the most comprehensive specification of equation (10).  $\hat{\beta}_1$  is negative and significant in all specifications, though the coefficient size varies substantially.  $\hat{\beta}_2$  is yet more sensitive to inclusion of different fixed effects. We conclude that even when looking at the exact same sample, failing to include the full set of fixed effects thus leads to substantially biased estimates.

## 7 Conclusions

In this paper, we use linked trade-tax administrative records on UK multinationals in manufacturing to estimate the extent of tax-motivated transfer mispricing in exports of real goods. Our findings suggest that, on average, a 1 percentage point tax difference reduces related-party export prices to low-tax countries by 3 percent relative to the prices charged at arm's length. The extent of tax-motivated transfer mispricing has increased in the post-2009 territorial tax regime and is substantially larger in R&D-intensive firms. The new evidence on transfer mispricing has several implications for policy and future research.

First, we document compelling evidence that transfer mispricing takes place in exports of real goods in addition to any shifting based on intra-firm loans or royalty and license fee payments for the use of intellectual property. This result points out another area of revenue leakage risk and calls for tax authorities to keep paying attention to transfer pricing issues in tangible goods. Moreover, transfer mispricing is not uniform across firms but concentrated in the most R&D-intensive ones. This finding provides tax authorities with useful guidance on where to look for mispricing activities. Second, the UK's shift from a worldwide to a more territorial tax regime in 2009 has increased the extent of transfer mispricing. This result is consistent with the view that, compared to a worldwide system, the territorial tax regime creates more incentives for profit shifting. It is also in line with previous studies that document more profit shifting by MNCs under the territorial tax system (Markle, 2016).<sup>39</sup> The revenue costs associated with increased transfer pricing under the territorial tax reform

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<sup>39</sup>However, two features of the pre-2009 worldwide system, deferral and limited cross crediting, might blur the distinctions from the territorial system (de Mooij and Ederveen, 2003).



hence represent another important aspect for consideration in the ongoing debate about international tax policy.<sup>40</sup>

Finally, in contrast to earlier research on France by Davies et al. (forthcoming), our finding suggests that transfer mispricing in goods is not concentrated in tax havens. If anything, the evidence suggests that low-tax, non-tax-haven destinations are at the center of UK multinationals' transfer mispricing activities. One intuitive explanation for this finding is that transfer mispricing in goods requires sufficiently large trade flows to shift relevant amounts of profits internationally. Small tax havens may simply not have enough trade flows coming their way. In addition, other ways of shifting profits may be easier for tax haven destinations. Future research should try to shed light on the differences between the UK, France, and other countries that might explain these differing findings. In any case, our results should caution policy-makers from focusing too much on tax havens compared with other non-haven, low-tax and medium-tax countries.

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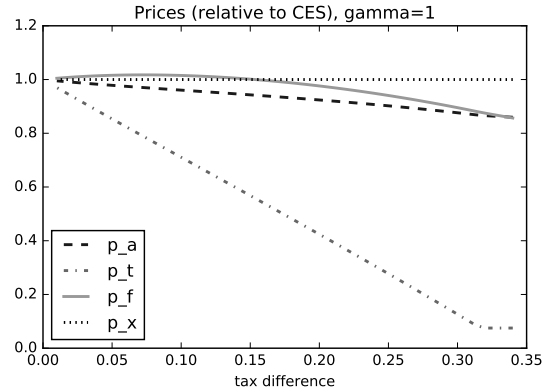
<sup>40</sup>This finding does not necessarily imply that worldwide taxation is preferable to territorial taxation, as the latter may have other desirable effects such as increasing the efficiency of investment allocation (see, for example, Liu (2017)).

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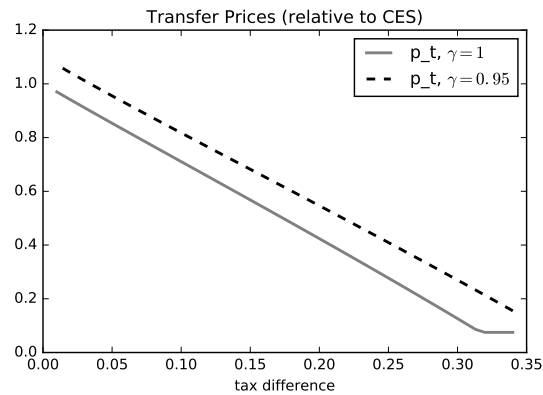
## 8 Figures

Figure 1. Simulated Prices in response to Tax Differential



*Notes:* This figures shows simulated paths of standard CES price ( $p_x$ ), final sales price ( $p(f)$ ), optimal arm's length price ( $p_a$ ), and optimal transfer price ( $p_t$ ), for different values of tax difference and  $\gamma = 1$ .

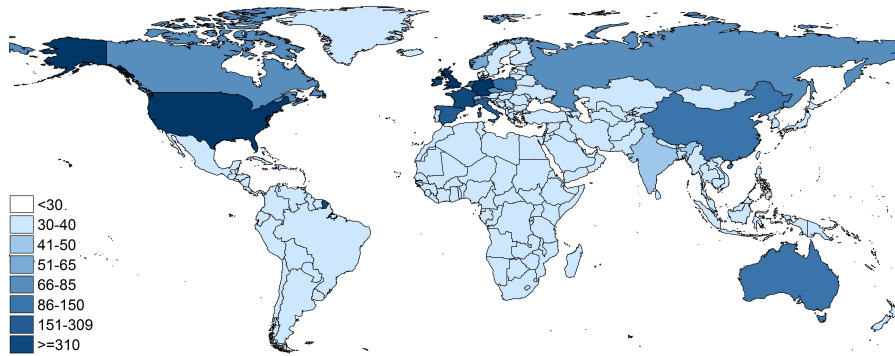
Figure 2. Optimal transfer prices for different  $\gamma$



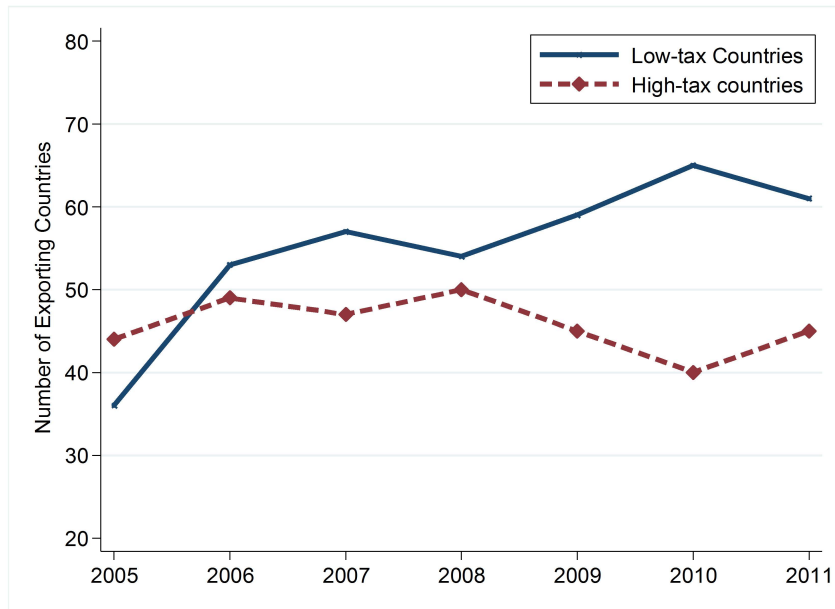
*Notes:* This figures shows the simulated path of optimal transfer price ( $p_t$ ) under different values of tax difference, for  $\gamma = 1$  and  $\gamma = 0.95$ , respectively.

Figure 3. Distribution of Affiliates

(a) Location of UK MNC Affiliates



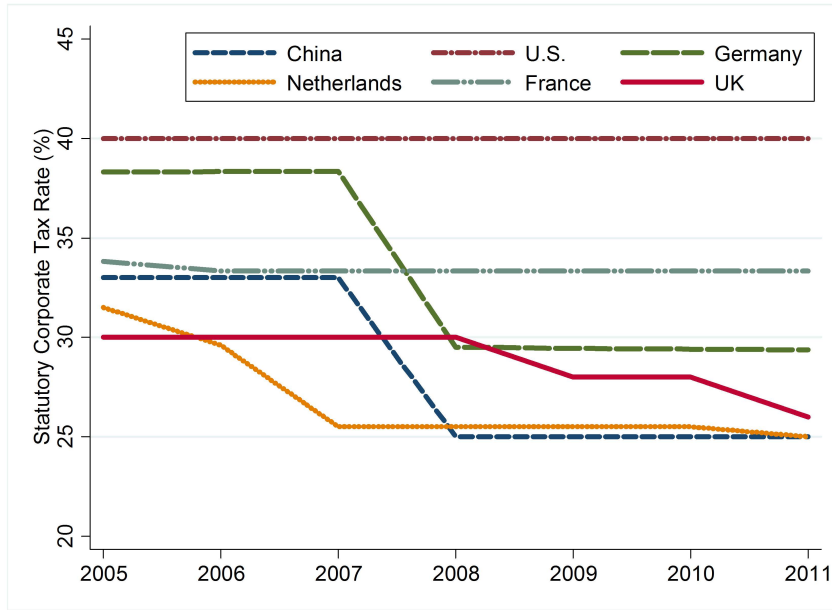
(b) Number of Low/High Tax Countries



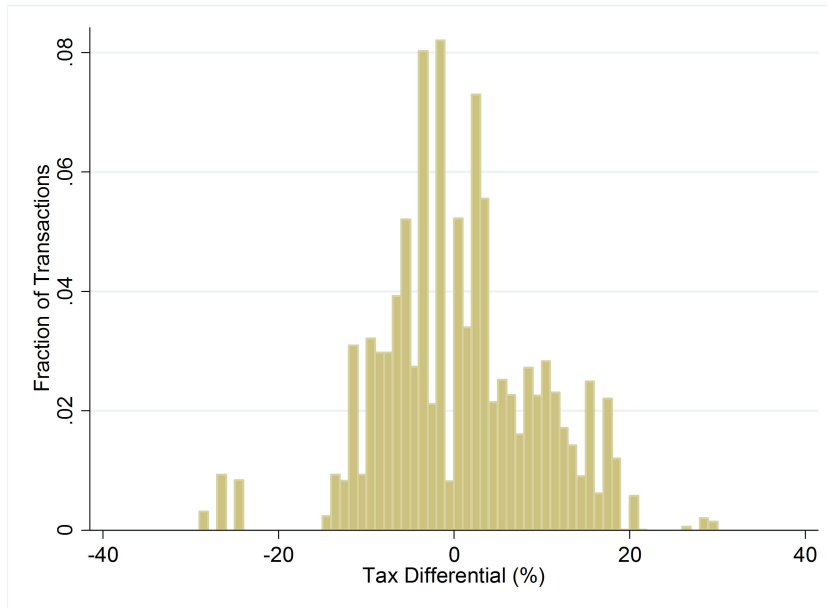
*Notes:* Panel A shows the worldwide location of UK MNC affiliates in 2011, the last year in our sample period. Panel B shows the number of countries with statutory tax rate lower than the UK rate (low-tax) and higher than the UK rate (high-tax), respectively, during 2005-2011.

Figure 4. Tax Incentives for Profit Shifting

(a) Statutory Tax Rate (%)



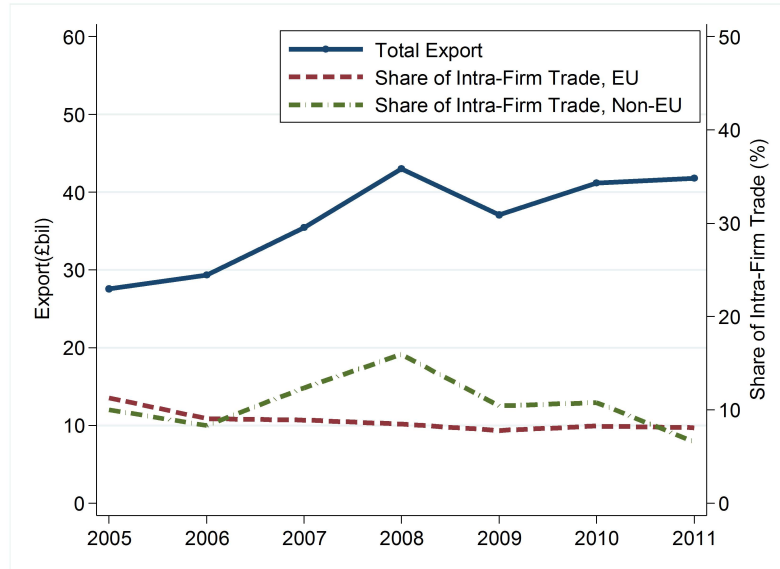
(b) Distribution of Tax Differential



*Notes:* Panel A shows the statutory tax rate in the UK and in its top-5 exporting partners during 2005-2011. Panel B shows a histogram distribution of the tax differential during the same time period.

Figure 5. Time-Series Export Values and the Share of Intra-Firm Trade

(a) Time-Series

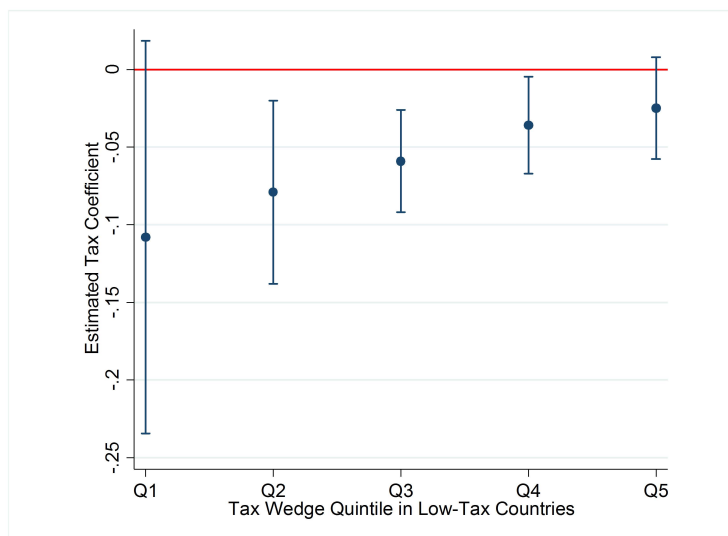


(b) Share of Intra-firm Exports to Tax Havens



*Notes:* Panel A shows the value of total exports in the final dataset during 2005-2011 (on the left y-axis), and the share of intra-firm trade in total exports within/outside the EU (on the right y-axis), respectively. Panel B shows the share of intra-firm trade to tax havens in total intra-firm trade, measured by total number of transactions (solid line) and value of exports (dashed line).

Figure 6. Non-linear Transfer Mispricing in Low-Tax Countries



*Notes:* This figure plots the point estimate of the tax coefficient  $\beta_1$  as in equation (10) and the corresponding 90% confidence intervals at each quintile of tax wedge  $\Delta\tau_{jt}$  in the low-tax countries.



## 9 Tables

Table 1. Summary Statistics

	Mean	Std. Dev	P25	P50	P75	Obs
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Product Characteristics</i>						
Export Value ( <i>GBP</i> )	115,151.10	463,230.80	956.00	4,518.00	28,388.00	931,773
Net Mass (in kilogram)	16,572.34	83,322.69	9.00	85.00	1,161.00	931,773
Average Value (per kilogram)	265.75	660.79	8.55	35.00	177.27	931,773
Number of Transactions	6.02	19.47	1.00	2.00	6.00	931,059
<i>Firm Characteristics</i>						
Log Sales	16.35	1.95	15.15	16.27	17.39	10,077
Intra-firm Trade	0.39	0.49	0	0	1	10,077
Profit Making	0.71	0.45	0	1	1	10,077
<i>Country Characteristics</i>						
Low Tax Country Dummy	0.55	0.50	0	1	1	705
Low Tax Wedge ( $\tau_{UK} - \tau_j$ , %)	7.68	5.72	3.00	6.00	11.50	445,883
High Tax Wedge ( $\tau_j - \tau_{UK}$ , %)	5.85	4.68	2.00	5.00	8.31	485,890

*Notes:* This table lists the summary statistics for the key variables in this paper's main analysis sample: an unbalanced panel of annual trade-tax records for all UK multinational exporters in manufacturing in years 2005-2011.

Table 2. Effect of the Tax Differentials on Transfer Pricing by UK Multinationals

$\Delta\tau_{jt} \times$	(1)	(2)
$I_{low,t} \times AFF_{ij}$	-0.030*** (0.011)	-0.027** (0.011)
$I_{high,t} \times AFF_{ij}$	-0.007 (0.006)	-0.000 (0.006)
$AFF_{ij} \times Post_t$		0.132*** (0.043)
$I_{low,t} \times AFF_{ij} \times Post_t$		-0.015*** (0.005)
$I_{high,t} \times AFF_{ij} \times Post_t$		-0.008 (0.007)
$R^2$	0.973	0.974
$N$	387,709	315,330

*Notes:* This table presents regression results on the causal effect of the tax differential on transfer prices of exports by UK multinational, based on equation (10). The main variables of interests are the three-way interaction terms  $\Delta\tau_{jt} \times I_{low,t} \times Aff_{ij}$  and  $\Delta\tau_{jt} \times I_{high,t} \times Aff_{ij}$ . All other variables are as previously defined. \*\*\*, \*\*, \* denotes significance at 1%, 5%, and 10% level, respectively.

Table 3. Heterogeneous Transfer Mispricing in R&amp;D

$\Delta_{\tau_{jt}} \times AFF_{ij} \times$	(1)	(2)	(3)	(4)	(5)
$I_{low,t}$				-0.033 (0.028)	-0.034 (0.030)
$I_{low,t} \times R\&D_{low,i}$	-0.010 (0.015)		-0.025 (0.023)		
$I_{low,t} \times R\&D_{medium,i}$	0.000 (0.017)		-0.015 (0.025)	0.014 (0.015)	0.017 (0.015)
$I_{low,t} \times R\&D_{high,i}$	-0.064*** (0.016)		-0.073*** (0.025)	-0.044* (0.024)	-0.041* (0.022)
$I_{low,t} \times Size_{small,i}$		-0.004 (0.019)	0.026 (0.022)		
$I_{low,t} \times Size_{medium,i}$		-0.037* (0.022)	-0.000 (0.004)		-0.020 (0.026)
$I_{low,t} \times Size_{large,i}$		-0.041*** (0.015)	0.009 (0.027)		-0.015 (0.022)
$I_{low,t} \times Diff_i$				0.019 (0.033)	0.033 (0.032)
$I_{high,t}$	-0.007 (0.006)	-0.007 (0.006)	-0.006 (0.006)	-0.009 (0.006)	-0.009 (0.006)
$R^2$	0.973	0.973	0.973	0.973	0.973
$N$	387,709	373,767	373,767	331,787	321,221

*Notes:* This table presents regression results on the heterogeneous effect of the tax differential on transfer prices of exports by UK multinational with low, medium, and high R&D intensity, based on equation (10). The R&D intensity indicators are defined in reference to the quartiles of the distribution of average firm-level R&D expenses relative to total sales. The size indicators are defined in reference to the quartiles of the distribution of average firm-level fixed assets. The indicator for differentiated products is based on Rauch (1999). \*\*\*, \*\*, \* denotes significance at 1%, 5%, and 10% level, respectively.

Table 4. Effect of the Tax Differentials on Transfer Pricing by UK Multinationals in Tax Havens

$\Delta_{T,t} \times$	Hines (2005)		Dharmapala and Hines (2009)		OECD (2000)		
	Tax Havens (1)	Non-Tax Havens (2)	Tax Havens (4)	Non-Tax Havens (5)	Tax Havens (7)	Non-Tax Havens (8)	Full Sample (9)
$I_{low,t} \times AFF_{ij}$	0.001 (0.024)	-0.029** (0.012)	0.002 (0.024)	-0.029** (0.012)	-0.030** (0.012)	-0.032*** (0.011)	-0.031*** (0.011)
$I_{high,t} \times AFF_{ij}$	0.030 (0.131)	-0.008 (0.006)	0.030 (0.132)	-0.008 (0.006)	-0.007 (0.006)	-0.007 (0.006)	-0.007 (0.006)
$I_{low,t} \times AFF_{ij} \times Haven_j$					-0.001 (0.021)		0.106* (0.064)
$I_{high,t} \times AFF_{ij} \times Haven_j$					0.077 (0.200)		0.098 (0.214)
$R^2$	0.991	0.973	0.991	0.973	0.973	0.973	0.973
$N$	22,895	332,266	22,328	332,830	387,709	375,626	387,709

*Notes:* This table presents regression results on the effect of the tax differential on transfer prices of exports by UK multinational in tax havens and non-haven countries, based on equation (10). The list of countries that are regarded as tax havens varies in Hines(2005), Dharmapala and Hines (2009), and the OECD list of Uncooperative Tax Havens. \*\*\*, \*\*, \* denotes significance at 1%, 5%, and 10% level, respectively.

Table 5. Effect of the Tax Differentials on Trade Diversion by UK Multinationals

Dependent variable:	$\ln(\textit{Weight})$		$\ln(\textit{UnitPrice})$		$\ln(\textit{TotalValue})$	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\tau_{jt} \times I_{low,t} \times AFF_{ij}$	-0.030 (0.020)	-0.013 (0.020)	-0.030*** (0.011)	-0.027** (0.011)	-0.060*** (0.023)	-0.041* (0.022)
$\Delta\tau_{jt} \times I_{high,t} \times AFF_{ij}$	-0.014* (0.009)	-0.011 (0.011)	-0.007 (0.006)	-0.000 (0.006)	-0.021** (0.009)	-0.011 (0.011)
$AFF_{ij} \times Post_t$		0.112 (0.104)		0.132*** (0.043)		0.244** (0.104)
$I_{low,t} \times AFF_{ij} \times Post_t$		0.017* (0.009)		-0.015*** (0.005)		0.001 (0.010)
$I_{high,t} \times AFF_{ij} \times Post_t$		0.001 (0.013)		-0.008 (0.007)		-0.007 (0.013)
$R^2$	0.975	0.976	0.973	0.974	0.967	0.969
$N$	387,709	315,330	387,709	315,330	387,709	315,330

*Notes:* This table presents regression results on the effect of the tax differential on the quantity of exports (Columns (1)-(2)), the transfer prices (Columns (3)-(4)), and the total value of exports (Columns (5)-(6)) by UK multinationals, respectively. \*\*\*, \*\*, \* denotes significance at 1%, 5%, and 10% level, respectively.

Table 6. Comparison to Existing Studies

Specification:	No FE	Vicard (2015)	Cristea & Nguyen (2016)	Cristea & Nguyen (2016)
$\Delta\tau_{jt} \times AFF_{ij} \times$	(1)	(2)	(3)	(4)
Panel A:				
$I_{low,t}$	-0.061*** (0.001)	-0.007*** (0.002)	-0.012 (0.011)	-0.005 (0.012)
$I_{high,t}$	0.002 (0.001)	-0.008*** (0.002)	-0.006 (0.005)	-0.011 (0.008)
$R^2$	0.0149	0.934	0.894	0.893
$N$	941,358	550,252	673,436	568,333
$I_{low,t}$	-0.054*** (0.003)	-0.007*** (0.002)	-0.026*** (0.010)	-0.025* (0.013)
$I_{high,t}$	-0.001 (0.003)	-0.009*** (0.002)	-0.007 (0.006)	-0.014** (0.007)
$R^2$	0.001	0.942	0.897	0.896
$N$	387,709	387,709	387,709	326,816
Both panels include:				
Fixed Effects	None	Firm-Product- Year, Country- Product-Year	Year, Country-Firm-Product, Low-tax Country Dummy-Year	Year, Country-Firm-Product, Low-tax Country Dummy-Year
Controls				Firm-level and Country-level

*Notes:* This table presents regression results on the effect of the tax differential on transfer prices of exports by UK multinational following specifications in a number of previous studies. \*\*\*, \*\*, \* denotes significance at 1%, 5%, and 10% level, respectively.

# A Appendix

Table A.1. List of Tax Havens

Country	Hines (2005)	Dharmapala and Hines (2009)	OECD List of Uncooperative Tax Havens (2000)
Andorra	1	1	1
Anguilla	1	1	1
Antigua and Barbuda	1	1	1
Aruba	1	0	1
Bahamas	1	1	1
Bahrain	1	1	1
Barbados	1	1	1
Belize	1	1	1
Bermuda	1	1	1
British Virgin Islands	1	1	1
Cayman Islands	1	1	1
Channel Islands	0	1	1
Cook Islands	1	1	1
Costa Rica	1	0	0
Cyprus	1	1	1
Djibouti	1	0	0
Dominica	1	1	1
Gibraltar	1	1	1
Grenada	1	1	1
Guernsey	1	0	0
Hong Kong	1	1	0
Ireland	1	1	0
Isle of Man	1	1	1
Jersey	1	0	0
Jordan	1	1	0
Lebanon	1	1	0
Liberia	1	1	1
Liechtenstein	1	1	1
Luxembourg	1	1	0
Macao	1	1	0
Maldives	1	1	1
Malta	1	1	1
Marshall Islands	1	1	1
Mauritius	1	0	1
Micronesia	1	0	0
Monaco	1	1	1
Montserrat	1	1	1
Nauru	1	0	1
Netherlands Antilles	1	1	1
Niue	1	0	1
Panama	1	1	1
Saint Kitts and Nevis	1	1	1
Saint Lucia	1	1	1
St. Martin	1	0	0
Saint Vincent and the Grenadines	1	1	1
Samoa	1	0	1
San Marino	1	0	1
Seychelles	1	0	1
Singapore	1	1	0
Switzerland	1	1	0
Tonga	1	0	1
Turks and Caicos Islands	1	1	1
Vanuatu	1	1	1

*Notes:* This table lists the countries that are regarded as tax havens in three different publications. The tax haven dummy indicator takes the value of one if the country was regarded as a tax haven under the corresponding publication, and zero otherwise.

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