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# Tax Evasion by Domestic and Foreign-Owned Portuguese Firms: A Bunching Analysis

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## Abstract

In this paper I examine whether firms report zero profits as a tax evasion strategy by testing the effects on bunching at zero of an exogenous shock to the cost of evasion in Portugal. I develop a unique identification strategy by exploiting the targeting of the reform to only certain sectors of economic activity. The results suggest that firms' reporting of zero profits is affected by the tax environment. However, the full effect of the reform is likely not observed in the empirical analysis because of firms' additional option to evade taxes by operating on the informal market, as suggested by a greater observed decrease among foreign-owned firms. <sup>1</sup>

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# 1 Introduction

Corporate tax revenues represent an important part of total taxes collected by the government in developed economies. Among OECD countries, for example, taxes on corporate income accounted for between five and twenty percent of total taxes collected by all levels of government in 2014 (OECD, 2016).

The collection of corporate tax revenue, however, presents a constant challenge to governments as firms find various ways to evade tax collection. Tax collection from firms operating in the informal market is a particular challenge for developing countries, while the main challenge in the developed world has become increasingly complex as multinational companies and cross-border business models become more prevalent. This type of business activity is more difficult for individual governments to track, and allows more possibilities for companies to evade taxes and reduce their tax burden. In some of the most extreme cases, MNCs have succeeded in reducing their effective tax rate to nearly zero (United States Government Accountability Office, 2008). In many cases, the lack of cross-country coordination in tax policy allows companies to do so through entirely legal mechanisms.

Portugal presents a unique case study of efforts to combat tax evasion and avoidance as a result of the reforms implemented during its economic assistance program from 2011-2014 (European Commission, Directorate-General for Economic and Financial Affairs, 2011). One of these reforms provided an interesting natural experiment in the form of an exogenous shock to the cost of tax evasion in certain sectors in economic activity, which I use to develop my identification strategy. As of 2013, consumers in Portugal can deduct from their personal tax bill 15% of the VAT paid in transactions in sectors particularly prone to tax evasion, such as automotive maintenance, restaurants, and beauty salons. Consumers can claim up to €250 per household member, and were also entered into a lottery to win a car when they participated in this scheme. This creates a conflict of interest between the consumer and the seller, and as a result induces firms to report these transactions to the tax authorities, making it riskier and thus more costly for them to evade taxes (Kofman and Lawarree, 1996).

I test the effects of this natural experiment using data from the Portuguese Ministry of Finance, which requires firms to submit their annual account information through an electronic database.<sup>2</sup> The anonymized set of these records from 2004-2012 was provided by the Portuguese National Statistical Office.<sup>3</sup> The comprehensive data and unique nature of the natural experiment created by the 2013 law allow me to identify and differentiate firm responses by sector of economic activity and multinational status.

I seek to quantify the extent of bunching of Portuguese firms at zero gross profits, the first and largest discontinuity in the corporate tax schedule. The positive tax rate on corporate income above zero has interesting and unique effects when compared to other kinks in the income tax schedule. First, this is the largest and most salient jump that firms face in their tax rate as their profits increase, jumping from zero to 12.5-25% depending on the year (see table 1). There is also a very large visible spike of firms at this point in the distribution in every year for which I have data, a spike which is mirrored in the data for other countries.

As a nonparametric estimator of behavioral response to taxation, bunching analysis has gained popularity to avoid common endogeneity issues. While the marginal tax rate depends on income, changes in the tax rate can endogenously affect the distribution of income as individuals and firms change their behavior in response (Chetty et al., 2011; Saez, 2010a).

In a bunching estimation, the actual distribution of reported taxable income is compared to a constructed counterfactual representing the distribution in the absence of any discontinuity in the

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<sup>2</sup>Informação Empresarial Simplificada (IES)

<sup>3</sup>Instituto Nacional de Estatística (INE)

tax rate. The density of the distribution in the counterfactual is estimated by fitting a polynomial to the empirical distribution, excluding a range directly around the discontinuity. At points in the distribution where the effective tax rate or monitoring intensity increases, the number of individuals or firms manipulating their income to remain below the threshold can be identified by looking for excess mass at these points.

I use the exogenous shock to evasion costs to set up a difference-in-differences estimation of the bunching response by the firms' foreign ownership status. I test how the magnitude of bunching at zero changes before and after the reform for firms in treated and untreated sectors, and compare this difference between firms with a presence only in Portugal and those that have an international parent company.

I find significant bunching at zero profits by all firms in all time periods, indicative of tax evasion around that threshold. The difference-in-differences analysis shows less post-reform bunching by firms in sectors targeted by the 2013 law when compared to other firms, suggesting that evasion through mis-reporting zero profits decreased in intensity in those sectors of economic activity post-reform. However, the estimated bunching only measures the response of bunching firms, i.e. those firms that evade taxes by mis-reporting their profits as zero. The results also indicate that bunching at zero decreased more for foreign owned than domestic firms. In keeping with the predictions of the model, this indicates that the reform was more effective in inducing active firms to report more taxable profits than in inducing firms operating informally to move to the formal sector, but that the magnitude of the policy's effect is obscured by the ability of domestic firms to also evade taxes by operating in the informal market.

The remainder of the paper is organized as follows. Section 2 contains a review of relevant literature on corporate tax evasion. I then lay out the theoretical framework and empirical strategy in Sections 3 and 4. In section 4.1 I present the particularities of the corporate tax system in Portugal, including the natural experiment which I use to test for evasion around zero profits, and I describe the data I use in Section 5. Finally, I present my results in Section 6.

## 2 Literature Review

Firms use various strategies to minimize their total tax bill:

- *Under-reporting revenues*: Firms partially or fully mis-report transactions to the tax authorities
- *Over-reporting costs*: Firms over-report their costs, where such costs are tax-deductible
- *Operating in the informal sector*: Firms do not register with the tax authorities and provide goods and services informally
- *Falsely reporting profits as zero*: Firms either under-report revenues or over-report costs such that their taxable income is zero
- *Shifting between personal and corporate income*: Business owners change whether they report income as individual or business, depending on the relative tax rates

Firms with locations in more than one tax jurisdiction also have several options to shift profits in order to take advantage of differential tax rates. These include transfer pricing, strategic internal debt allocation, and transfer of IP rights and royalty payments.

Estimates of the economic impact of such tax avoidance are difficult to obtain because the transactions are generally designed to avoid detection by the tax authorities. Revenue lost may be

significant, from an annual estimated €88 billion in the US to €140 billion in the UK (OECD, 2017; Murphy, 2014).

Additionally, countries face different challenges in the types of tax evasion that prevail. For example, the share of taxpayers operating in the informal sector and failing to file as active with the tax authorities is estimated to range from less than ten percent in developed countries to over fifty percent in the developing world (Keen, 2012; Erard and Ho, 2001; Gauthier and Gersovitz, 1997; Gauthier and Reinikka, 2006).

Academic studies of profit shifting, on the other hand, tend to focus on a single country or region where confidential data is made available to researchers, limiting the comparability or aggregation of such results (OECD, 2015). However, one IMF analysis estimates the average annual revenue loss may be close to five percent of total corporate tax revenue (IMF, 2014).

Governments across the world are working individually and collaboratively to recuperate lost tax revenue. Common approaches include increasing audit frequency, increasing the penalty for evasion, and publishing information about tax avoiders as a shaming mechanism.

The most prominent current effort to combat tax shifting by multinationals is the OECD and G20's Base Erosion and Profit Shifting project (BEPS) to harmonize tax rules across jurisdictions and combat evasion by multinational corporations (OECD, 2015). OECD, G20 and developing countries are working together to develop a set of best practices for taxing profits in the location where economic activity occurs.

One part of BEPS, the Automatic Exchange of Information, aims to facilitate the sharing of tax information across the various jurisdictions where multinational corporations report business activities. Specifically, the tax authority in source countries—where tax information is often gathered automatically through such forms as withholding and bank statements—agree to share this data with the tax authority in the residence countries.

For such projects to work, however, it is important to fully understand the dynamics of such business practices in the varied economies participating in the project. The business activity, contribution to the economy, and nature of firms differ in every country, and therefore we cannot necessarily generalize the results of country-specific efforts.

Bunching techniques have recently become more common as a way to estimate the behavioral response to changes in the tax rate and enforcement. At discontinuities in the tax schedule that coincide with changes in the effective tax rate, reporting requirements, or enforcement intensity, we would expect to see an excess mass of firms in the distribution in a window directly before the discontinuity (Chetty et al., 2011). As a nonparametric estimator, bunching analysis has been gaining popularity in the taxation literature to avoid common endogeneity issues, but has mainly been used so far to look at personal income taxation, in part because the corporate tax schedule is generally flat and presents fewer step-wise discontinuities than the personal income tax schedule, which in most countries is designed as a progressive system (Chetty, 2012; Saez et al., 2012; Saez, 2010a; Almunia and Lopez-Rodriguez, 2012; Devereux et al., 2014; Dekker et al., 2016). The main drawback is that the conclusions obtained with bunching analysis can generally only be applied to the setting or country in which they are tested, making it even more important for researchers to continually test results in different settings.

Researchers have generally examined responses at corporate tax thresholds falling far above zero, meaning that they can ignore the extensive response of firms and focus on intensive margins. Research on the kink at zero is more widespread among the personal tax literature, particularly in the case of the Earned Income Tax Credit in the United States. Emanuel Saez (Saez, 2010b) examined bunching of individual taxpayers at zero earnings, the first and most significant kink in the tax schedule in the United States, and found evidence of bunching particularly by self-employed earners, with an implied tax elasticity of around 0.25. He excluded extensive margin responses from

his model, suggesting that his estimate provides a lower bound on the tax response, as it does not capture households who are better off either participating only in the informal market, or ceasing to work. However, the extensive response is likely to be minimal because of the proportional nature of the tax rate, meaning that households with profits close to zero would be better off misreporting zero profits in order to pay zero taxes than exiting the workforce. The same effect should hold for firms, who face a sunk cost of entry into the market.

Some researchers have been able to gain access to confidential data that allows them to directly measure profit shifting, a type of tax avoidance available only to firms that operate in more than one tax jurisdiction. [Clausing \(2003\)](#) uses monthly data from the US Bureau of Labor Statistics on import and export prices, differentiated by whether they are between related parties or not, and finds direct evidence consistent with transfer pricing by firms, estimating that a 1% reduction of the tax rate in the country of destination or origin is associated with a 1.8% reduction in intrafirm export prices and a 2% increase in intrafirm import prices. [Harju et al. \(2015\)](#) use a unique panel dataset from the Finnish Tax Administration which includes tax record information on all Finnish businesses and their main owners, allowing them to conduct a first-differences analysis of shifting between corporate and personal income bases in response to exogenous variation in the Finnish tax code. They also find direct evidence of income shifting consistent with tax avoidance, with a marginal deadweight loss of approximately 0.30 caused by the behavioral response to tax changes.

This paper contributes an examination of how tax enforcement penalties change the relative incentives and costs of different channels of tax evasion, using firms' foreign ownership status as a proxy for the relative ease with which different types of firms utilize different channels. I also allow for the possibility that firms can not only choose between operating in the formal and informal markets, but can choose to falsely report zero profits to avoid paying any profit tax, while still benefiting from subsidies, legal protection, and other advantages available only to firms operating in the formal market. This analysis contributes to the literature on how governments can target their tax enforcement policies to best address the most prevalent and harmful types of tax evasion in their respective economies, as in for example [Gordon and Li \(2009\)](#).

### 3 Model

To obtain a prediction for the changes in bunching at zero that should result from an exogenous shock to the cost of tax evasion, I follow the model of Best et al., where the firm chooses its optimal levels of production and tax avoidance ([Best et al., 2015](#)).<sup>4</sup> Where [Best et al. \(2015\)](#) examine tax avoidance through cost mis-reporting, I model evasion through manipulation of reported revenue, with a convex and differentiable cost of misreporting that depends on the magnitude of the difference between actual and reported revenue. This cost is assumed to be monetary and non-tax deductible.<sup>5</sup>

My main addition to the model is to incorporate the behavior of firms evading taxes by mis-reporting zero profits, and firms that choose not to participate in the formal market and conduct all of their production or activity underground.

When such a firm  $i$  exists entirely in the informal sector, I say that it is a *ghost*, after the terminology used for example by [Cowell and Gordon \(1995\)](#), and its after-tax profit in a given year

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<sup>4</sup>Tax avoidance includes both legal behavior of firms to reduce their tax burden, and illegal behavior, or tax evasion.

<sup>5</sup>The model predictions are equivalent across both channels of evasion. I therefore choose revenue mis-reporting as a more realistic representation of the reform tested in the empirical application.

is given by:

$$\tilde{\Pi}_i^s(y) = R(y) - \alpha_i C(y) - \beta_s \quad (1)$$

where  $y$  is the output level, and  $R(y)$  and  $C(y)$  are total revenue and total costs, respectively.

Each firm also faces a fixed cost  $k$  of entry into the market, which I assume has been paid in a previous year and therefore enters into neither the firm's production or evasion decision. This accounts for the possibility that a firm's annual profit may be negative in a given year, but it will continue to operate so as not to lose its investment in  $k$  with the expectation that it will return to profitability in a future period, as in Dixit (1989). I also assume that market conditions are the same, and therefore all firms face the same price, with no loss of generality.

The fixed cost of underground business activity is sector-specific, and measured by  $\beta_s$ . This allows for the fact that operating without detection by tax authorities is much easier for firms in some sectors, such as household services, than in others, such as banking.

Each firm also has a specific cost parameter, given by  $\alpha_i$   $[1, \infty]$ . As  $\alpha$  increases, firms face a higher cost of production - i.e., are higher-cost.

The firm chooses the level of activity that maximizes (1):

$$\max_y \tilde{\Pi}_i^s(y) = R(y) - \alpha_i C(y) - \beta_s \quad (2)$$

which satisfies:

$$\frac{R'(y_i^*)}{C'(y_i^*)} = \alpha_i \quad (3)$$

This implies that those firms with a higher cost of production at a given  $y$  will produce less than lower-cost ones.

I assume that only domestic firms operate as ghosts.

A firm  $i$  can also choose to report some activity in the formal sector. I call such a firm an *iceberg* after the work of Keen (2012), with after-tax profit given by

$$\Pi_i^s(y, e) = R(y) - \alpha_i C(y) - \eta_s \gamma_j g(e) - \tau [R(y) - \mu \alpha_i C(y) - e] \quad (4)$$

where  $\tau$  is the tax rate. Each firm chooses some amount  $e$  of its revenue to under-report to the tax authorities, with an associated increasing and convex cost of evasion  $g(e)$ . This type of cost could include hiring extra accountants and lawyers, managing two sets of books, and dealing in cash transactions rather than going through a bank. It is also associated with the probability of being caught evading taxes, with the firm facing a penalty if caught.

The parameter  $\eta_s$  captures the difference in the cost of tax evasion in the formal market from one sector to another. For example, businesses with large amounts of small cash transactions, such as corner grocery stores or small cafes, will find it easier to hide transactions from the tax authorities than those in other sectors.

The cost of formal-sector evasion is scaled by  $\gamma_j$ , which depends on whether the firm is domestic,  $d$ , or an affiliate of a multinational,  $m$ , with  $\gamma_m = v\gamma_d$ ,  $[0 < v < 1]$ , so that  $\gamma_m < \gamma_d$ . This reflects the relative ease of evasion in the formal and informal markets. While domestic firms have more familiarity with the tax environment and reality of the underground economy in a given country, they

do not have the option of shifting profits between tax jurisdictions to take advantage of differential tax rates, as multinational firms do.

As in [Best et al. \(2015\)](#), I also allow a share  $\mu \leq 1$  of the firm's reported costs to be tax deductible. To simplify the analysis, I set  $\mu = 1$  throughout, representing the case of full cost deductibility.

Iceberg firms may report zero profits or positive profits, depending on which yields the highest net-of-tax return.<sup>6</sup> I call firms falsely reporting zero profits *bunchers*.

The buncher's strategy entails setting a level of evasion  $\hat{e}$  such that reported profits equal zero:

$$\begin{aligned} R(y_i^*) - \mu\alpha_i C(y_i^*) - \hat{e} &= 0 \\ \hat{e} &= R(y_i^*) - \mu\alpha_i C(y_i^*) \\ \frac{d(\hat{e})}{d(\alpha)} &< 0 \end{aligned} \tag{5}$$

with  $y_i^*$  given by (3).

The iceberg, on the other hand, optimally chooses  $e$  and  $y$  so as to maximize (4). When  $\mu = 1$ , the optimal evasion and activity levels satisfy

$$\frac{R'(y_i^*)}{C'(y_i^*)} = \alpha_i \tag{6}$$

$$g'(e_i^*) = \frac{\tau}{\eta_s \gamma_j} \tag{7}$$

$$j = m, d \tag{8}$$

$$(9)$$

The iceberg firm's optimal  $y_i^*$  is decreasing in  $\alpha_i$ . This means that lower-cost firms will produce more, as was the case for ghosts (*see* (3)).

Moreover, the optimal activity level  $y_i^*$  is decreasing in  $\tau$ . This implies that an increase in the tax rate faced by a given firm will cause it to decrease production.

The optimal formal-market tax evasion for iceberg firms results from a trade-off between the evasion costs and the tax rate. Evasion decreases with  $\gamma_j$  and  $\eta_s$ , hence it is lower for domestic firms ( $\gamma_m < \gamma_d$ ) and for firms in sectors with a high cost of formal-market evasion. It also increases with the tax rate  $\tau$ , implying that firms will mis-report higher costs to evade their taxes to a greater extent when taxes are higher.

Additionally, since  $g(e)$  is increasing and convex, the level of evasion and associated cost of formal-market evasion will always be higher for bunchers than icebergs at a given  $\alpha_i$ :

$$\begin{aligned} \hat{e} &= R(y_i^*) - \alpha_i C(y_i^*) \\ e_i^* &< R(y_i^*) - \alpha_i C(y_i^*) \\ g(\hat{e}) &> g(e_i^*) \end{aligned} \tag{10}$$

The firm's decision about whether to operate as a ghost, a buncher, or a iceberg depends on the interaction between the costs of evasion in the informal and formal market in the sector in which it operates, its level of efficiency, and its multinational status.

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<sup>6</sup>Iceberg firms can also earn negative profits. However, the risk of audit is higher for firms reporting negative profits and therefore the associated cost of evasion will be higher, as for example in [Saez \(2010a\)](#). This implies that a firm will only report negative profits if it actually earns negative profits, and will never choose  $e$  such that it reports negative profits when its profits are actually positive.

Respective after-tax profits for the three types of firm are given by:

- *Ghosts*:  $\pi_g = R(y_i^*) - \alpha_i C(y_i^*) - \beta_s$
- *Bunchers*:  $\pi_z = R(y_i^*) - \alpha_i C(y_i^*) - \eta_s \gamma_j g(\hat{e})$
- *Icebergs*:  $\pi_p = R(y_i^*) - \alpha_i C(y_i^*) - \eta_s \gamma_j g(e_i^*) - \tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*]$

Domestic firms will choose between the three options based on which yields the highest after-tax profits, given the relative costs of formal and informal evasion in its sector, while multinational or foreign-owned firms will choose only between acting as bunchers and icebergs. The results follow those for example of [Virmani \(1987\)](#) for small firms in the distribution of firms across the spectrum of evasion channels.

### 3.1 Margins: Buncher to Ghost

A domestic firm in a given sector will choose to report zero profits as a buncher rather than conducting all activity in the informal market as a ghost when the expected return is strictly higher, which occurs when the cost of evading at the level  $\hat{e}$  is strictly less than the fixed cost of being a ghost:

$$\begin{aligned} \eta_s \gamma_{dg}(\hat{e}) &< \beta_s \\ \text{where} & \\ \hat{e} &= R(y_i^*) - \alpha_i C(y_i^*) \end{aligned} \tag{11}$$

with the following indifference condition:

$$\begin{aligned} \eta_s \gamma_{dg}(\hat{e}) - \beta_s &= 0 \\ \tilde{\eta}_z(\alpha) &= \frac{\beta_s}{\gamma_{dg}(\hat{e})} \\ \hat{e} &= R(y_i^*) - \alpha_i C(y_i^*) \\ \frac{d(\tilde{\eta}_z)}{d(\alpha)} &> 0 \end{aligned} \tag{12}$$

where  $\tilde{\eta}_z$  represents the values along the spectrum of possible  $\eta$  within sector  $s$  at which a firm of a given  $\alpha$  would be indifferent between operating as a ghost or a buncher. A firm of  $\alpha_i$  facing  $\eta_s > \tilde{\eta}_z$  prefers to be a ghost, while the same firm facing  $\eta_s < \tilde{\eta}_z$  can expect higher profits from operating as a buncher.

Within a given sector, therefore,  $\tilde{\alpha}_z$  represents the value of alpha at which the actual cost of evasion in the formal market in sector  $s$  is low enough for firms to prefer to operate as bunchers than as ghosts. This occurs where  $\tilde{\eta}_z$  intersects with  $\eta_s$ . Firms with  $\alpha < \tilde{\alpha}_z$ , i.e. lower-cost firms, will earn higher profits as ghosts, while higher-cost firms will be bunchers.

At a given  $\eta$  and  $\beta$ , higher-cost firms bunch and lower-cost firms will operate as ghosts.

### 3.2 Margins: Iceberg to Ghost

A domestic firm will operate as an iceberg, producing at the optimal  $y_i^*$  and evading at the optimal level  $e_i^*$ , rather than a ghost when it expects to earn higher profits by doing so:

$$\begin{aligned} R(y_i^*) - \alpha_i C(y_i^*) - \eta_s \gamma_d g(e_i^*) - \tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*] > \\ R(y_i^*) - \alpha_i C(y_i^*) - \beta_s \end{aligned} \quad (13)$$

A firm in a given sector will be indifferent between operating as a iceberg or a ghost when:

$$\begin{aligned} R(y) - \alpha_i C(y) - \eta_s \gamma_d g(e_i^*) - \tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*] - \\ [R(y) - \alpha_i C(y) - \beta_s] = 0 \\ \tilde{\eta}_p(\alpha) = \frac{\beta_s - \tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*]}{\gamma_d g(e_i^*)} \\ \frac{d(\tilde{\eta}_p)}{d(\alpha)} > 0 \end{aligned} \quad (14)$$

where  $\tilde{\eta}_p$  represents the value at which firms are indifferent between being icebergs and ghosts. Firms facing  $\eta_s > \tilde{\eta}_p$  will prefer to be ghosts, while those facing  $\eta_s < \tilde{\eta}_p$  can expect higher returns by operating as icebergs.

Within a given sector, therefore,  $\tilde{\alpha}_p$  represents the value of alpha at which the actual cost of evasion in the formal market in sector  $s$  is low enough for firms to prefer to operate as icebergs than as ghosts. This occurs where  $\tilde{\eta}_p$  intersects with  $\eta_s$ .

$$\begin{aligned} \eta_s = \tilde{\eta}_p(\tilde{\alpha}_p) = \frac{\beta_s - \tau[R(y_i^*) - \alpha_p C(y_i^*) - e_i^*]}{\gamma_j g(e_i^*)} \\ \tilde{\alpha}_p = \frac{\eta_s \gamma_j g(e_i^*) - \beta_s + \tau[R(y_i^*) - e_i^*]}{\tau[C(y_i^*)]} \end{aligned} \quad (15)$$

Firms with  $\alpha < \tilde{\alpha}_p$ , i.e. lower-cost firms, will operate as ghosts, while higher-cost firms will be icebergs.

As for  $\tilde{\eta}_z$ ,  $\tilde{\eta}_p$  is increasing in  $\beta_s$ , meaning that there will be a higher share of firms choosing to be ghosts rather than icebergs in sectors where  $\beta_s$  is higher.

### 3.3 Margins: Buncher to Iceberg

Finally, I look at the margin between bunchers and icebergs, which represent the universe of active firms operating in the formal market. This decision is relevant for both multinational and domestic firms.

A firm will choose to be a buncher rather than an iceberg if the expected profit from evading at the level  $\hat{e}$  is less than or equal to that obtained at the optimal level of evasion  $e_i^*$ , with the following indifference condition for the firm on the margin between evading as a buncher or an iceberg:

$$\begin{aligned}
& R(y_i^*) - \alpha_i C(y_i^*) - \eta_s \gamma_j g(\hat{e}) - \\
& [R(y_i^*) - \alpha_i C(y_i^*) - \eta_s \gamma_j g(e_i^*) - \tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*]] = 0 \\
& \text{where} \\
& \hat{e} = R(y_i^*) - \alpha_i C(y_i^*) \\
& \tilde{\eta} = \frac{\tau[R(y_i^*) - \alpha_i C(y_i^*) - e_i^*]}{\gamma_j [g(\hat{e}) - e_i^*]} \\
& \frac{d(\tilde{\eta})}{d(\alpha)} < 0
\end{aligned} \tag{16}$$

Within a given sector,  $\tilde{\alpha}$  represents the value of alpha at which firms can expect higher returns from operating as icebergs than as bunchers.

Firms facing  $\eta_s > \tilde{\eta}$  will prefer to be icebergs, while lower-cost firms will expect higher post-tax returns as bunchers. Intuitively, this follows from the fact that high-cost firms benefit more from being able to deduct some portion of their costs from their total tax bill, making it relatively more advantageous for them to report some positive taxable profit. Additionally, since bunchers always have a higher level of evasion than icebergs and the firm-specific cost of formal-market evasion is always scaled by the sector-specific cost  $\eta_s$ , firms will only choose bunching over iceberg evasion when  $\eta_s$  is low enough to do so.<sup>7</sup>

Additionally,  $\tilde{\eta}$  is decreasing in  $\gamma_j$ , meaning that of a smaller share of active domestic firms in a given sector will be bunchers than that of multinational firms. This also implies that domestic firms will need to be relatively more efficient than multinational firms to expect higher profits as bunchers than icebergs, reflecting the overall lower cost of formal-market evasion faced by multinational firms with the additional options for evasion provided by profit shifting.

The distribution of firms in  $\alpha$  is such that the lowest-cost firms will be ghosts, the highest-cost will be icebergs, and the intermediate firms will be bunchers. This follows from the result that the highest-cost firms benefit the most from cost deductibility and other advantages available to firms registered with the tax authorities, while the lowest-cost firms benefit the most from retaining their full profits without paying any taxes.

I assume that both multinational and domestic firms are normally distributed in  $\alpha$  within a sector.

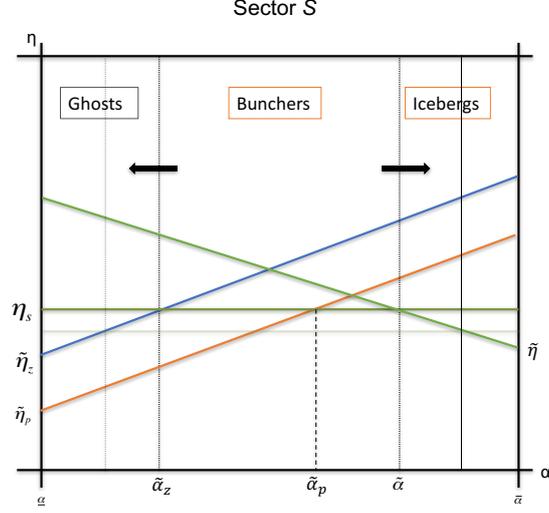
### 3.4 Exogenous shock to $\eta_s$

A Portuguese law increasing the risk of detection in certain sectors of economic activity provides an opportunity to test how firms' behavior aligns with the predictions of the model. Such an increase in the cost of evasion in the formal sector will affect both bunchers and icebergs, and both multinational and domestic firms.

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<sup>7</sup>Firms earning negative profits will be the least profitable, i.e. those with the highest  $\alpha$ , and therefore those to the rightmost spectrum of the distribution of icebergs. Therefore on the margins between bunchers and icebergs and ghosts and icebergs, we should expect only firms earning positive profits.

Figure 1: Firms in Sector  $S$  after an increase in  $\eta$



Note: Firms are visualized along the distribution of  $\alpha$  from the lowest to highest-cost, and the range of possible values of  $\eta$  in sector  $s$ .  $\tilde{\eta}_z(\alpha)$  represents the value of  $\eta$  at which firms are indifferent between operating as bunchers and ghosts, as a function of  $\alpha$ . Firms facing  $\eta_s > \tilde{\eta}_z$  can earn higher profits as ghosts, while firms facing  $\eta_s < \tilde{\eta}_z$  expect higher profits as bunchers.  $\tilde{\alpha}_z$  represents the value of alpha at which the actual cost of evasion in the formal market in sector  $s$  is low enough for firms to prefer to operate as bunchers than as ghosts.  $\tilde{\eta}_p(\alpha)$  represents the value of  $\eta$  at which firms are indifferent between operating as ghosts and icebergs, as a function of  $\alpha$ . Firms facing  $\eta_s > \tilde{\eta}_p$  can earn higher profits as ghosts, while firms facing  $\eta_s < \tilde{\eta}_p$  expect higher profits as icebergs.  $\tilde{\alpha}_p$  represents the value of alpha at which the actual cost of evasion in the formal market in sector  $s$  is low enough for firms to prefer to operate as icebergs than as ghosts. Firms at a given level of  $\alpha$  facing  $\eta > \tilde{\eta}_z$  would expect higher returns as ghosts than bunchers and vice versa, while firms facing  $\eta > \tilde{\eta}_p$  would expect greater returns as icebergs than ghosts and vice versa.  $\tilde{\eta}$  represents the indifference condition within a given sector for firms on the margin between operating as bunchers and icebergs. Firms facing  $\eta_s < \tilde{\eta}$  will operate as bunchers, while those facing  $\eta_s > \tilde{\eta}$  will be icebergs.

When  $\eta_s$  increases, the lowest-cost domestic bunchers become ghosts, while the highest-cost bunchers become icebergs. This will result in a decrease in observed bunching, but some of this decrease may come from firms moving to the informal market. For multinational firms, all of the decrease in bunching comes from bunching firms becoming icebergs, i.e. beginning to report non-zero profits to the tax authorities.

In a sector where all three types of firms are present (ghosts, bunchers, and icebergs), marginal domestic bunchers will respond to the increase in  $\eta$  by either moving to the illegal sector - i.e., becoming ghosts - or beginning to report positive profits as icebergs (see figure 1). The lowest-cost bunchers will become ghosts, while the highest-cost bunchers will become icebergs. Multinational bunchers, on the other hand, will only become icebergs.

Domestic firms' decision comes from the tradeoff between  $\eta_s$  and  $\beta_s$ , i.e. the relative costs of evasion in the formal and informal market. When firms are forced to report more transactions to the tax authorities, it may become unprofitable for them to operate in the formal market at all, and they will prefer to pay the fixed cost of moving to the informal market. This tradeoff makes informal-market evasion relatively more attractive for domestic than multinational firms, who have more options for evading in the formal market through activities such as profit shifting.

Observed bunching at zero decreases for all firms. Because part of the response from domestic firms comes from movement to the informal market, where they no longer appear in administrative

records, the decreased bunching will appear to be larger for multinational firms. This implies that the full effect of the policy will not be observed for domestic firms.

To test the effects of the law in Portugal, I identify the proportion of firms reporting zero profits before and after a sector-specific increase in the cost of evasion. To see how the effects were transmitted across firms with different relative costs of evasion in the formal and informal markets, I make a comparison across domestic and foreign-owned firms. The results are in line with the predictions of the model.

## 4 Empirical Strategy

### 4.1 Natural Experiment: Shock to Evasion Costs in Portugal

In August 2012, the Portuguese government passed a law creating incentives for consumers to ask for receipts associated with their individual taxpayer identification number for transactions in sectors particularly prone to tax evasion:

- Automotive vehicle maintenance and repair
- Maintenance and repair of motorcycles and motorcycle parts
- Lodging, restaurants, and similar businesses
- Hair salons and beauty institutes

When individuals fill out their personal income tax returns, they can see a list of the transactions which were reported by businesses with their taxpayer identification number. If there are any transactions missing, consumers can flag them to the tax authorities.

The law, which went into effect at the beginning of 2013, allowed consumers to deduct from their personal tax bill 15% of the VAT paid in these transactions, up to €250 per household member. Consumers were also entered into a lottery to win a car when they participated in this scheme. By doing so, the government effectively increased the risk of detection for firms under-reporting transactions.

I use this exogenous shock as a natural experiment to test the predictions of the model regarding the effects of an increase in the cost of tax evasion on bunching at zero. I consider that this reform increases the cost of evasion in the formal market by increasing the probability of detection of under-reported revenue, corresponding in the model to an increase in  $\eta_s$ , as in section 3.4.

As in most developed economies, Portuguese companies are subject to different effective tax rates based on their taxable income. The top statutory corporate tax rate in Portugal has been decreasing for several decades, falling from over 50% in 1985 to 23% in 2015. As part of Portugal's efforts to consolidate its public finances in the wake of the 2009 European financial crisis, it has introduced a series of reforms to its corporate income tax code, including a federal surtax on income above a certain level.<sup>8</sup> Table 1 shows corporate tax rates in Portugal during the relevant period 2010-2014 for entities resident in Portugal or permanent establishments of non-resident entities. ([PricewaterhouseCoopers, 2014](#))<sup>9,10</sup>

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<sup>8</sup> "Derrama Estadual"

<sup>9</sup>The rates cited here are for resident entities and permanent establishments of non-resident entities that exercise commercial, industrial, or agricultural activities as their main activity in Portugal.

<sup>10</sup>SMEs are micro, small, and medium-sized enterprises, defined by the European Commission as firms with less

Table 1: Corporate Taxation in Portugal: 2010-2014

		2010-2011		2012	2013	2014	
		< €12,500	> €12,500			< €15,000	> €15,000
BASE RATE	Continent	12.5%	25%	25%	25%	23%	23%
	Madeira	10%	25%	25%	25%	SME: 17%	SME: 23%
	Azores	8.75%	17.5%	17.5%	17.5%	23%	23%
						SME: 17%	SME: 23%
						18.4%	18.4%
						SME: 13.6%	SME: 18.4%

Note: Tax rates as reported by PWC in their annual summary of corporate taxation in Portugal. SMEs are micro, small, and medium-sized enterprises, defined by the European Commission as firms with less than 250 employees and either less than €50 million in annual turnover or a balance sheet total of less than €43 million.

Figure 2: Portuguese Tax Authority Definition of Corporate Taxable Income and Tax Payable

<b>Taxable profit</b> = Net income + Positive changes in net equity not reflected in the income - Negative changes in net equity not reflected in the income ± Fiscal corrections (e.g. non-deductible costs or non taxable proceeds)
<b>Taxable income</b> = Taxable profit - Tax losses from previous accounting periods - Tax Incentives
<b>Income assessed for corporate tax (IRC)</b> = Taxable income * Tax rate
<b>Assessed IRC</b> = IRC assessed income - Tax credit
<b>Payable IRC</b> = Assessed IRC - Withholding at Source - Advance Payments

Note: Unlike pre-tax profits, taxable income also includes tax deductions and credits for which the company is eligible under Portuguese tax law, and tax credits or losses carried forward from previous accounting periods. A tax loss is defined as negative net profits in a given year. In this case the company reports no taxable income in that year and pays no taxes, but can carry forward the negative balance to reduce its taxable income in a following year in which it has positive net profits. A company can also defer tax credits for which it would be eligible in a year in which it has no taxable income.

The definition of corporate taxable income and tax payable in Portugal can be seen in Figure 4.1.

## 4.2 Bunching Estimation

To analyze bunching at zero profits by firms I follow the approach of Emanuel Saez, who analyzed bunching of personal taxable income at zero in the United States. I implement subsequent refinements of the bunching technique, particularly those of Chetty et al and Kleven and Waseem (Saez, 2010b; Chetty et al., 2011; Kleven and Waseem, 2013). The basic idea of this technique is to estimate the difference between the distribution of firms' actual reported income and what they would have reported in the absence of any discontinuity in the tax schedule.

Where corporate tax rates are uniform and firms vary continuously along a given characteristic such as profitability, we would expect firms to locate smoothly along the distribution of taxable

than 250 employees and either less than €50 million in annual turnover or a balance sheet total of less than €43 million.

income. If, however, the introduction of kinks in the corporate tax schedule induces firms to evade taxes, we would see excess mass in the corporate tax distribution as firms bunch below these kinks, and missing mass above. This can result from firms hiding their true profits through legal or illegal means to avoid paying the higher tax rate on income above the kink, or from firms ceasing real economic activity at the point where their profits would exceed the location of the kink. However as in [Saez \(2010a\)](#), I assume that firms will prefer to remain active and report zero profits or move to the informal market than to cease operations, because of the fixed sunk cost of production.

Bunching analysis has become an increasingly prominent method in the empirical literature for detecting and quantifying such behavior. This approach entails comparing the actual distribution of firms' reported profits to a constructed counterfactual representing the distribution in the absence of any discontinuity in the tax rate or enforcement intensity. By comparing the two, it is possible to estimate the number of firms changing their behavior in response to the tax rate and the magnitude of their response.

More generally, in the case of a discontinuity in the tax rate, firms below some point  $K$  in the distribution of corporate income face a rate of  $\tau_1$ , and above it face the higher  $\tau_2$ . To avoid facing  $\tau_2$ , some firms in a strictly dominated region  $z^* + \Delta z^*$  in the distribution of firm profits falsely report their profits as zero, acting as bunchers.

Such tax avoidance is not without risk, however. Firms could for example face costs associated with hiring extra accountants and lawyers, managing two sets of books, or dealing in cash transactions rather than going through a bank. Another type of cost is associated with the risk of an audit, as for example in [Almunia and Rodriguez \(Almunia and Lopez-Rodriguez, 2012\)](#). Because of these costs, some firms within  $z^* + \Delta z^*$  will remain icebergs rather than bunching at zero.

The share  $B$  of active firms whose profits are maximized by falsely reporting zero profits can be estimated through  $\int_K^{K+\Delta z} h(z) dz$ .  $h(z)$  represents the density distribution of reported firm profits in the absence of any discontinuity in the tax rate (i.e. if all firms faced the same tax rate  $\tau_1$ ).  $K + \Delta z$  represents the highest point along the income distribution where firms choose to move below  $K$  in response to the tax rate  $\tau_2$ . In the case of zero profits, both  $K$  and  $\tau_1$  are equal to zero.

To estimate the counterfactual distribution of firm taxable income, a flexible polynomial is fitted to the observed empirical distribution, with firms grouped into  $j$  bins by their reported pre-tax net profits:

$$c_j = \sum_{i=0}^p \beta_i (y_j)^i + \sum_{i=y_L}^{y_U} \gamma_i \mathbf{1}[y_j = i] + \nu_j \quad (17)$$

where  $c_j$  is the number of firms in bin  $j$ ,  $p$  is the order of the polynomial, and  $y_j$  is the upper limit of the profits in bin  $j$ . To accurately construct the counterfactual, the contribution of firms around  $K$  must be excluded, setting a lower limit of  $y_U$  and an upper limit of  $y_L$  on the excluded range. This ensures that the counterfactual distribution reflects the profits of firms around the threshold as they would behave if the tax rate remained the same above and below—effectively, if the tax rate were  $\tau_1$  for all firms. This accounts for the behavior of firms that respond to the positive tax rate above the kink point by bunching at the kink. Iceberg firms, whose post-tax profits are higher if they produce and evade at the optimal levels, are present in the observed empirical distribution.

The counterfactual distribution on the intensive margin is therefore obtained by estimating the regression with only the included firms:

$$\hat{c}_j = \sum_{i=0}^p \beta_i (y_j)^i \quad (18)$$

The resulting parameter  $b(\tau_1, \tau_2)$  represents the excess mass of firms in the distribution located below the kink point  $K$ , given as the fraction of firms below the kink relative to the density in the counterfactual situation of a constant tax rate  $\tau_1$  throughout the entire distribution, i.e. the share of bunchers among active firms. The response of ghost firms will not be observed in the bunching estimation.

## 5 Data

The data comes from the accounting records of Portuguese firms covering the period 2010-2014. Although the dataset comes from records submitted by the entire universe of Portuguese firms, many variables—including profit and tax-related information—are reported only for the subset of firms classified as “sociedades,” which are collectively-owned firms and can be either publicly traded or privately owned.<sup>11</sup> Because there is such limited data on individually-owned firms, I exclude all but the collectively-owned firms, which comprise 32% of the sample.

I classify each firm as foreign-owned or domestic, using the variable describing the country of ultimate ownership.<sup>12</sup> If a firm reported any country other than Portugal for this variable, I classified it as foreign-owned, meaning that it is a subsidiary of a firm located in another country. Because the data is anonymized, I was unable to identify Portuguese firms that are the ultimate owners of multinational enterprises. The estimates for foreign-owned firms therefore reflect the behavior of the overseas owners of an international conglomerate in conjunction with their Portuguese subsidiaries. Of the collectively-owned firms active between 2010-2014, 3.5% were classified as foreign-owned (*see table 2*).

### 5.1 Descriptive statistics

Table 2: Descriptive Statistics: 2010-2014

	2010	2011	2012	2013	2014
	<i>A. Profit Variables (Means)</i>				
Pre-tax profit-loss (th. euro)	51.3	11.2	6.4	20.6	23.4
Taxable Income [1] (th. euro)	89.2	45.3	37.6	53.9	59.8
	<i>B. Firm Characteristics (Means)</i>				
Num Employees	8	8	8	7	7
Sales (th. euro)	935	915.1	878.6	852	851.1
Interest & similar earnings (th. euro)	4.1	4.2	7.3	8.6	10.7
Royalties (th. euro)	.22	.23	.24	.32	.25
Supplemental earnings (th. euro)	14.2	13.2	13	13.4	13
Unspecified earnings (th. euro)	6.7	5.7	5.3	4.4	4.3
Deferred tax credits (th. euro)	12.1	11.4	11.7	11.1	9.6
Interest paid & similar losses (th. euro)	23.1	24.9	28	25.9	24.7
Number of firms (th.)	360.3	360.6	353.6	355.7	362.4

Note: Means are reported only for firms organized collectively. Outliers are identified through visual inspection of the data and excluded.

<sup>11</sup>The other type of firm is called “*impresa individual*,” which are firms held by a single individual.

<sup>12</sup>“*país da última unidade de controlo institucional*”

## 5.2 Outcome variables

I first test the results using the variable “pre-tax profit-loss,” as reported in the each firms’ annual account. Since the dataset does not include a variable with each firm’s taxable income, I also construct an approximation of taxable income using the available information to use as a robustness check, which I refer to as “Taxable Income [1]”.

I arrive at the constructed Taxable Income [1] variable using the approach of [Graham and Kim \(2009\)](#), who use this method to look at firms’ taxable income in the United States. The authors test the validity of this specification using information from firms’ tax returns, finding that the results hold. This approach is similar to that used by [Chetty \(2012\)](#) for Denmark, and [Gruber and Saez \(2002\)](#) for the US to simulate personal taxable income from administrative datasets.

I begin with the variable recording firms’ pre-tax profits minus losses. I then add interest and similar earnings, supplemental earnings, earnings from royalties, other unspecified earnings, and deferred tax liabilities. From this total, I subtract interest paid and similar losses and deferred tax credits.

## 6 Results

I use bunching analysis to quantify the response of the universe of Portuguese firms to the biggest discontinuity in the corporate tax code, which occurs at zero. I refine my approach by looking at differences in the mean bunching response at zero by firms’ foreign ownership status and sector of economic activity, defined as follows:

- Foreign-owned firms: ultimate owner in a country that is not Portugal
- Domestic firms: ultimate owner in Portugal
- Sectorally treated firms: in one of the sectors of economic activity targeted by the prior law
- Non-sectorally treated firm: in any other sector of economic activity

This identification strategy helps overcome the difficulty of isolating the tax-related share of the response at zero profits by comparing the bunching response of firms before and after a reform exogenously affecting the cost of evasion in certain sectors of economic activity. Assuming that any other changes during that time period affected treated and non-treated firms equally, bunching at zero by firms in targeted sectors should decrease relative to those in non-targeted sectors after the reform. This would suggest that tax evasion is a component of firms’ reports of zero taxable profits.

To gain additional information about the transmission mechanism of the policy, I also compare responses across domestic and foreign-owned firms, using this as a proxy for differences in the relative ease of evasion in the formal and informal markets. This provides an indirect way of signaling a response in the informal market, an option which is more accessible to domestic than foreign-owned firms.

Pre-treatment characteristics of the firms can be seen in tables [3](#) and [4](#).

Before the reform, foreign-owned firms reported higher profits on average than domestic firms. Additionally, firms in sectors targeted by the 2012 enforcement policy reported lower average profits in the pre-treatment period and in fact reported negative profits. This could be indicative of tax evasion in these sectors, or of particular characteristics of operating in these sectors that reduce profitability to very low levels.

Table 3: Pre-treatment characteristics: by foreign ownership status

Variable	Mean (th. euro)	Std. Dev. (th. euro)	N
Domestic firms			
Taxable Income [1]	22.67	1773.1	710785
Pre-tax profit	5.9	336.89	710956
Foreign-owned firms			
Taxable Income [1]	436.71	6052.24	9594
Pre-tax profit	276	1838.08	9724

Note: Foreign-owned firms were on average more profitable than domestic firms in the pre-treatment period.

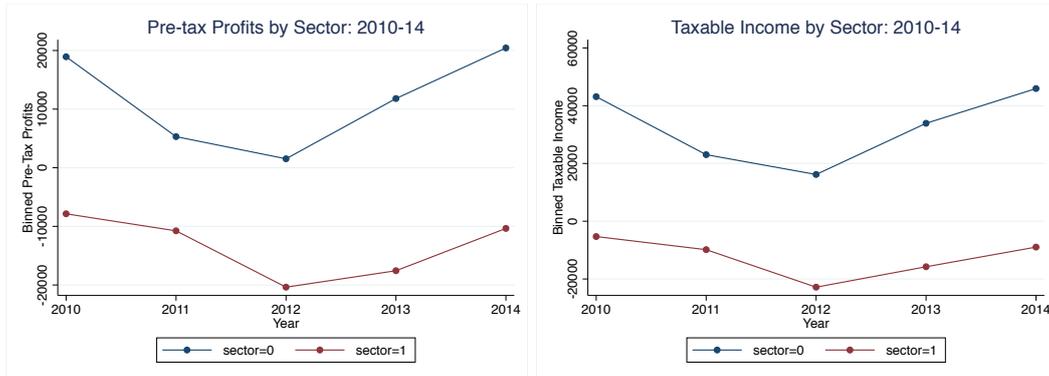
Table 4: Pre-treatment characteristics: by sectoral treatment status

Variable	Mean (th. euro)	Std. Dev. (th. euro)	N
Non-treated firms			
Taxable Income [1]	33.08	2013.57	633593
Pre-tax profit	12.12	417.65	633933
Treated firms			
Taxable Income [1]	-7.59	463.45	86792
Pre-tax profit	-9.32	204.37	86805

Note: Non-treated firms were on average more profitable than treated firms in the pre-treatment period.

To see whether broader economic trends before the reform might have played a factor in differentiating treated and control sectors, confounding any treatment effects, I graphically examined the two variables of interest for the control and treatment groups (*see figure 3*). It appears that the trends across the two groups were generally comparable before the reform.

Figure 3: Common Trends: Control and Treated Firms



Note: Sector=0 designates firms in sectors that were not targeted by the reform, while sector=1 represents the treated firms.

I test for bunching at zero in the two years before the reform was announced (2010-2011) and in the first two years it was in place (2013-2014). I do not test for bunching in 2012, the year the

reform was announced, because of uncertainty in how firms would respond given that the law was passed in the middle of the year to take effect starting in the following year.<sup>13</sup>

I begin by collapsing each variable into bins of 1,000 euros and creating a variable with the frequency in each bin. Each bin contains frequencies of all firms reporting profits greater than or equal to the lower bound and less than the upper bound. This means that firms reporting exactly zero profits will be included in the first bin with value 1,000. I set the upper and lower bounds of the excluded regions using visual inspection of the frequency plots around zero, setting the lower bound where the distribution below zero spikes up from its trend and the upper bound where it dropped again above zero.

Figure 6 shows pre- and post-reform bunching for firms in treated sectors.

The results are reported below, with bunching mass defined as the height of the empirical distribution proportional to the estimated counterfactual.

The magnitude of the bunching response varies depending on the specification used, although the direction of the results remains the same. When looking only at the sectoral treatment, I find that bunching at zero by firms in treated sectors decreases relative to bunching by those in untreated sectors, indicating that the reform reduced the share of bunchers among active firms in treated sectors when compared to untreated sectors. Assuming that larger trends with some impact on bunching would have equally affected treated and untreated sectors, this suggests some causal impact of the policy. It also indicates that firms predominantly experienced the reform as an increase in the cost of evasion on the formal market, as would be expected given the nature of the reform.

Bunching at zero by foreign-owned firms increases in the post-reform time period for both treated and untreated firms, but with a smaller increase for firms in treated sectors. This corresponds to a relative decrease in the mean difference in bunching for foreign-owned treated firms.

Bunching at zero by domestic firms decreases in the years after the reform by both measures, and on average decreases more strongly among targeted firms.

This relative decrease is smaller than that of foreign-owned firms, in line with the predictions of the model. However, this is not necessarily because multinational firms responded more to the policy, but may hide some movement of domestic firms to the informal market, where they can no longer be observed in the dataset.

## 7 Conclusion

The bunching results indicate that many Portuguese firms mis-report their profits as zero. The decrease in bunching by firms targeted by the Portuguese tax authority through the 2012 reform when compared to non-targeted firms suggests that evasion through mis-reporting zero profits drives at least some part of this behavior, and that firms experienced this reform predominantly as an increase in the cost of mis-reporting transactions rather than an increase in the cost of operation on the informal market.

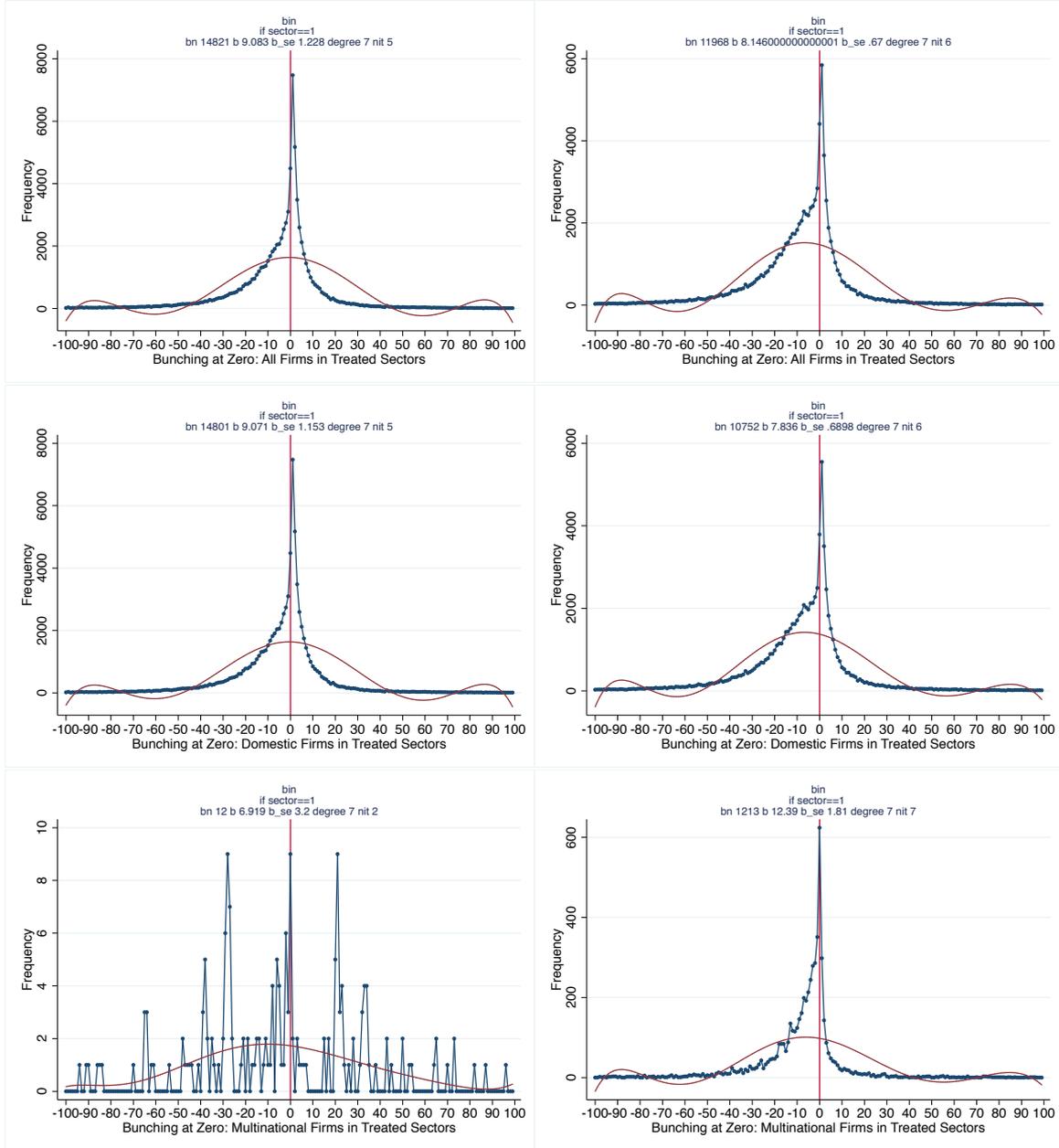
The results also indicate that bunching at zero decreased more for foreign-owned than domestic firms, although this is likely due to some movement of domestic firms to the underground economy.

The next step to expand this research will be to conduct a parallel empirical analysis of how firm exits and entries depend on sector of economic activity and foreign ownership status, to confirm

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<sup>13</sup>In 2014, there was no information on the country of each firm's ultimate owner, so I used firms' multinational status as reported in 2013.

Figure 4: Pre-tax Profits Before and After the Reform



Note: Bunching is shown for firms in treated sectors, as measured by pre-tax profits. Estimated bunching at zero, indicated above each plot by  $b$ , decreases post-reform overall and among domestic firms, while it increases for foreign-owned firms.

Bunching at Zero by Sector		
VARIABLES	(1) Pre-tax net profit	(2) Taxable Income [1]
Treated sectors		
2010-2011	9.083** (1.2)	9.258** (0.439)
2013-2014	8.146** (0.7885)	8.86** (.6251)
Difference	-0.937	-0.398
Non-treated sectors		
2010-2011	8.94** (1.032)	11.05** (0.51)
2013-2014	9.72** (1.189)	11.99** (1.17)
Difference	0.78	0.94
Difference in means	-1.717	-1.338

Note: Bunching is estimated as the excess density of firms in the empirical distribution reporting zero profits relative to the counterfactual. Binwidth is 1,000 euros. Standard errors are obtained through bootstrapping. Estimated bunching at zero decreases by firms in treated relative to non-treated sectors after the reform. This is consistent with an increase in the cost of evasion that is predominantly transmitted as a shock to formal-market evasion, although this could come through bunching firms both moving to the informal market and beginning to report positive profits.

Bunching at Zero by Sector: Foreign-Owned Firms		
VARIABLES	(1) Pre-tax net profit	(2) Taxable Income [1]
Treated sectors		
2010-2011	6.92** (2.37)	5.58* (2.9)
2013-2014	12.39** (1.73)	31.6** (10.17)
Difference	5.47	26.02
Non-treated sectors		
2010-2011	8.15** (2.9)	15.87** (.93)
2013-2014	17.85** (1.84)	45.69** (3.93)
Difference	9.7	29.82
Difference in means	-4.23	-3.8

Note: Bunching is estimated as the excess density of firms in the empirical distribution reporting zero profits relative to the counterfactual. Binwidth is 1,000 euros. Standard errors are obtained through bootstrapping. Estimated bunching at zero increases after the reform in both treated and non-treated sectors. Relative to the control sectors, however, bunching at zero decreases.

Bunching at Zero by Sector: Domestic Firms		
VARIABLES	(1) Pre-tax net profit	(2) Taxable Income [1]
Treated sectors		
2010-2011	9.07** (1.2)	12.4** (1.02)
2013-2014	7.84** (0.65)	8.4** (.55)
Difference	-1.23	-4
Non-treated sectors		
2010-2011	8.89** (1.24)	12.99** (1.17)
2013-2014	9.236** (1.11)	11.42** (1.09)
Difference	0.346	-1.57
Difference in means	-1.576	-2.43

Note: Bunching is estimated as the excess density of firms in the empirical distribution reporting zero profits relative to the counterfactual. Binwidth is 1,000 euros. Standard errors are obtained through bootstrapping. Bunching at zero decreases post-reform for treated firms relative to non-treated firms. The decrease is smaller than for multinational firms, suggesting that there was some response of firms on the informal market, which cannot be observed in the data.

the main transmission channel of the policy. The current empirical strategy does not allow me to make any conclusions about firms in the informal market to test the predictions of the model regarding ghosts. Using newly available entries to the IES dataset from 2015 and 2016, it would be possible to test for anomalously low entry rates or anomalously high exit rates for domestic firms in the sectors affected by the reform, findings which would support the hypothesis that some of the decrease in bunching was driven by movement to the informal. However, a robust identification strategy is needed to exclude other factors that drive exits and entries, particularly if these sectors were affected more than others by the financial crisis.

If tax records for Portuguese firms could be obtained, these would also be useful to test the robustness of the results.

Understanding whether and to what extent firms change their tax evasion strategy to alleviate increases in the effective tax rate they face, or choose the location of different parts of their business to take advantage of geographic discrepancies in tax rates, contributes important policy implications regarding the most efficient corporate tax schedule and the most efficient use of resources by tax authorities charged with combatting evasion.

## 8 Appendix

### 8.1 Pre-tax Profits

Figure 5: Pre-tax Profits Before and After Reform: Domestic Firms

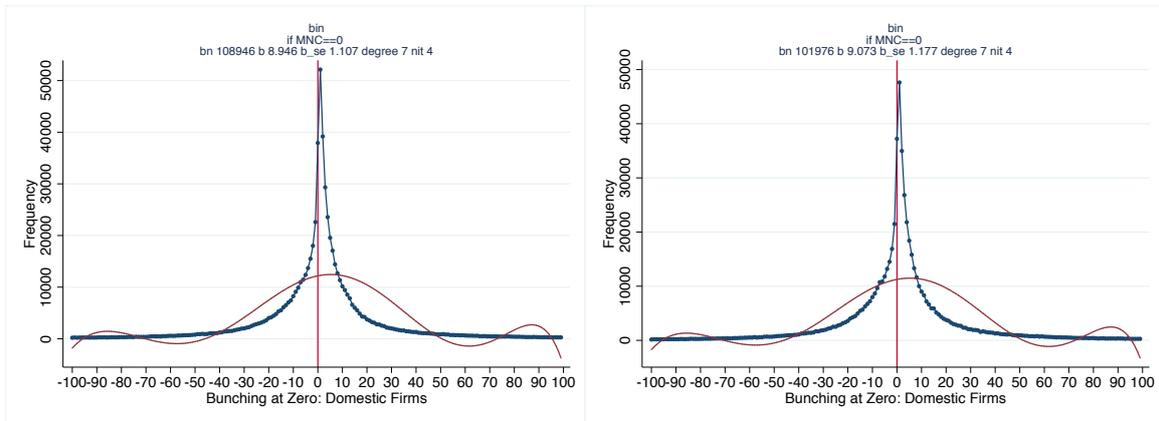


Figure 6: Pre-tax Profits Before and After Reform: Multinational Firms

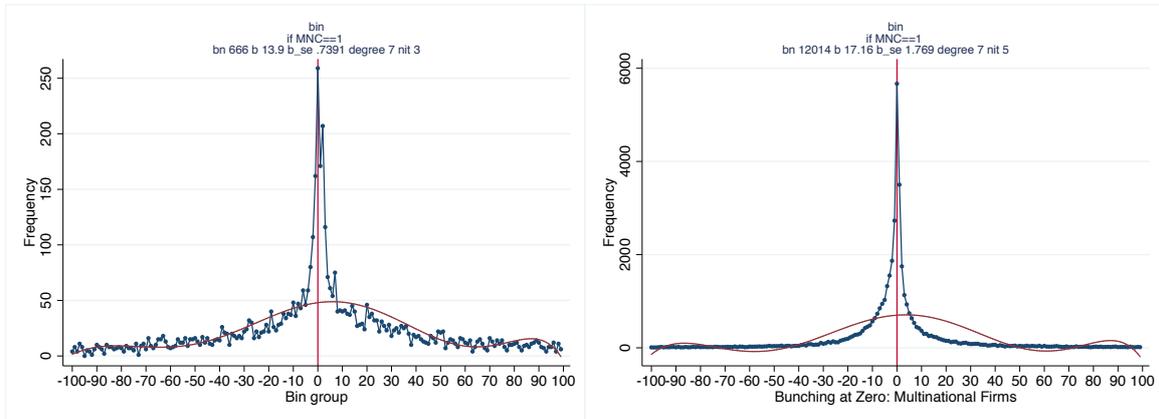


Figure 7: Pre-tax Profits Before and After Reform: All Firms in Untreated Sectors

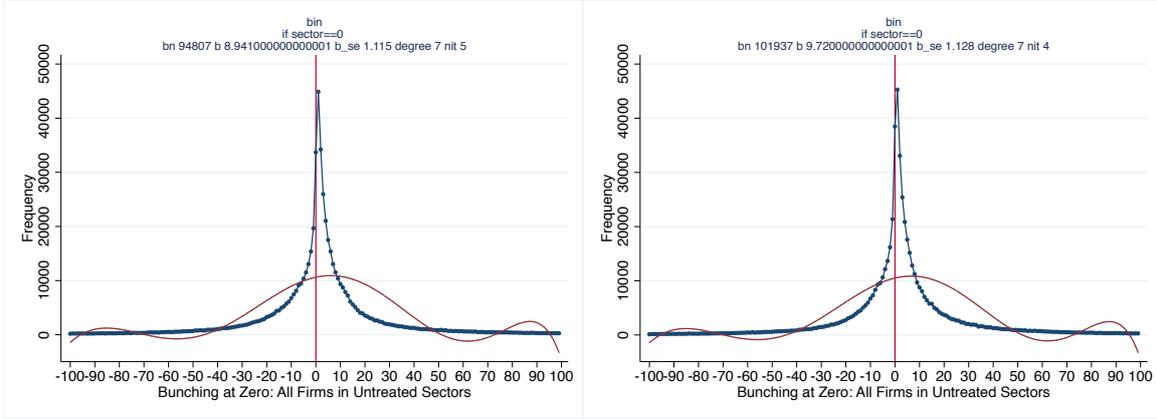


Figure 8: Pre-tax Profits Before and After Reform: All Firms in Treated Sectors

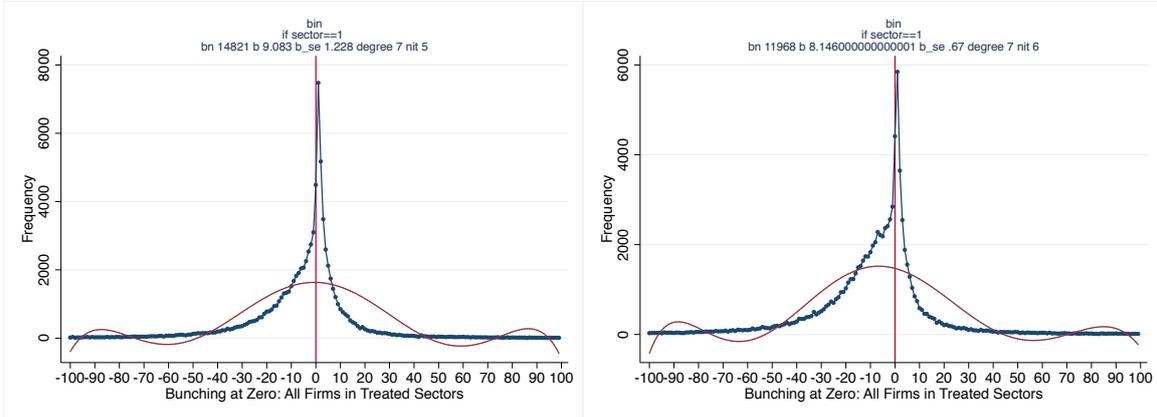


Figure 9: Pre-tax Profits Before and After Reform: Domestic Firms in Untreated Sectors

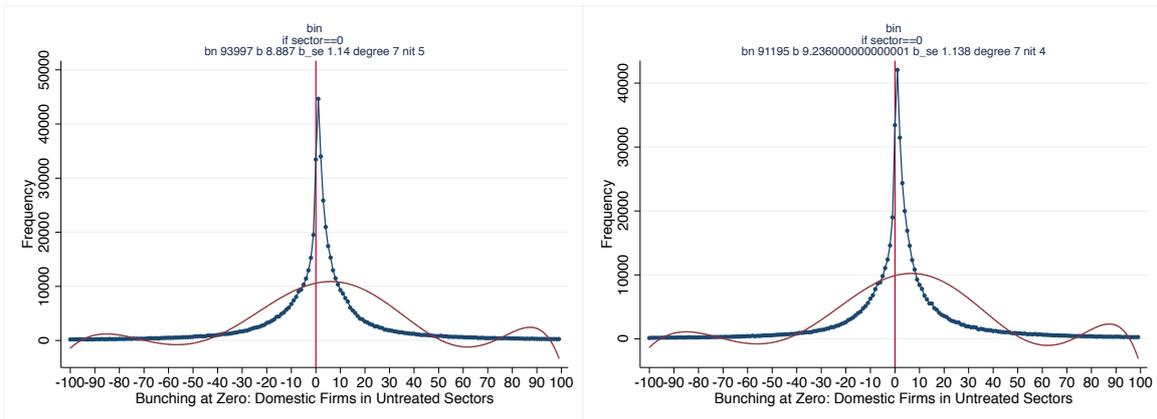


Figure 10: Pre-tax Profits Before and After Reform: Domestic Firms in Treated Sectors

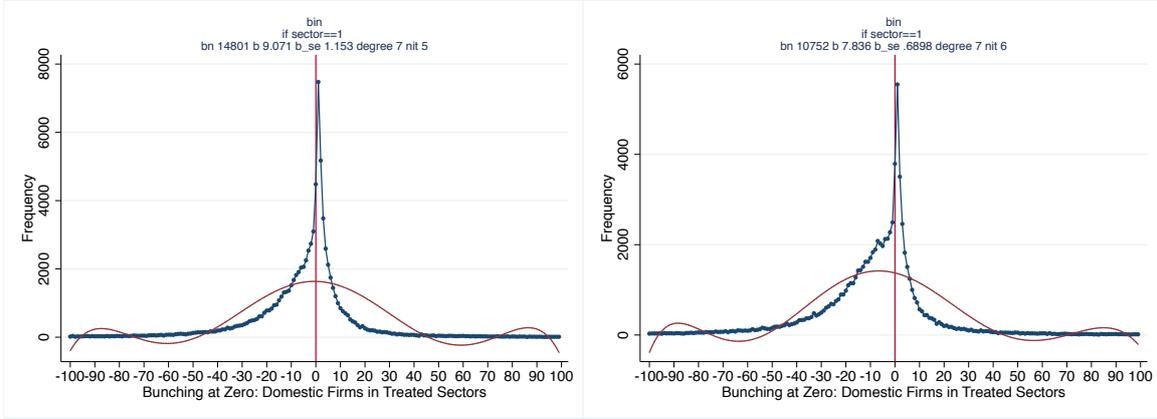


Figure 11: Pre-tax Profits Before and After Reform: Domestic Firms in Untreated Sectors

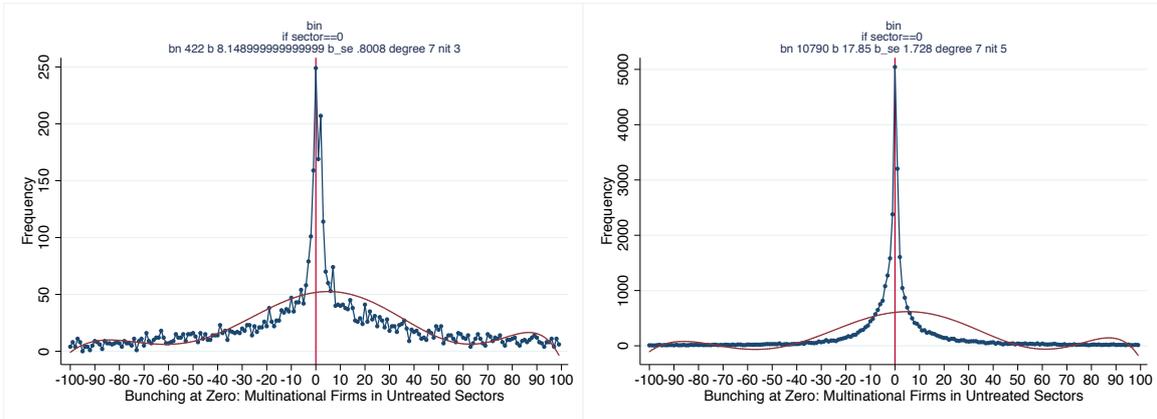
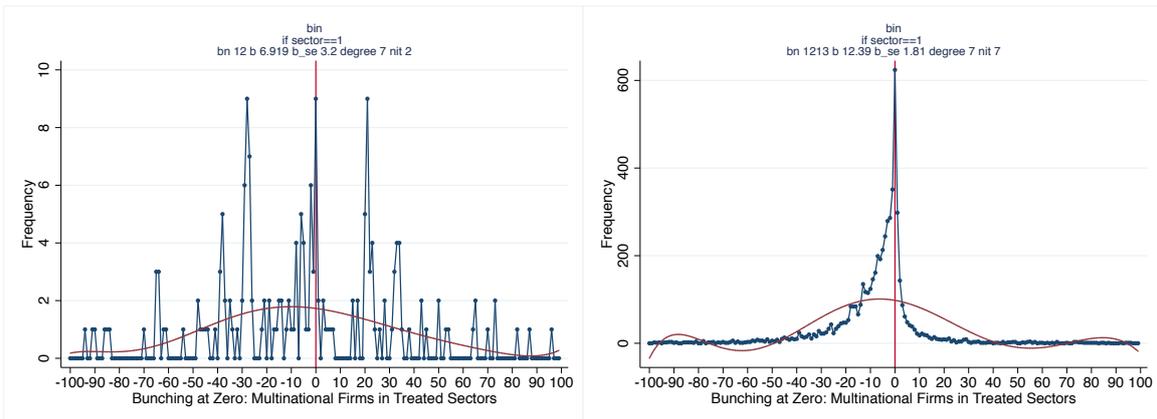


Figure 12: Pre-tax Profits Before and After Reform: Multinational Firms in Treated Sectors



## 8.2 Taxable Income [1]

Figure 13: Taxable Income [1] Before and After Reform: Domestic Firms

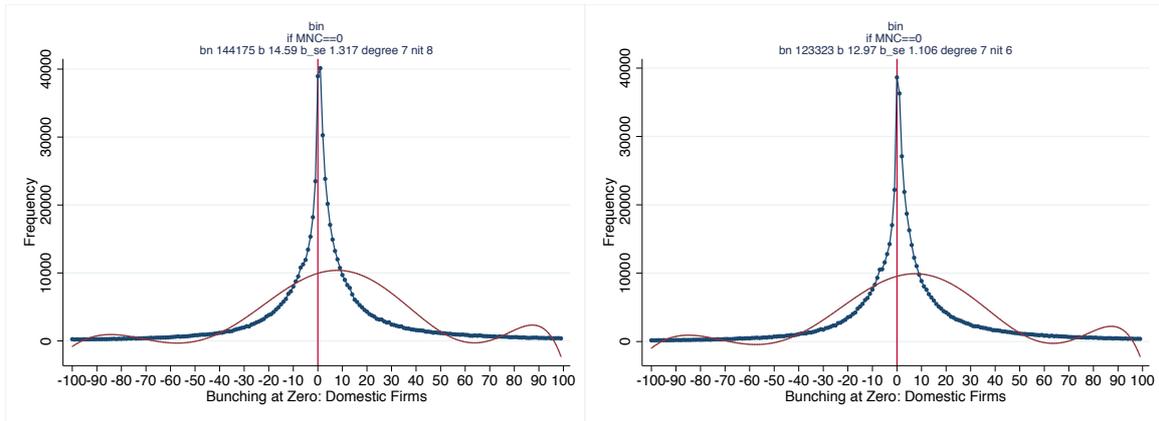


Figure 14: Taxable Income [1] Before and After Reform: Multinational Firms

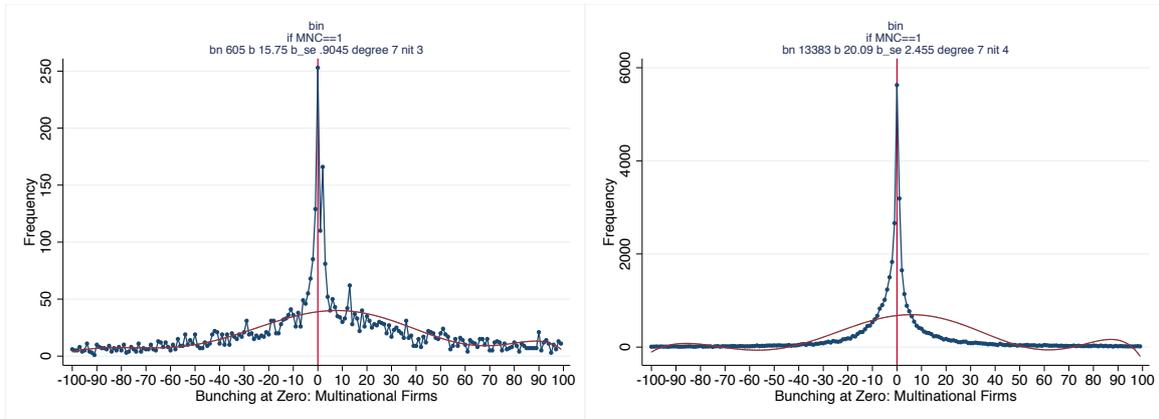


Figure 15: Taxable Income [1] Before and After Reform: All Firms in Untreated Sectors

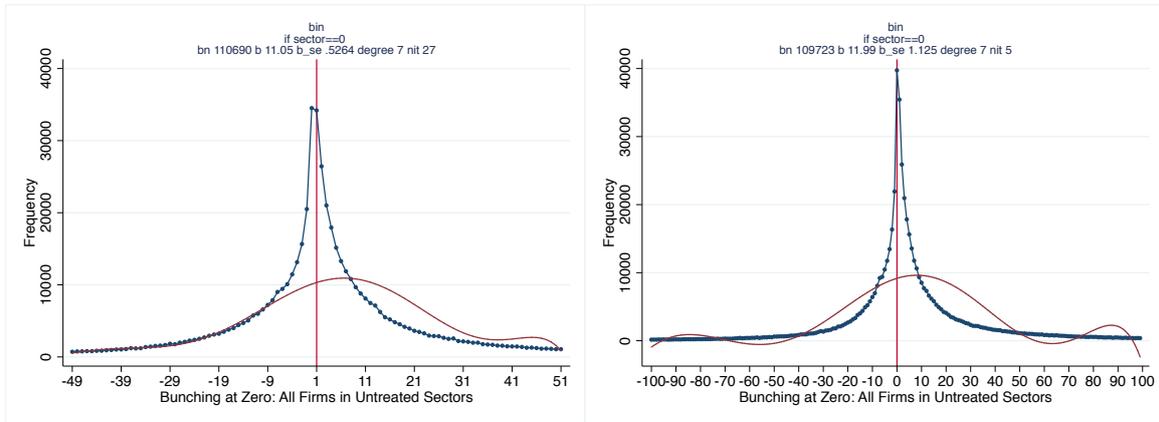


Figure 16: Taxable Income [1] Before and After Reform: All Firms in Treated Sectors

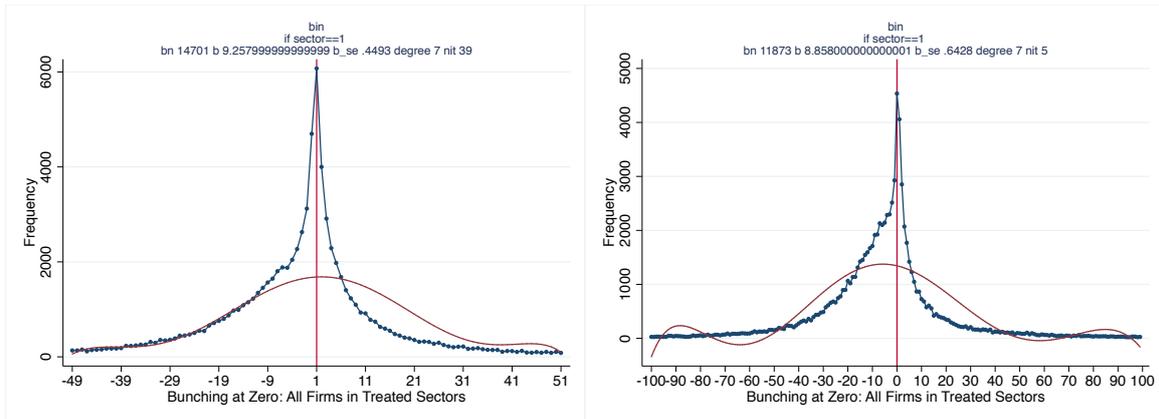


Figure 17: Taxable Income [1] Before and After Reform: Domestic Firms in Untreated Sectors

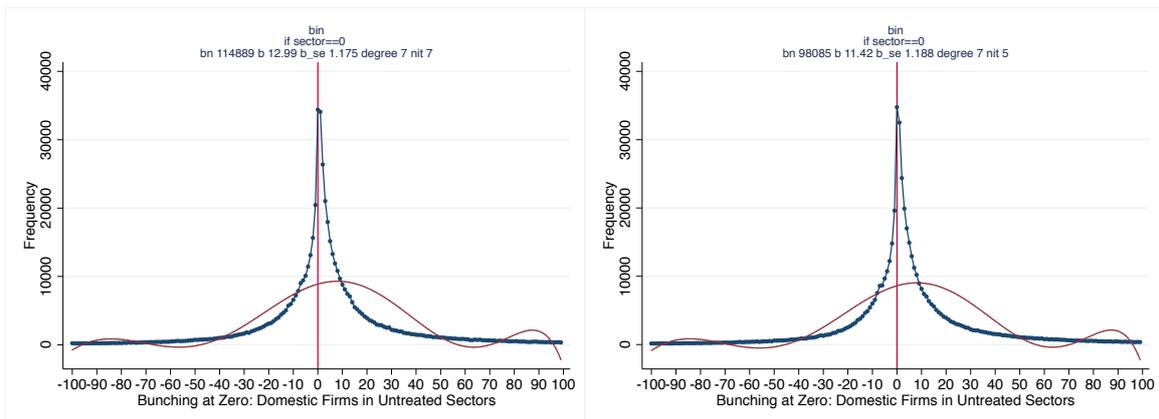


Figure 18: Taxable Income [1] Before and After Reform: Domestic Firms in Treated Sectors

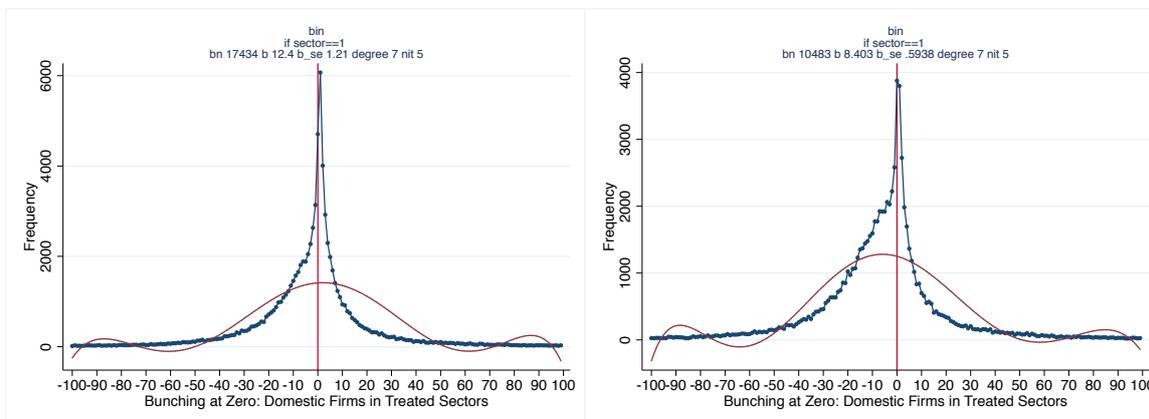


Figure 19: Taxable Income [1] Before and After Reform: Domestic Firms in Untreated Sectors

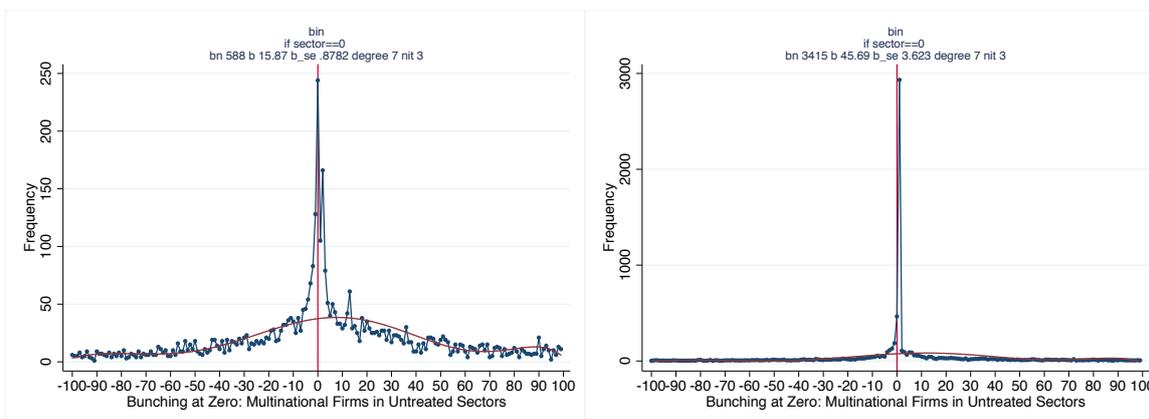
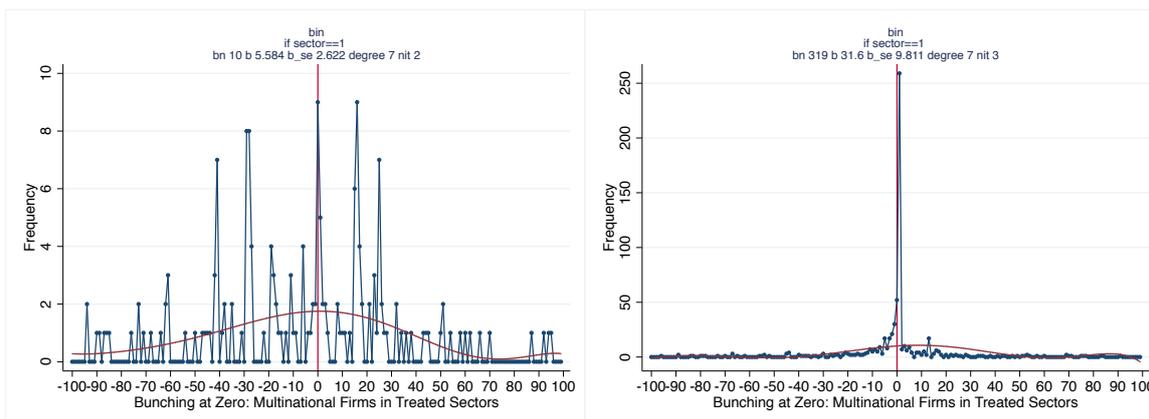


Figure 20: Taxable Income [1] Before and After Reform: Multinational Firms in Treated Sectors



## References

- Almunia, M. U.-B. and Lopez-Rodriguez, D. B. d. E. (2012). The efficiency cost of tax enforcement: evidence from a panel of Spanish firms. (MPRA Paper No. 44153).
- Best, M. C., Brockmeyer, A., Kleven, H. J., Spinnewijn, J., and Waseem, M. (2015). Production vs Revenue Efficiency With Limited Tax Capacity : Theory and Evidence From Pakistan ? *Journal of Political Economy*, 123(6):45.
- Chetty, R. (2012). Bounds on Elasticities With Optimization Frictions: A Synthesis of Micro and Macro Evidence on Labor Supply. *Econometrica*, 80(3):969–1018.
- Chetty, R., Friedman, J. N., Olsen, T., and Pistaferri, L. (2011). Adjustment Costs, Firm Responses, and Micro vs. Macro Labor Supply Elasticities: Evidence from Danish Tax Records. *The Quarterly Journal of Economics*, 126(2):749–804.
- Clausing, K. A. (2003). Tax-motivated transfer pricing and US intrafirm trade prices. *Journal of Public Economics*, 87(9-10):2207–2223.
- Cowell, F. A. and Gordon, J. P. (1995). Auditing with ghosts. *The economics of organised crime*, pages 185–196.
- Dekker, V., Strohmaier, K., and Bosch, N. (2016). A data-driven procedure to determine the bunching window: An application to the netherlands. Technical report, Hohenheim Discussion Papers in Business, Economics and Social Sciences.
- Devereux, M. P., Liu, L., and Loretz, S. (2014). The Elasticity of Corporate Taxable Income: New Evidence from UK Tax Records †. *American Economic Journal: Economic Policy*, 6(2):19–53.
- Dixit, A. (1989). Entry and Exit Decisions under Uncertainty. *Journal of Political Economy* *Journal of Political Economy This*, 97(3):620–638.
- Erard, B. and Ho, C. C. (2001). Searching for ghosts: Who are the nonfilers and how much tax do they owe? *Journal of Public Economics*, 81.
- European Commission, Directorate-General for Economic and Financial Affairs (2011). The economic adjustment programme for portugal.
- Gauthier, B. and Gersovitz, M. (1997). Revenue erosion through exemption and evasion in cameroon, 1993. *Journal of Public economics*, 64(3):407–424.
- Gauthier, B. and Reinikka, R. (2006). Shifting tax burdens through exemptions and evasion: An empirical investigation of uganda. *Journal of African Economies*, 15(3):373–398.
- Gordon, R. and Li, W. (2009). Tax structures in developing countries: Many puzzles and a possible explanation. *Journal of Public Economics*, 93(7-8):855–866.
- Graham, J. R. and Kim, H. (2009). The effects of the length of the tax-loss carryback period on tax receipts and corporate marginal tax rates. Technical report, National Bureau of Economic Research.
- Gruber, J. and Saez, E. (2002). The elasticity of taxable income: evidence and implications. *Journal of public Economics*, 84(1):1–32.

- Harju, J., Matikka, T., and Rauhanen, T. (2015). The Effect of VAT Threshold on the Behavior of Small Businesses: Evidence and Implications. In *CESifo Area Conference on Public Sector Economics*.
- IMF (2014). Imf policy paper: Spillovers in international corporate taxation.
- Keen, M. (2012). Taxation and Development—Again. *IMF Working Paper*, pages 1–30.
- Kleven, H. J. and Waseem, M. (2013). Using Notches to Uncover Optimization Frictions and Structural Elasticities: Theory and Evidence from Pakistan. *The Quarterly Journal of Economics*, (December):669–723.
- Kofman, F. and Lawarree, J. (1996). A prisoner’s dilemma model of collusion deterrence. *Journal of Public Economics*, 59(1):117 – 136.
- Murphy, R. (2014). The £119.4bn Tax Gap: Tax evasion in 2014 - and what can be done about it. page 85.
- OECD (2015). Beps action 11: Improving the analysis of beps - public discussion draft.
- OECD (2016). Revenue statistics - oecd countries: Comparative tables.
- OECD (2017). Fighting tax evasion - OECD.
- PricewaterhouseCoopers (2014). Guia fiscal: Irc.
- Saez, E. (2010a). Do Taxpayers Bunch at Kink Points? *American Economic Journal: Economic Policy*, 2(3):180–212.
- Saez, E. (2010b). Do Taxpayers Bunch at Kink Points? 2(August):180–212.
- Saez, E., Slemrod, J., and Giertz, S. H. (2012). The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A Critical Review. *Journal of Economic Literature*, 50(1):3–50.
- United States Government Accountability Office (2008). U.s. multinational corporations: Effective tax rates are correlated with where income is reported.
- Virmani, A. (1987). INDIRECT TAX EVASION AND PRODUCTION EFFICIENCY.