Firms' (mis)reporting under a minimum tax: Evidence from Guatemalan corporate tax returns

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Abstract

This paper studies firm responses under a minimum tax in the context of a developing country. Minimum taxes are attractive to governments because under such regimes evasion incentives are expected to be lower than under profit taxation, hence increasing tax collection. The specific focus of the present analysis is the Guatemalan corporate income tax regime faced by firms registered in *Regimen Optativo*. This regime features a minimum tax scheme in which firms pay the largest tax liability between a tax on profits and a tax on turnover. Moreover, firms can be exempted from this scheme depending on their reported gross margin, a statistic based on the firms' cost structure. As a result of this complex framework, firms face a tax liability function where two kinks and a firm-specific notch coexist, creating differentiated misreporting incentives. The paper exploits this variation to identify firm behavior consistent with evasion strategies, using bunching analysis. The empirical evidence suggests strong firm responses to the minimum tax and no loss carryforward kinks, as well as to the notch created by the minimum tax exemption rule, most of which seem in accordance with evasion behavior. Upper-bounds for average *reported* profits are estimated to be as low as 42% of *actual* firms' profits, implying an evasion rate of 58% in the absence of the minimum tax scheme. The results presented are consistent with the view that minimum taxes can be an effective mechanism to lower tax evasion in environments with limited enforcement capabilities. The evidence also suggests that exemption rules can play an important role in reducing the effectiveness of minimum tax schemes.

Keywords: Behavioral Responses to Taxation, Bunching, Public Finance, Guatemalan Income Tax.

JEL Codes: H25, H26, O12.

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1. Introduction

It is well documented that, despite similar statutory tax rates, developing countries have relatively low tax revenues in comparison to the developed world. For instance, in 2010 the average tax-to-GDP ratio in low income countries was 13.0%, in contrast with the OECD mean of 35.4%. The difference is particularly striking when comparing income tax collection, which represented 12.9% of GDP in OECD countries, while only reaching 3.5% in low income countries (IMF, 2011). Such a reality points at significant limitations in the ability of developing countries to collect taxes, and several studies have discussed different dimensions of this problem, including informality and tax evasion (e.g. Gordon and Li, 2009; IDB, 2013; Beasly and Persson, 2014).

This paper studies firm behavior under a minimum tax scheme in the context of a developing country. Minimum taxes are a form of taxation that calculates the amount a taxpayer owes using alternative bases (e.g. profits, turnover), levying the largest liability of the two. These schemes are attractive to governments in advanced and developing economies because under such regimes evasion incentives are expected to be lower than under profit taxation, hence increasing tax collection.[2] Until recently, this type of policies was considered suboptimal from a social welfare perspective, due to their distortionary nature. However, new research has shed some light into this issue (Best et al., 2015).

The specific focus of this paper is the Guatemalan corporate income tax regime faced by firms registered in *Regimen Optativo*. This regime features a minimum tax scheme in which firms pay the largest tax liability between a tax on profits and a tax on turnover. As shown in the paper, the kink in the tax liability function created by this policy induces bunching behavior among firms, which allows for the identification of evasion responses (Saez, 2010; Chetty et al., 2011). Moreover, *Regimen Optativo* also features an exemption rule, based on the firm's cost structure, as well as no loss carryforward. The former trait causes a *firm-specific* upward notch in the tax liability function, while the latter generates an

[2] Some examples include Bolivia, Cambodia, Cameroon, Chad, Colombia, Dominican Republic, El Salvador, Gabon, Guatemala, Honduras, Hungary, India, Ivory Coast, Liechtenstein, Madagascar, Mauritius, Nicaragua, Nigeria, Pakistan, Panama, Republic of the Congo, Senegal, Slovakia, South Korea, Tanzania, and the United States. (see Price-Waterhouse-Coopers, 2014).

additional kink, similar to the one provoked by the minimum tax.[3] The differentiated misreporting incentives that arise as a result of these kinks and notch provide helpful variation, which is exploited in the paper to identify behavior consistent with evasion strategies.

The present study contributes to the growing literature focusing on firms' behavior in developing countries in three ways. First, it focuses on the analysis of exemption rules and their impact within the framework of a minimum tax scheme. To the best of the author's knowledge, a systematic approach to this issue has not been attempted in any previous studies. Using previously unexplored Guatemalan administrative data, the empirical analysis demonstrates that firms react strongly to the incentives created by this type of notch, strategically misreporting specific cost categories to become exemption-eligible. Second, this paper provides new empirical evidence in support of the use of minimum taxes as a tool to increase tax revenue. Estimates obtained from bunching analysis suggest that the minimum tax induces firms to reduce misreporting, as a proportion of *reported* profits, by as much as 137%. Third, the paper exploits the no loss carryforward rule of *Regimen Optativo* to derive a method that allows the estimation of upper bounds for the ratio of reported-to-actual profits. According to these calculations, firms report, on average, no more than 42% of their true profits in the absence of the minimum tax scheme. This number implies that evasion arising from profit misreporting would be at least 58% of actual profits if this scheme was not in place. The large estimated rate of evasion is consistent with other estimates found in the literature for developing countries.[4]

The rest of the paper is structured as follows. Section 2 introduces the theoretical model used throughout the analysis. Section 3 provides a description of the Guatemalan income tax and the dataset. Section 4 discusses the methodology which guides the empirical analysis, with results presented in Section 5. Finally, the conclusions of the paper are summarized in Section 6.

[3] In this context, a kink occurs when there is a discontinuous change in the tax rate, but not in the tax liability. Instead, a notch represents a discontinuous change in the level of the tax liability.

[4] For instance, Bachas and Soto (2017) estimate that evasion could be as large as 70% of actual firm profits in the case of Costa Rica. Similarly, Pecho et al. (2012) present estimates of income tax non-compliance in Latin America ranging between 34.5% and 72%.

2. Theoretical Model

This section develops the theoretical framework needed to understand a minimum tax scheme, as well as the implications of introducing an exemption rule into this setup. It starts by separately describing optimal firm behavior under a pure profit tax and a turnover tax. Then, building on those cases, it presents a model where firms face a minimum tax. Finally, the model is expanded to account for the introduction of an exemption rule.

2.1. Profit maximization under a pure profits tax

The basic model used in this paper is an extension of the canonical income tax model (Allingham and Sandmo, 1972) in which firms maximize profits, taking into account a tax liability function, as well as the expected benefits and costs of evasion. The tax liability faced by firms, $T(y, \hat{c})$, depends on output y and reported cost $\hat{c}$.[5, 6] As is common in the literature, the model assumes that firms face total costs $c(y)$ that are a convex function of output; private costs of evasion $h(\hat{c} - c(y))$ that are a convex function of misreported cost; and, as is the case in the developing world, imperfect enforcement.[7] Hence, the firm's problem is,

$$\max_{y,\hat{c}} \; y - c(y) - T(y, \hat{c}) - h(\hat{c} - c(y)). \tag{1}$$

For the case of a pure profits tax with a marginal rate τ_π, the tax liability function becomes $T(y, \hat{c}) = \tau_\pi(y - \hat{c})$. The key feature of such a scheme is that firms can fully deduct costs from their turnover, in order to determine their taxable income. The firm's first order conditions for an interior solution are,

$$c'(y)\left[1 - h'(\hat{c} - c(y))\right] = 1 - \tau_\pi \tag{2}$$

$$h'(\hat{c} - c(y)) = \tau_\pi. \tag{3}$$

[5] The terms output and turnover are used interchangeably in this study. This follows from a normalization of the price level, which simplifies the exposition of the problem.

[6] For simplicity, firms can only misreport cost in this framework. However, the model can be extended to account for turnover misreporting without changing the basic results presented in this section. See the appendix for a model with such a representation.

[7] The choice of the private costs of evasion as a convex function of misreported cost, $h(\hat{c} - c(y))$, mirrors the typical penalty structure observed in many tax systems around the world. Moreover, it also replicates the penalty structure of the Guatemalan tax system, which will be the subject of analysis in the empirical section.

Optimal evasion is governed by equation (3), which indicates that firms will engage in tax evasion by misreporting costs, up to the point where the marginal cost of doing so equals the tax rate.[8] Furthermore, in this simplified model, combining equations (2) and (3) yields,

$$c'(y) = 1. \tag{4}$$

This condition implies that a pure profits tax is non-distortionary, since the determination of the optimal output level is independent of the tax rate.[9] Therefore, under this scheme, if the government decides to increase the tax rate, firms will react by adjusting their level of cost misreporting, $\hat{c} - c(y)$, without altering their output decision. In other words, any observed behavioral response would map directly to a change in the firm's evasion pattern, as there is no real (i.e. output) response in this framework.

2.2. Profit maximization under a turnover tax

An alternative approach to profits taxation often observed in developing countries is turnover taxation. The main difference with the pure profits tax setting is that this type of taxation does not allow for costs deduction. In this context, the tax liability function takes the form $T(y, \hat{c}) = \tau_y y$, where τ_y represents the tax rate on turnover. The first order conditions for an interior solution to this problem are,

$$c'(y)\left[1 - h'\left(\hat{c} - c(y)\right)\right] = 1 - \tau_y \tag{5}$$

$$h'\left(\hat{c} - c(y)\right) = 0, \tag{6}$$

which together imply,

$$c'(y) = 1 - \tau_y. \tag{7}$$

Contrary to the pure profits tax, a turnover tax has a distortionary effect, as equation (7) relates the optimal output level to the tax rate. As a consequence, a firm under this tax regime will produce

[8] The dependence of the level of misreporting on the tax rate relies on the specification of $h\left(\hat{c} - c(y)\right)$, as discussed in the literature (Yitzhaki, 1974; Cremer and Gahvari, 1994; Slemrod and Yitzhaki, 2002). The result in equation (3) is consistent with a setting in which the probability of detection is an increasing function of the evaded amount. It is also consistent with a scenario in which there are variable costs of evasion on top of the expected penalty incurred if caught by the tax authority.

[9] The characterization of a profit tax as non-distortionary is used for tractability. However, this is not in agreement with the empirical evidence. See Auerbach et al. (2008) for an example of this literature.

less output than under a profit tax. Moreover, the firm will not engage in tax evasion via cost misreporting, as the marginal benefit of this action would be zero.[10]

2.3. Profit maximization under a minimum tax

The previous two cases serve as the foundation for the analysis of firm behavior under a minimum tax scheme (MTS). These types of schemes find their rationale in the fact that firms have no incentives to misreport costs whenever they face a turnover tax, hence, reducing evasion.[11]

A typical minimum income tax liability function has the form,[12]

$$T(y, \hat{c}) = \max \ \{\tau_\pi(y - \hat{c}), \tau_y y\}. \tag{8}$$

Equation (8) indicates that a firm faces the largest tax liability between a profit tax and a turnover tax. For a given combination of output and reported cost, $(y, \hat{c})$, the two liabilities are equal when,

$$\tau_\pi(y - \hat{c}) = \tau_y y \qquad \Leftrightarrow \qquad \hat{p} \equiv \frac{(y-\hat{c})}{y} = \frac{\tau_y}{\tau_\pi}. \tag{9}$$

Here, $\hat{p}$ is known as the reported (pre-tax) profit margin. The value τ_y/τ_π –referred to as the MTS *payment* threshold, from this point onwards– defines which tax liability is higher. Firms reporting a profit margin lower than the MTS payment threshold face a turnover tax, while those reporting a larger profit margin are required to pay a tax on profits. This means that the incentives for a profit-maximizing firm change depending on whether it locates to the left or the right of the MTS payment threshold. Figure 1 provides a graphical representation of how a minimum tax scheme works.

In order to have a better understanding of how firm behavior is affected by a minimum tax, let us suppose that we start in a scenario with a pure profit tax. Under this regime, a firm with a reported profit margin below the MTS threshold would locate on the profit tax liability function (dashed line), as

[10] In this model, the possibility of turnover misreporting is ignored for simplicity. See the appendix for a model that incorporates this margin of evasion. The main results are unchanged, as turnover misreporting also decreases with respect to its level under a profit tax, as long as the tax rate on turnover is lower than the tax rate on profits.

[11] The cost of reducing evasion using a minimum tax comes from the distortion to production incentives. Nonetheless, Best et al. (2015) show that minimum taxes can be more socially efficient than profit taxes in environments with low enforcement.

[12] Examples of this type of tax liability function are provided by Best et al. (2015) for the case of Pakistan, and Mosberger (2016) for the case of Hungary. In the empirical section, the Guatemalan corporate tax regime will be added to this list, but there are many other similar schemes around the world.

shown by point A in Figure 2.[13] At that point, there is no tax distortion to output and evasion is positive, in line with equations (3) and (4). If the tax regime suddenly changed to a minimum tax scheme, the firm would face a higher tax liability. Before accounting for any response, the firm would find itself at point B in the figure. However, given the new tax incentives, the firm will respond by decreasing output and reducing evasion, in accordance with equations (6) and (7). As a result, the firm's reported profit margin will increase, and the firm will locate at point C.[14] In aggregate, firms' responses will create bunching in the density distribution at the MTS threshold, as illustrated in Panel (b) of Figure 2.

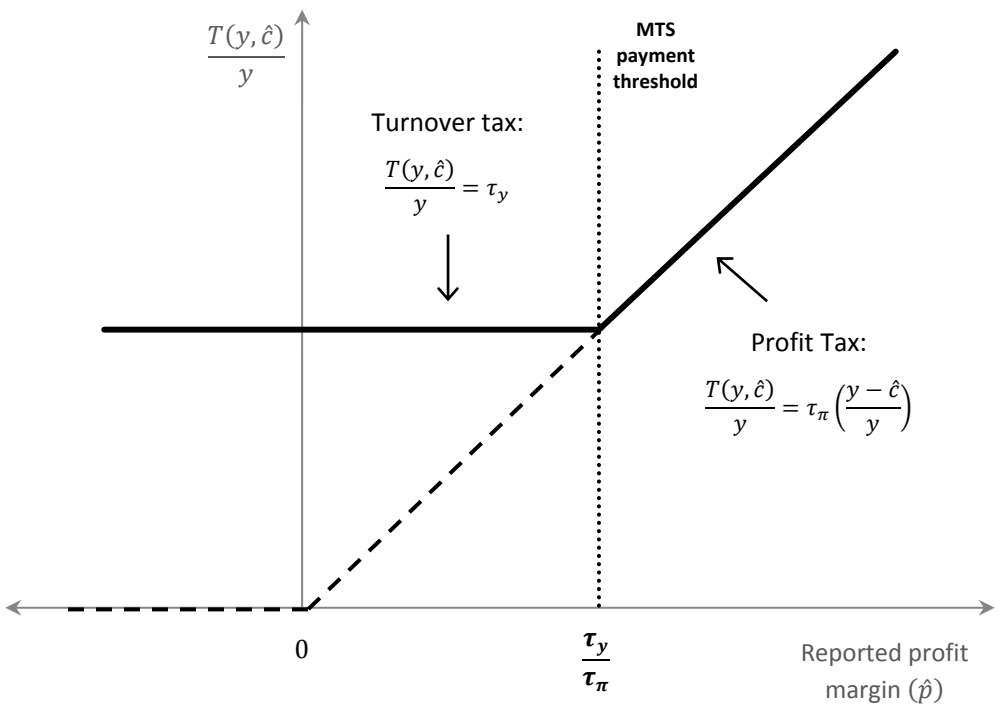
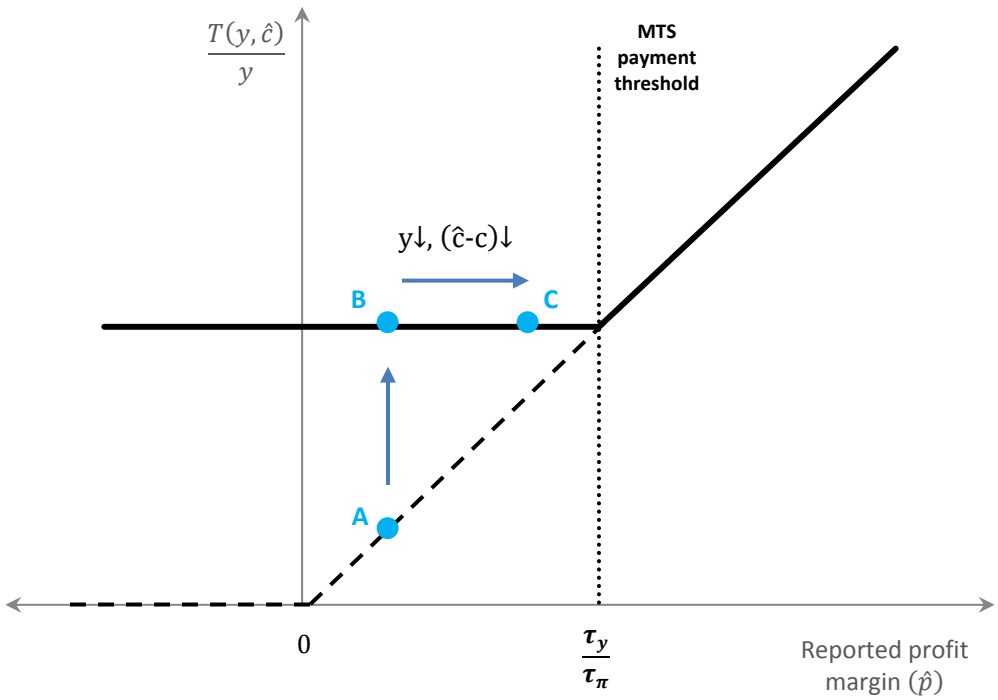


Figure 1 – Income tax liability function under a minimum tax scheme. The figure illustrates the implications of introducing a minimum tax on the income tax liability function, expressed as a proportion of turnover, y. The dashed line shows what the tax liability would have been under a pure profits tax (assuming no loss carryforward); the solid line corresponds to the tax liability under the minimum tax scheme. Firms with a reported profit margin, $\hat{p} \equiv \frac{y-\hat{c}}{y}$, above the threshold $\frac{\tau_y}{\tau_\pi}$ face a tax rate τ_π on reported profits. Instead, firms with a reported profit margin below the threshold pay a tax rate τ_y on turnover. As a result, the conditions that characterize firm behavior change depending on which side of the threshold the firm is located.

[13] Throughout this paper, the term "tax liability function" may also be used (imprecisely, admittedly) to refer to the function $T(y,\hat{c})/y$. This is mainly done so when describing the tax liability function as a proportion of turnover in the different figures presented in the study.

[14] The reported profit margin can be written as $\hat{p} = \frac{y-c(y)}{y} - \frac{\hat{c}-c(y)}{y}$. The first term corresponds to the firm's "true" profit margin and is decreasing in output under the assumption of decreasing returns to scale. The second term captures the evasion component and is increasing in misreported cost. Thus, if a firm reduces both its output and misreported cost, its reported profit margin will increase.

Panel (a) – Tax liability functions and firm behavior



Panel (b) – Density distributions and bunching

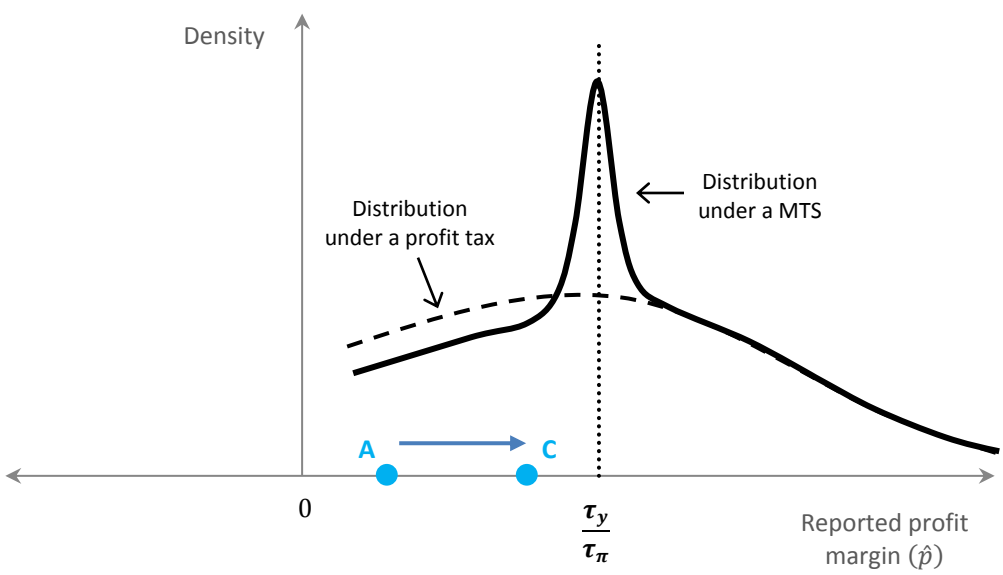


Figure 2 – Firm behavior and bunching when switching from a profit tax to a minimum tax scheme. Point A depicts a firm facing a profit tax, with an initial reported profit margin below the MTS payment threshold. When a minimum tax scheme is introduced, the firm suddenly finds itself at point B, where the initial reported profit margin does not reflect the firm's optimal choices any longer. Under the new tax incentives, the firm responds by reducing both its output and misreported cost. The firm's new optimal choice is illustrated by point C, where the reported profit margin moves closer to the MTS payment threshold, causing bunching in the density distribution.

Contrary to the case shown in Figure 2, firms with an initial reported profit margin above the MTS payment threshold will not show any behavioral response. This is because their incentives remain unchanged after the introduction of the minimum tax scheme. Thus, under the new regime, the overall tax revenue gains from lower evasion, as well as the efficiency costs from distorting production, are all coming from firms with an initial reported profit margin below the MTS payment threshold.

2.4. Implications of adding an exemption rule to the MTS

An implicit assumption of the minimum tax framework developed above is that all firms are required to pay the minimum tax, provided that their profit margin lies below the MTS payment threshold. However, in practice, it is not uncommon to find schemes that exempt a group of firms from facing the minimum tax. As it is shown below, accounting for exemption rules is important because of their effect on tax incentives. When an exemption rule is available, firms take into consideration their eligibility prospects at the time of making output and evasion decisions.

The previous model can be expanded to account for the effects of an exemption rule. Let θ be a binary parameter that defines whether a firm is exempt or not, with $\theta = 1$ if the firm is eligible for a minimum tax exemption, and $\theta = 0$ if the firm is non-exempt. The tax liability function under this scheme is,

$$T(y, \hat{c}) = \theta\tau_\pi(y - \hat{c}) + (1 - \theta) \max \ \{\tau_\pi(y - \hat{c}), \tau_y y\}. \tag{10}$$

Equation (10) is equivalent to equation (8) whenever a firm is non-exempt, and it reverts into a pure profits tax if a firm is exempt.

In order to fully appreciate the implications of the new setup on the tax liability function, it is convenient to consider different specifications of this exemption rule. The next subsections will analyze two broad categories of exemption rules, which create a notch in the tax liability function.

2.4.1. Exemption rules that create an upward notch in the tax liability function

Suppose, for simplicity, that the government defines the exemption rule according to the following condition,

$$\theta \equiv \begin{cases} 0, & \frac{y-\hat{c}}{y} > \varphi \\ 1, & \frac{y-\hat{c}}{y} \leq \varphi. \end{cases} \tag{11}$$

This definition indicates that firms are exempt if their profit margin is less or equal to an exogenous value φ –the MTS *exemption* threshold–, but are non-exempt otherwise.[15]

It is useful to point out that equation (11) provides a condition that is similar in nature to equation (9), insofar it relates the MTS exemption threshold to the profit margin.[16] However, both conditions differ in a fundamental manner. One way to think about the separate roles of the MTS exemption and payment thresholds is to view the former as a parameter defining the *intention to treat*, and the latter as the *actual treatment* determinant. For instance, a firm with a reported profit margin above the MTS exemption threshold will be non-exempt, but it will only pay the minimum tax if its profit margin is below the MTS payment threshold. On the other hand, a firm with a reported profit margin below the MTS exemption threshold is, by definition, exempt, which means it is not subject to pay the minimum tax, independently of whether its profit margin lies above or below the MTS payment threshold.

Figure 3 illustrates the consequences of such an exemption rule on the shape of the tax liability function. There are two cases to consider, each depending on how the MTS exemption threshold relates to the MTS payment threshold. Panel (a) shows that when $\varphi \geq \frac{\tau_y}{\tau_\pi}$ the tax liability function reverts to that of a pure profits tax. This occurs because all firms that would be subject to pay the minimum tax are exempt from doing so, rendering the MTS payment threshold irrelevant.[17] The second case arises when $\varphi < \frac{\tau_y}{\tau_\pi}$ and is depicted in panel (b). In this situation, there is an upward notch in the tax liability function exactly at the MTS exemption threshold. Firms with a profit margin below φ avoid the minimum tax, but those with a higher profit margin must pay it if they also lie to the left of the MTS payment threshold.

Clearly, in both cases the existence of an exemption rule has important implications on the impact of a minimum tax scheme on firm behavior. For instance, a firm facing the tax liability function in panel (a) will not have incentives to bunch at the MTS payment threshold. However, if it faces the tax

[15] The specification of this exemption rule is based on a simplified version of the Guatemalan case, which is analyzed in the empirical section.

[16] The use of the profit margin in equation (11) to define the exemption rule is deliberate. In practice, these rules may not be stated in terms of the profit margin. However, the basic results of this section remain the same, as long as there is a mapping between the statistic that defines the exemption rule and the profit margin.

[17] In this highly stylized framework, this case seems trivial, as no government would create an exemption rule that effectively dismantles their minimum tax scheme. However, in practice, the MTS exemption threshold can be firm-specific, when considered in terms of the profit margin. The Guatemalan minimum tax scheme analyzed in the empirical section provides an example where this is the case.

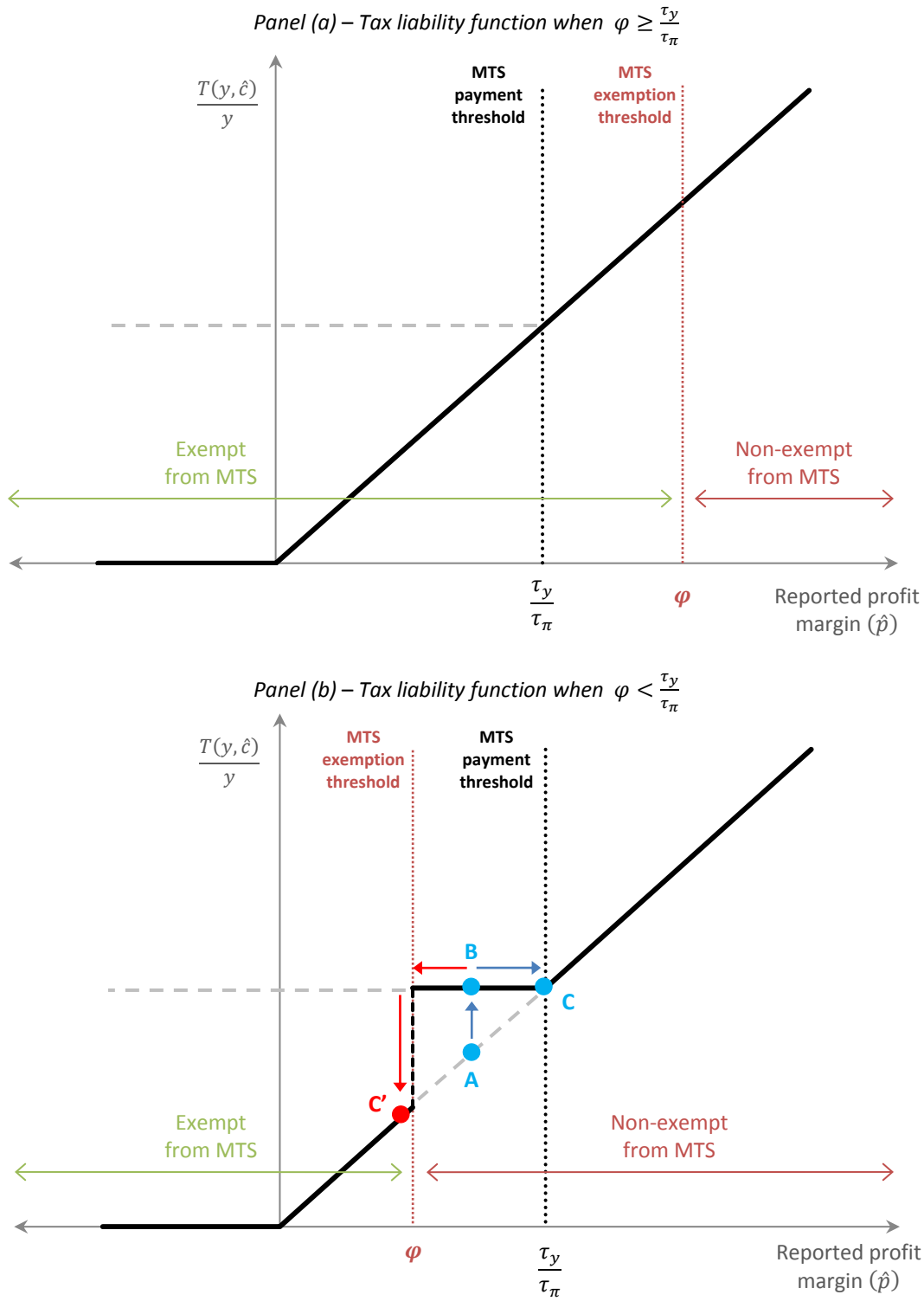


Figure 3 – Implications of exemption rules that create an upward notch. In the above graphs, firms' exemption from a minimum tax scheme is dictated by the parameter φ. To the left of φ firms are exempt and, hence, the tax function corresponds to that of a pure profit tax. Instead, to the right of φ firms are non-exempt, resulting in a tax function akin to that of Figure 1. Panel (a) illustrates the case where φ effectively eliminates the MTS, while panel (b) shows the case where it creates an upward notch at the MTS exemption threshold. In contrast to the environment in Figure 2, a firm in panel (b) can now choose to move from points A to C, or from points A to C'.

liability function in panel (b), the firm will evaluate its best alternative –that which maximizes after-tax profits– between two options. The first one is to respond to the kink at the MTS payment threshold, in which case the firm will follow the path from points A to C, increasing its reported profit margin. A firm choosing this path will bunch at the MTS payment threshold in the same fashion as in Figure 2. The second alternative is to respond to the notch at the MTS exemption threshold. If it chooses to do so, the firm will adjust its output and evasion choices so that its reported profit margin drops to point C', where the firm is now exempt from paying the minimum tax. In this latter case, firms will bunch to the left of the MTS exemption threshold.[18]

2.4.2. Exemption rules that create a downward notch in the tax liability function

Now, let us consider an alternative case, where the government inverts the exempt and non-exempt groups by defining the rule as follows,

$$\theta = \begin{cases} 0, & \frac{y-\hat{c}}{y} < \varphi \\ 1, & \frac{y-\hat{c}}{y} \geq \varphi. \end{cases} \tag{12}$$

Contrary to (11), in this setting firms are exempt from the minimum tax scheme if their profit margin is greater or equal to the MTS exemption threshold, φ, but remain non-exempt otherwise.[19] The implications of this simple change in the eligibility rule are presented in Figure 4.

As in the case of the previous subsection, there are two cases to consider. Panel (a) shows that when $\varphi \geq \frac{\tau_y}{\tau_\pi}$ the MTS tax liability function remains unaffected by the exemption rule. This is because all the exempt firms are to the right of the MTS payment threshold, meaning that they did not have to pay the minimum tax even in the absence of the exemption rule.[20] Panel (b) presents the case when $\varphi < \frac{\tau_y}{\tau_\pi}$. In this scenario, there is a downward notch in the tax liability function exactly at the MTS exemption threshold. Firms with a reported profit margin below φ are non-exempt and face the minimum tax, but those with a higher profit margin are exempt. While firms in panel (a) have incentives

[18] For cases where the MTS exemption threshold is firm-specific in terms of the reported profit-margin, as in the empirical section, this bunching will not be evident in the corresponding density distribution. This occurs because every firm faces the notch at a different value of the profit margin.

[19] This specification is based on a simplified version of the Hungarian case, which is analyzed by Mosberger (2016).

[20] As was the case of panel (a) in Figure 3, this seems trivial, as no government would be expected to implement an exemption rule that has no relevance. Nevertheless, this can occur inadvertently for some firms if the MTS exemption threshold is firm-specific, when expressed in terms of the profit margin. The Hungarian exemption rule to their minimum tax scheme provides an example of such a setup.

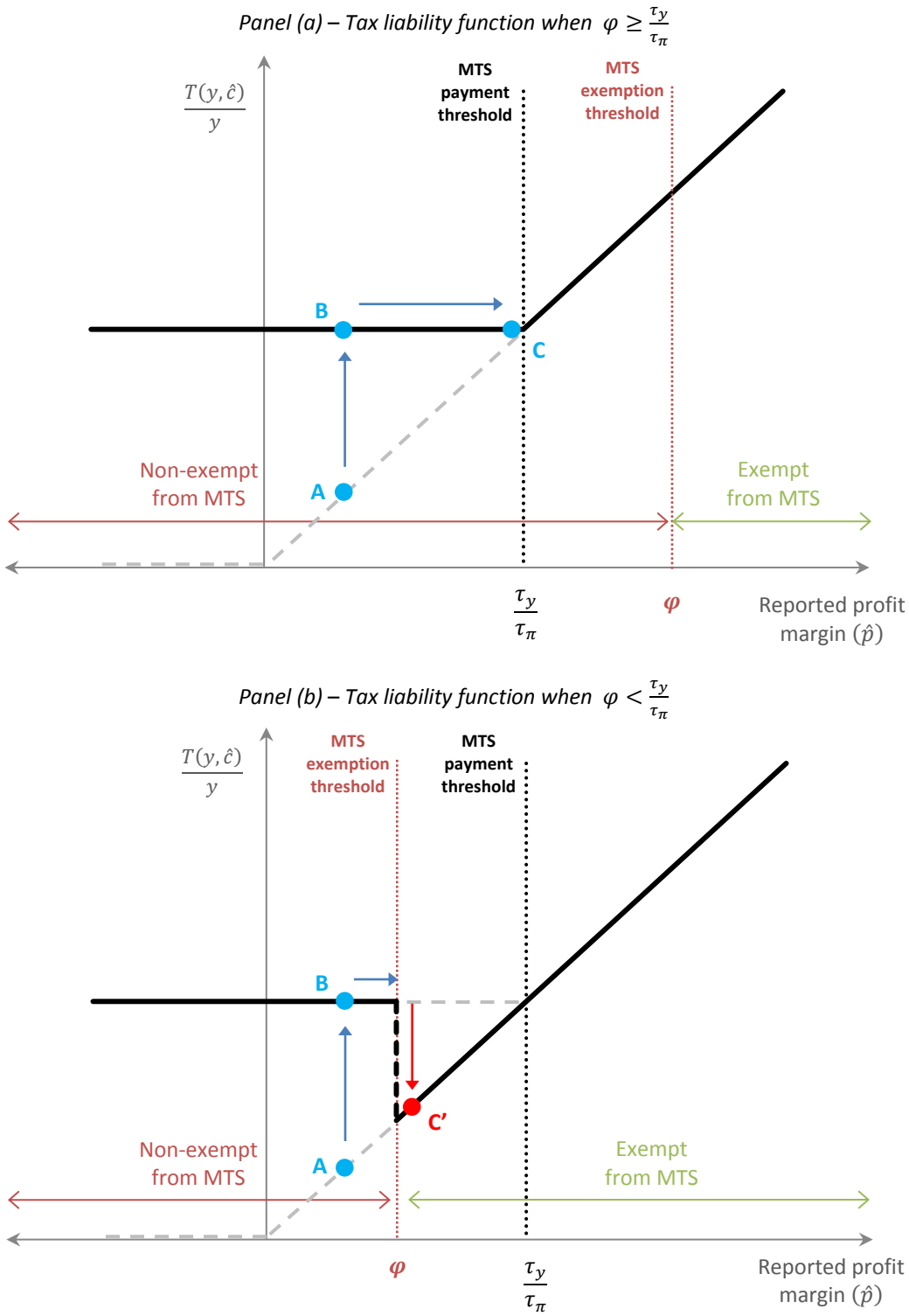


Figure 4 – Implications of exemption rules that create a downward notch. Firms' exemption from the minimum tax scheme is defined by the parameter φ. Firms with a reported profit margin below φ are non-exempt and, thus, face a tax function identical to that of Figure 1. Instead, firms to the right of φ are exempt, facing a tax function that corresponds to a pure profit tax. Panel (a) illustrates the case where φ has no impact on the MTS tax liability function; firms in this setting behave as in Figure 2, moving from points A to C. Panel (b) shows the case where a downward notch is created; firms respond to the new tax incentives by moving from points A to C'.

to bunch at the MTS payment threshold, moving from points A to C, those in panel (b) face incentives to bunch at the MTS exemption threshold, repositioning from points A to C'.

3. Context and Data

3.1. Guatemalan income tax and minimum tax scheme

As mentioned earlier in this study, one of the reasons why the analysis of taxpayer behavior is important for developing countries is their persistently low tax revenues. Guatemala represents an example of this reality. With a tax-to-GDP ratio averaging 11% in recent years –of which income tax is only about 2% of GDP–, the difficulties surrounding tax collection are a central aspect of the country's fiscal policy. Evasion levels are believed to be high, given the legal and financial limitations of the tax authority, with some estimates placing the rates of noncompliance for income tax and VAT around 40% and 35%, respectively (ICEFI, 2015).

Guatemala's corporate income tax law allows taxpayers to choose between two schemes, *Regimen General* and *Regimen Optativo*, with the former being a tax on turnover and the latter a tax on profits with a minimum tax (i.e. a minimum tax scheme of the type shown in section 2). According to data from *Superintendencia de Administración Tributaria* (SAT), Guatemala's tax authority, approximately 60% of corporate income tax is collected from *Regimen Optativo* (Franco, 2011).

In this paper, the analysis is restricted to firms filing under *Regimen Optativo*. In this regime, firms must pay a tax on profits, with a marginal rate of 31%, if their reported profit margin is at least 3% of reported turnover. Firms reporting a profit margin below this threshold, pay a minimum tax equivalent to 0.93% of their turnover.[21] Additionally, there is an exemption rule based on a firm's reported *gross margin*, a measure that subtracts the direct cost of goods sold (COGS) from turnover but does not consider the costs of services sold.[22] Firms with a gross margin larger than 4% of turnover are non-exempt, while firms with a lower gross margin are eligible to claim the exemption. In order to fully

[21] The tax rate on profits and the minimum tax changed after 2012, following a tax reform. The data used in this analysis is unaffected by these adjustments, as it does not cover the post-reform period.

[22] The gross margin is regarded as a measure of how a firm's *production costs* relate to its turnover. The cost of goods sold (COGS) refers to the direct costs attributable to the production of the goods sold by a company. This amount includes the cost of the materials used in creating the good along with the direct labor costs used to produce the good. It excludes indirect expenses such as distribution costs and sales force costs.

obtain the exemption, qualified firms must also submit a series of legal and accounting documents at least two months before the filing deadline for annual income tax returns.[23]

Finally, it is important to remark that Guatemala's corporate income tax regimes do not allow loss-carryforward. Table 1 summarizes the main features of corporate income taxation under *Regimen Optativo*.

Table 1 – Corporate Income Tax Rates and Tax Bases under *Regimen Optativo*

	Firms reporting losses	**Firms reporting profits**	
	$0\% > \hat{p}$	$3\% > \hat{p} \geq 0\%$	$\hat{p} \geq 3\%$
Non-exempt $\hat{g} > 4\%$	0.93% of reported turnover and no loss carryforward	0.93% of reported turnover	31% of reported profits
Exempt $4\% \geq \hat{g}$	0% of reported profits and no loss carryforward	31% of reported profits	31% of reported profits

Notes: $\hat{p}$ denotes a firm's reported *profit* margin; $\hat{g}$ indicates a firm's reported *gross* margin.

3.2. Data

The data used in this paper comes from a novel panel database of Guatemalan tax administrative records. This dataset contains the universe of corporate income tax returns filed annually under *Regimen Optativo* for the years 2006 to 2012. Since the units of analysis in this paper are all firms filing in this regime, individual taxpayers are not considered in the sample.

Consistency checks were carried out to ensure basic reliability of the data, which resulted in some observations being dropped. Firms reporting revenues from exports are not considered due to the impossibility to distinguish which of them are eligible for income tax exemption under Guatemalan tax law.[24] The total number of observation points remaining after filtering is 133,122, which corresponds

[23] Among the required documentation, firms must submit an affidavit and externally-audited financial statements.
[24] Exporting firms were, on average, approximately 2,000 per year, for a total of 13,529 observations.

to an average of about 19,000 firms per year. Table 2 provides summary statistics for the final sample under analysis.

Table 2 – Summary Statistics for Firms under *Regimen Optativo*

Indicator	Full Sample	2006	2007	2008	2009	2010	2011	2012
	A. Means (in millions of Quetzales)							
Profits	0.3	0.4	0.3	0.3	0.2	0.3	0.4	0.3
Turnover	10.1	8.3	10.0	9.8	9.7	9.9	10.9	11.6
Total Costs	9.7	7.9	9.6	9.5	9.5	9.6	10.6	11.3
COGS	6.0	4.8	6.2	5.9	5.7	5.8	6.4	6.8
Profit Margin	-1.2%	-0.1%	-0.5%	-1.4%	-1.7%	-1.8%	-1.3%	-1.5%
Gross Margin	59.4%	60.5%	59.8%	59.5%	59.2%	58.7%	58.9%	59.0%
	B. Other Characteristics							
Share of exemption-eligible firms	9.4%	8.5%	9.0%	9.4%	9.6%	10.2%	9.8%	9.4%
Share of returns filed electronically	44.9%	26.9%	37.3%	40.1%	45.1%	49.2%	53.4%	59.0%
Observations	133,122	17,222	18,404	18,606	19,068	19,767	20,103	19,952

Notes: The statistics above are calculated including only the sample of firms under analysis. "COGS" refers to the direct cost of goods sold.

4. Empirical Strategy

Based on the theoretical framework developed earlier in this paper, this section adapts the model to the case of the Guatemalan corporate income tax scheme. It starts by describing the scheme's tax liability function and exemption rule in a form comparable to those shown in Section 2. Then, it analyzes the expected behavioral responses of firms in this setting, yielding a set of testable predictions from the model. Finally, it describes the bunching methodology used to estimate firms' responses from the empirical data.

4.1. Tax liability function and exemption rule under Regimen Optativo

In terms of the model described in Section 2, the main features of the Guatemalan minimum tax scheme can be incorporated into a tax liability function with the following form,

$$T(y, \hat{c}_{COGS}, \hat{c}_o) = \theta \max \ \{\tau_\pi(y - \hat{c}_{COGS} - \hat{c}_o), 0\} + (1-\theta) \max \ \{\tau_\pi(y - \hat{c}_{COGS} - \hat{c}_o), \tau_y y\} \qquad (13)$$

where,

$$\theta \equiv \begin{cases} 0, & \frac{y-\hat{c}_{COGS}}{y} > 4\% \\ 1, & \frac{y-\hat{c}_{COGS}}{y} \leq 4\%. \end{cases} \qquad (14)$$

Here, the variable $\hat{c}_{COGS}$ incorporates the firm's reported cost of goods sold (COGS), while the variable $\hat{c}_o \equiv \hat{c} - \hat{c}_{COGS}$, referred to as "other" costs, is defined as the difference between total reported costs and reported COGS. Notice that, in the first term of equation (13), the inability of exempt firms to carry forward net operating losses creates, in practice, a kink in the tax liability function at $\hat{p} = 0$.[25] The second term of the tax function in equation (13) describes the tax liability faced by non-exempt firms. As in the theoretical framework, this term generates a kink at the MTS payment threshold, which in this context occurs at $\hat{p} = \tau_y/\tau_\pi = 0.93\%/31\% = 3\%$.

A feature of the exemption rule in equation (14) is that it is expressed in terms of the reported gross margin, $\hat{g} \equiv \frac{y-\hat{c}_{COGS}}{y}$. However, in order to reconcile this rule with the theoretical framework, equation (14) needs to be considered in terms of the profit margin, which is the statistic that matters to determine the tax base. This transformation yields,

[25] The figures presented in Section 2 incorporated this feature; however, for simplicity, the equations representing the theoretical tax liability functions did not.

$$\theta = \begin{cases} 0, & \frac{y-\hat{c}_{COGS}-\hat{c}_o}{y} > 4\% - \frac{\hat{c}_o}{y} \\ 1, & \frac{y-\hat{c}_{COGS}-\hat{c}_o}{y} \leq 4\% - \frac{\hat{c}_o}{y}. \end{cases} \tag{15}$$

The key difference between equation (15) and equation (11) –its theoretical equivalent– is that, in this case, the MTS exemption threshold is *firm-specific*, as $\varphi(y, \hat{c}_o) = 4\% - \frac{\hat{c}_o}{y}$. Therefore, firms for which $\varphi(y, \hat{c}_o) \geq 3\%$ will face a tax liability function as in panel (a) of Figure 3. Instead, for firms with $\varphi(y, \hat{c}_o) < 3\%$, a tax liability function of the type depicted in panel (b) of the same figure will apply.

To facilitate the understanding of how a firm-specific MTS exemption threshold affects the tax function, it is helpful to see these features graphically. Figure 5 shows the implications of this exemption rule on the Guatemalan minimum tax scheme. Panel (a) depicts the tax liability function faced by firms, ignoring the effects of the exemption rule. The figure is equivalent to Figure 1, with a MTS payment threshold at 3%. On the other hand, panel (b) incorporates the relationship between the firm's reported profit margin and its reported "other" costs, $\hat{c}_o$, as implied by the exemption rule in equation (15). As it can be seen, the resulting tax function is somewhat complex. In terms of their cost structure, firms can be allocated into one of three groups.[26] Firms with $\frac{\hat{c}_o}{y} \leq 1\%$ face a pure profits tax with a kink at $\hat{p} = 0$, created by the no loss carryforward rule. Those with $1\% < \frac{\hat{c}_o}{y} \leq 4\%$ face a kink at the MTS payment threshold, a notch at the firm-specific MTS exemption threshold, $\varphi(y, \hat{c}_o)$, and a second kink at $\hat{p} = 0$, which basically reproduce the tax liability function of panel (b) in Figure 3. Finally, firms with $\frac{\hat{c}_o}{y} > 4\%$ only face a kink at the MTS payment threshold and a notch at $\varphi(y, \hat{c}_o)$, with the latter located at negative values of the firm's reported profit margin. The substantial heterogeneity generated by this complex structure will be useful to corroborate the empirical results shown in later sections.

4.2. Firm behavior and testable predictions

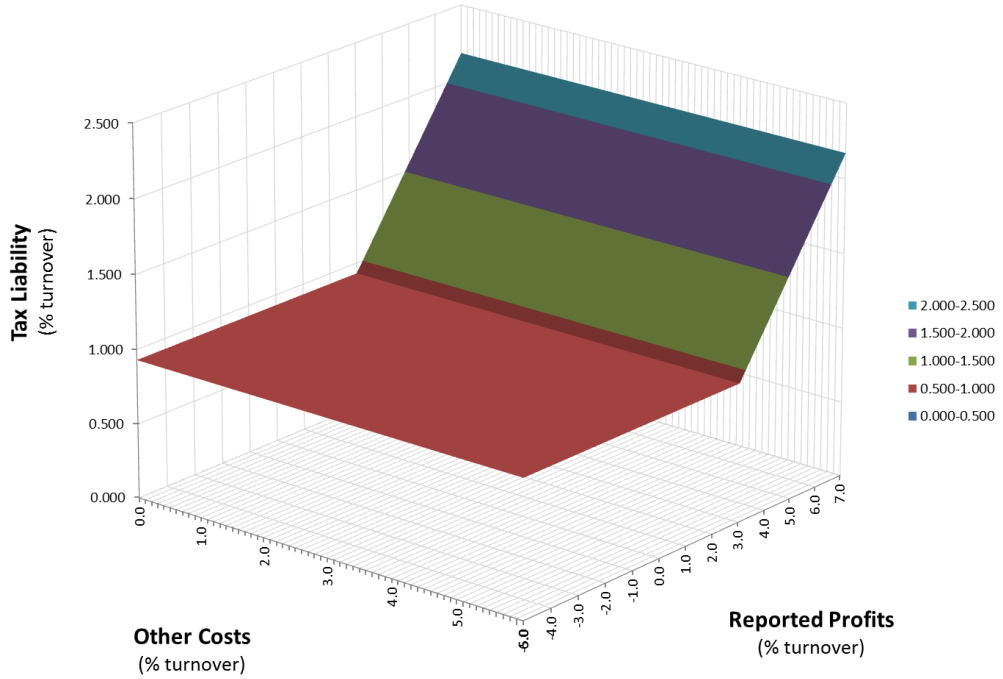
Under *Regimen Optativo*, the basic firm's problem can be written as,

$$\max_{y,\, \hat{c}_{COGS},\, \hat{c}_o} \; y - c_{COGS}(y) - c_o(y) - T(y, \hat{c}_{COGS}, \hat{c}_o) - h\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big). \tag{16}$$

In this setting, firms choose output, reported COGS and reported other costs to maximize their after-tax profits. The cost of evasion function, $h\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big)$, considers misreporting of both

[26] These groups are separated by the white lines in panel (b) of Figure 5.

Panel (a) – Minimum Tax Scheme for non-exempt firms under Regimen Optativo



Panel (b) – Minimum Tax Scheme and Exemption Rule under Regimen Optativo

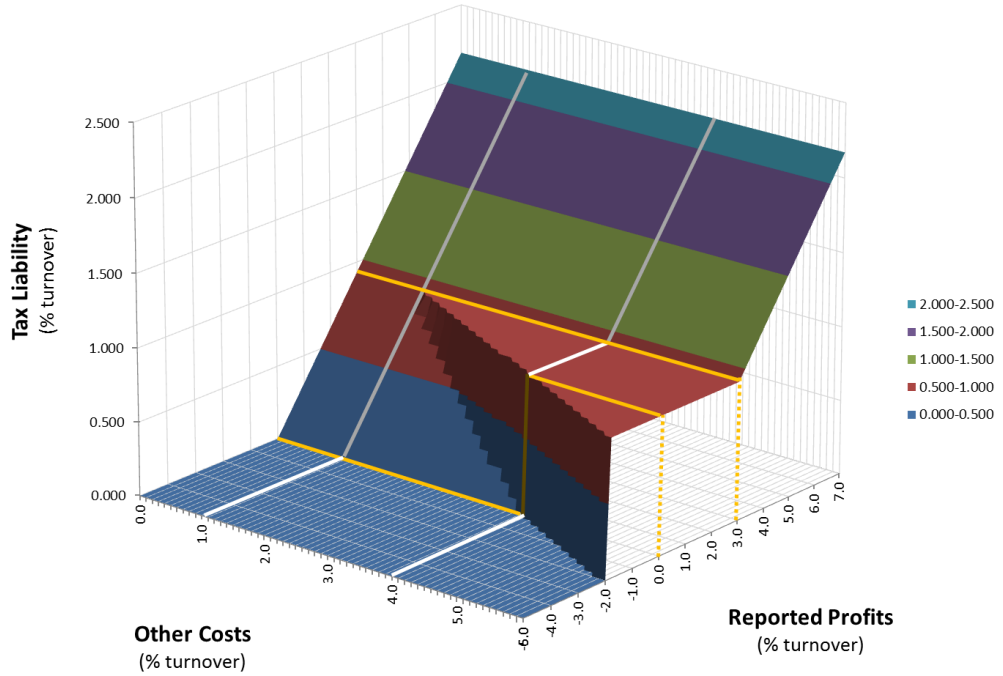


Figure 5 – Implications of the exemption rule for the Guatemalan minimum tax scheme. Panel (a) displays the minimum tax scheme, ignoring the implications of the exemption rule. Non-exempt firms face a kink in the tax function at $\hat{p} = 3\%$. When accounting for the exemption rule, the tax function also features a notch whose location varies depending on the firm-specific MTS exemption threshold. Panel (b) shows that this location is related to the firm's reported "other" costs (i.e. the difference between the firm's total costs and COGS).

types of cost.[27] Allowing the total cost function to be expressed as $c(y) = c_{COGS}(y) + c_o(y)$, yields optimal responses in line with those of the theoretical model.[28]

Overall, three groups of testable implications can be considered. The first group relates to firms' expected bunching at the kinks of the tax liability function. The second group results from the repercussions of the notch created by the exemption rule. A third group arises from the differentiated incentives to misreport faced by firms selling physical goods versus those selling services. All these sets of implications are discussed below.

4.2.1. Bunching at the kinks of the tax liability function

As shown in Figure 2, kinks in the tax liability function can lead to bunching when firms behave optimally. In the Guatemalan setting, there is two differentiated kink-induced responses expected from firms. On the one hand, non-exempt firms face a kink at the MTS payment threshold (i.e. $\hat{p} = 3\%$). On the other, exempt firms face the kink at $\hat{p} = 0$. Therefore, the two predictions arising from the existence of kinks in the tax liability function are the following:

Prediction 1 - Non-exempt firms will have incentives to bunch at $\hat{p} = 3\%$. As explained in the theoretical framework, non-exempt firms whose reported profit margin under a profit tax lies below 3% will respond to a minimum tax by decreasing both output and cost misreporting.[29] This, in turn, increases the reported profit margin, causing bunching at the MTS payment threshold.

Prediction 2 - Exempt firms will have incentives to bunch at $\hat{p} = 0\%$. Contrary to the non-exempt group, exempt firms face a kink at $\hat{p} = 0\%$. This is a consequence of the impossibility to engage in loss carryforward. Interestingly, from an analytical point of view this is equivalent to a minimum tax with a tax rate, $\tau_y = 0\%$, which implies that there is no real distortion as firms' optimal output choice is guided by the condition $c'(y) = 1 - \tau_y = 1$. In other words,

[27] As in the theoretical framework, this specification ignores turnover misreporting. The model can be expanded to include this type of misreporting without altering its general conclusions.

[28] This total cost specification assumes that a given firm can only produce a level of output, y, with a unique combination of COGS and other costs. While this assumption about the firm's technology may be too restrictive in the long run, it seems plausible in the short run. For the full derivation of the model's optimality conditions in this setup, see the appendix.

[29] Conditional on being non-exempt, a firm's reported COGS and other costs are equivalent for tax purposes. Hence, there is no differentiated response in either, and a firm facing the minimum tax will reduce its cost misreporting in both margins.

any observed bunching by exempt firms at the specified threshold cannot be caused by an output response; instead, it would be generated by the evasion response, thus providing direct evidence of firms' cost misreporting behavior.[30]

4.2.2. Bunching at the MTS exemption threshold

Figure 5 illustrates how the exemption rule of *Regimen Optativo* generates a firm-specific notch in the tax liability function. This notch creates incentives for firms to misreport their gross margin, with the aim of becoming exemption-eligible and avoiding the minimum tax scheme. However, not all firms face the same misreporting incentives, as discussed earlier. Besides their cost structure, firms' incentives are also affected by their reported profit margin.[31] For instance, a firm with a reported profit margin larger than 3% has no incentives to misreport $\hat{g}$, since their tax liability is the same whether it is exempt or non-exempt. However, if its reported profit margin is lower than 3%, there are two scenarios in which it will have incentives to misreport its gross margin. The first case is when the firm's other costs are such that $4\% \geq \frac{\hat{c}_o}{y} > 1\%$ and their reported profit is positive; this corresponds to the middle quadrant in panel (b) of Figure 5. The second case occurs if the firm reports losses and its cost structure is such that $\frac{\hat{c}_o}{y} > 4\%$; a notch is also visible in the respective quadrant in panel (b) of Figure 5. Table 3 summarizes firms' incentives to misreport the gross margin according to their profitability and cost structure.

The heterogeneity of incentives to misreport the gross margin provides a valuable source of testable implications of the model. The predictions derived from this framework are:

Prediction 3 - Firms with incentives to misreport their gross margin will bunch at $\hat{g} = 4\%$. As discussed above, firms located in quadrants where there is a notch will have incentives to misreport their gross margin. These firms will tend to bunch below $\hat{g} = 4\%$ in order to avoid payment of the minimum tax.

Prediction 4 - Firms with no incentives to misreport their gross margin, will not bunch at this threshold at $\hat{g} = 4\%$. In contrast to the previous group, firms located in quadrants where there is no notch face no incentives to misreport their gross margin. Hence, this group serves as a placebo test, as firms should not bunch at $\hat{g} = 4\%$.

[30] In a model that allows turnover misreporting, the difference in interpretation is that the evasion response is composed of both turnover and cost misreporting. However, the no-real-response argument remains unaffected.
[31] Profit margin groups are separated by the yellow lines in panel (b) of Figure 5.

Table 3 – Incentives to misreport the gross margin by firms' cost structure and profitability

	Firms reporting losses	Firms reporting profits	
	$0\% > \hat{p}$	$3\% > \hat{p} \geq 0\%$	$\hat{p} \geq 3\%$
$1\% \geq \frac{\hat{c}_o}{y}$	No incentives	No incentives	No incentives
$4\% \geq \frac{\hat{c}_o}{y} > 1\%$	No incentives	***Incentives to misreport***	No incentives
$\frac{\hat{c}_o}{y} > 4\%$	***Incentives to misreport***	No incentives	No incentives

Notes: $\hat{p}$ denotes a firm's reported profit margin; $\hat{c}_o$ indicates reported other costs, defined as the difference between total reported cost and reported COGS; y represents the firm's turnover.

4.2.3. Differentiated behavior of merchandise and services firms

An additional implication of the minimum tax exemption rule is that firms selling physical goods – referred to as *merchandise* firms from here onwards– are more likely to engage in misreporting of the gross margin, in comparison to firms selling services. This is because, in the Guatemalan context, the gross margin only takes into consideration the direct costs of producing physical goods, but it does not include the costs of producing services.[32] Thus, it is expected that, on average, merchandise firms will have a lower gross margin than services firms. This means that, for a given profit margin, merchandise firms are expected to be closer to the MTS exemption threshold than services firms. This leads to the following prediction:

> **Prediction 5 - Merchandise firms will show stronger bunching at $\hat{g} = 4\%$ than services firms.** For any given profit margin, merchandise firms will have, on average, a smaller gross margin. Hence, for merchandise firms with an initial gross margin above 4%, the additional COGS misreporting needed to cross the MTS exemption threshold is smaller than that required by services firms. Given the resulting difference in the marginal and total cost of misreporting, merchandise firms are expected to have a stronger response to the notch created by the MTS exemption, in comparison to services firms.

[32] For a more detailed explanation, see the description of the gross margin provided in earlier sections.

Since it is expected that firms engage in cost misreporting, Prediction 5 cannot be tested directly. This is because the actual values of COGS and other costs are not observable. Therefore, the analysis uses an instrument to separate firms into those likely to have a high ratio of COGS (i.e. lower gross margin before misreporting) and those expected to have a low one. The instrument used exploits the availability of detailed information on the sources of turnover, with firms categorized as either merchandise or services, as follows:

- *Merchandise firms* - Firms reporting sales of physical goods equivalent to more than 80% of total turnover are considered in this category.[33] Given their business focus, a large proportion of total costs coming from either production or inventory costs would be expected. Hence, it is likely that these group of firms will run a high COGS ratio before misreporting occurs.
- *Services firms* - Firms reporting sales coming from services provision amounting to more than 80% of turnover are selected in this category. Due to the nature of their activities, a small proportion of physical goods production or inventory costs would be expected. As a result, these firms are assumed to have a low COGS ratio before any misreporting takes place.

4.3. Methodology for the estimation of bunching responses

The existence of kinks and notches allows for the use of bunching techniques to identify firms' responses (Saez, 2010; Chetty et al., 2011; Kleven and Waseem, 2013). In the specific case of a minimum tax scheme, Best et al. (2015) show that firms' responses can be decomposed into an output and an evasion component. This paper uses their method to obtain estimates of those margins of response.

Let us express the reported profit margin as,

$$\hat{p} = \frac{y - c(y)}{y} - \frac{(\hat{c} - c(y))}{y}, \tag{17}$$

where the first term in the right-hand side encapsulates the firm's true profit margin, while the second term captures cost misreporting.[34] When $\Delta\hat{p}$ is small the above decomposition can be used to totally differentiate $\hat{p}$ and obtain,

[33] This percentage is arbitrary. However, robustness checks were carried out for both types of firms, with values ranging from 51% to 90%. No significant changes in the results were observed.

[34] As this decomposition will be used to obtain response estimates for non-exempt firms, there is no need to distinguish between COGS and other costs.

$$
\begin{aligned}
\Delta\hat{p} &= \frac{\partial\hat{p}}{\partial y}dy + \frac{\partial\hat{p}}{\partial(\hat{c}-c)}d(\hat{c}-c) \\
&= \left(\frac{\hat{c}}{y} - c'(y)\right)\frac{dy}{y} - \frac{d(\hat{c}-c)}{y} \\
&= ((1-\hat{p})-1)\frac{dy}{y} - \frac{d(\hat{c}-c)}{y} \\
&\approx \frac{{\tau_y}^2}{\tau_\pi}\varepsilon_y - \frac{d(\hat{c}-c)}{y}
\end{aligned}
$$

The third row in the previous expression follows from the definition of the reported profit margin and the firm's optimality condition for output. The fourth row approximation arises from realizing that $\hat{p} \cong \frac{\tau_y}{\tau_\pi}$ in the vicinity of the MTS payment threshold, as well as from the definition of the elasticity of output with respect to the net-of-tax rate,

$$
\varepsilon_y \equiv \frac{dy/y}{d(1-\tau)/(1-\tau)}
$$

where the fact that $\frac{d(1-\tau)}{(1-\tau)} = -\tau_y$ when crossing the kink is also used.[35]

The usefulness of the approximation above is that it allows us to separate the output and evasion responses. The first term in the right-hand side captures the real response as a proportion of the elasticity of output. The decomposition shows that this term will be relatively insensitive to the output elasticity, as $\frac{{\tau_y}^2}{\tau_\pi}$ will be a very small value.[36] The second term absorbs the evasion response, as a proportion of turnover. This latter term can be converted to a ratio of reported profits as follows,

$$
\frac{d(\hat{c}-c)}{y} = \left(\frac{y-\hat{c}}{y}\right)\frac{d(\hat{c}-c)}{y-\hat{c}} \approx \left(\frac{\tau_y}{\tau_\pi}\right)\frac{d(\hat{c}-c)}{y-\hat{c}}
$$

In order to obtain empirical estimates using the previous decomposition, an estimate of the change in the reported profit margin is required. This estimate can be calculated from the excess mass observed at the bunching point. Following Saez (2010), when the bunching response, B, is local we can approximate the change in the reported profit margin as,

[35] The basic idea is that, to the right of the MTS payment threshold, the *effective* tax rate on output is zero because costs are fully deductible (i.e. there is no output distortion); however, to the left of the threshold, output is taxed at a rate τ_y. See Best et al. (2015) for further details.

[36] In the case of the Guatemalan tax system, this value is equal to 0.000279.

$$B \approx \Delta\hat{p}\, f_0\left(\frac{\tau_y}{\tau_\pi}\right) \quad \Leftrightarrow \quad \Delta\hat{p} \approx \frac{B}{f_0\left(\frac{\tau_y}{\tau_\pi}\right)}$$

where $f_0\left(\frac{\tau_y}{\tau_\pi}\right)$ is the density of the profit margin around the MTS payment threshold in the absence of the minimum tax kink.

The key aspect for this calculation to provide a good estimate of the bunching response is the choice of counterfactual density distribution. The standard approach in the literature is to fit a polynomial using data from the empirical density distribution, leaving out the area visibly affected by the bunching response. However, in the setting of this paper applying that procedure directly would likely lead to a biased estimate of the bunching response. This is because in the absence of a minimum tax, firms would be expected to bunch at $\hat{p} = 0\%$, due to the no loss carryforward rule. Since, under a minimum tax, non-exempt firms are not expected to bunch at that threshold, using the empirical density distribution of this group to estimate the counterfactual distribution would not be appropriate. Instead, the approach followed here is to obtain the counterfactual distribution from the empirical density distribution of exempt firms, as this group represents the environment that would be faced by non-exempt firms in the absence of the minimum tax.

5. Empirical Results

This section shows the empirical evidence obtained using Guatemalan tax administrative data. First, evidence of bunching at the MTS payment threshold is analyzed. Second, evidence of gross margin misreporting is presented. Finally, estimates of evasion obtained from the bunching responses are provided.

5.1. Evidence of bunching at the kinks

Prediction 1 states that non-exempt firms will have a tendency to bunch at the MTS payment threshold, while Prediction 2 indicates that exempt firms will have bunching incentives at $\hat{p} = 0\%$. The empirical evidence shown in Figure 6 strongly supports these theoretical predictions. Panel (a) presents the density distribution of the reported profit margin for exempt and non-exempt firms. As seen in the figure, for the case of non-exempt firms there is clear evidence of bunching at $\hat{p} = 3\%$. In contrast,

exempt firms show large bunching at $\hat{p} = 0\%$, although there is also a smaller amount of bunching at the MTS threshold.

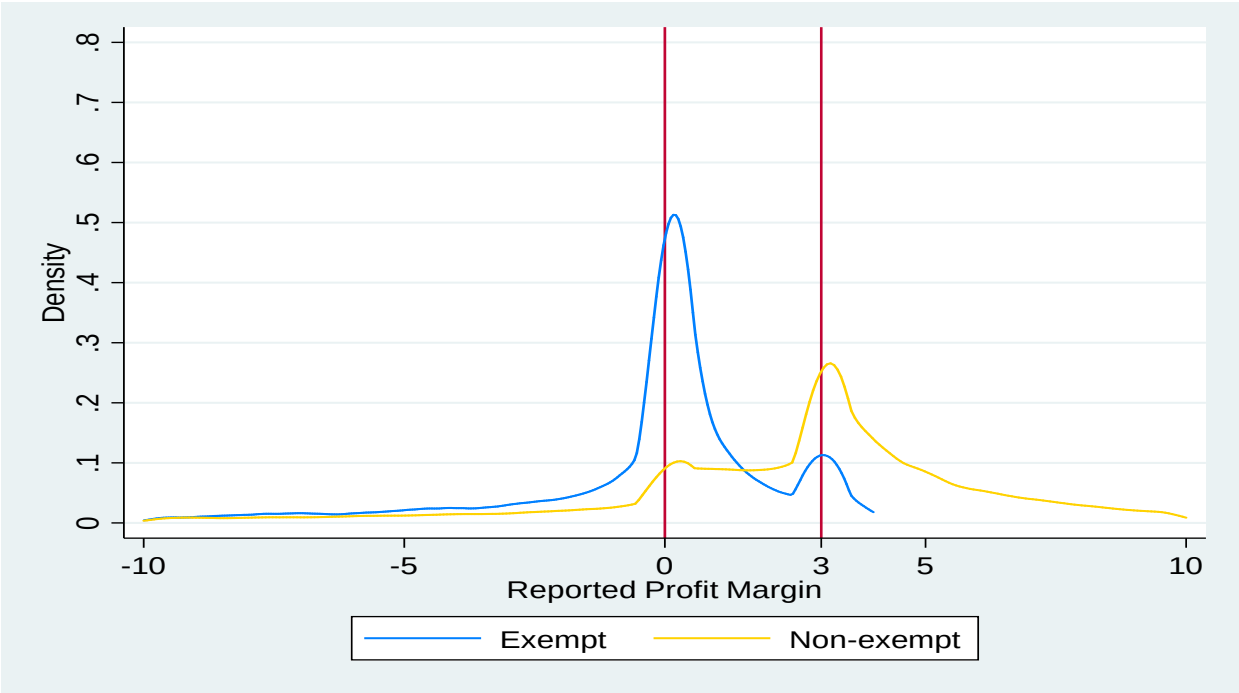
A possible explanation for the unexpected bunching of exempt firms at the MTS payment threshold is that there are fixed costs of obtaining the exemption.[37] In other words, a firm may be exemption-eligible, but may decide not to claim this benefit if the costs of doing so exceed the tax gains received by the firm. As explained earlier in the paper, firms claiming the MTS exemption face costs associated with submitting a series of legal and accounting documents well in advance of the filing deadline. A firm that has not complied with these requirements is liable to pay the minimum tax, which means it faces the same incentives as non-exempt firms. Unfortunately, the dataset does not include information on whether a given firm presented this documentation or not.

However, one way to indirectly test this hypothesis is to analyze firms' behavior by turnover groups. If the costs of obtaining the exemption are fixed, firms with higher turnover should be less affected by them, as they represent a smaller proportion of their turnover. Panel (b) of Figure 6 provides some empirical support for this hypothesis. Exempt firms with a reported turnover below 8 million quetzales –*low turnover* firms– show sizeable bunching at the MTS payment threshold.[38] In contrast, exempt firms with a reported turnover above 8 million quetzales –*high turnover* firms– appear to behave differentially, as they bunch significantly at $\hat{p} = 0\%$, while having a negligible concentration at the MTS threshold. As a comparison, non-exempt firms do not seem to alter their behavior, independently of their level of turnover.

Further evidence in support of the fixed-cost hypothesis is provided in panels (c) and (d) of Figure 6. In the first of these panels, the density distribution of the reported profit margin is shown for firms, according to their cost structure. As indicated in Figure 5 and Table 3, firms face different misreporting incentives depending on their ratio of other costs to turnover. Firms with $\frac{\hat{c}_o}{y} \leq 1\%$ essentially face a pure profit tax and, hence, should not show any bunching at the MTS payment threshold in the absence of fixed costs. However, the empirical density shows bunching at this threshold. As in the case of panels (a) and (b), the density distributions presented in panel (d) illustrate that this bunching diminishes significantly for firms with a higher level of turnover. Interestingly, firms

[37] The literature on crime displacement has highlighted the importance of fixed costs when enforcement is selective. For instance, Yang (2008a) analyzes the role of fixed costs of switching to alternative duty-avoidance methods in the context of customs reform in the Philippines, finding evidence consistent with their existence.
[38] The exchange rate for the Guatemalan quetzal was roughly Q8 per US$1 for the period of analysis.

Panel (a) – By exemption-eligibility



Panel (b) – By exemption-eligibility and turnover

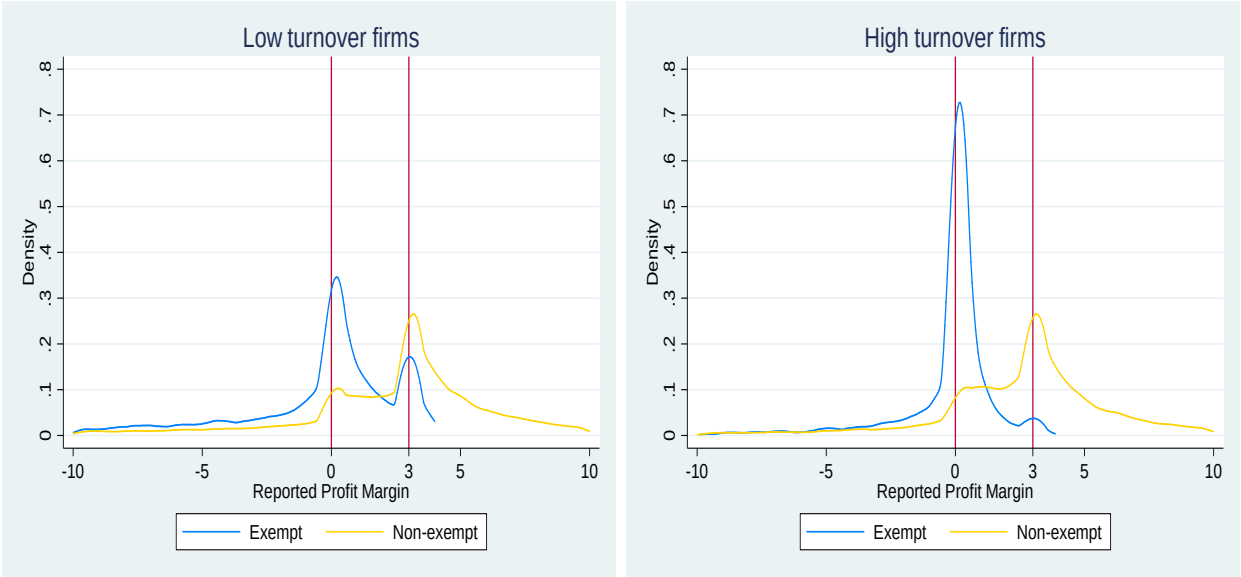
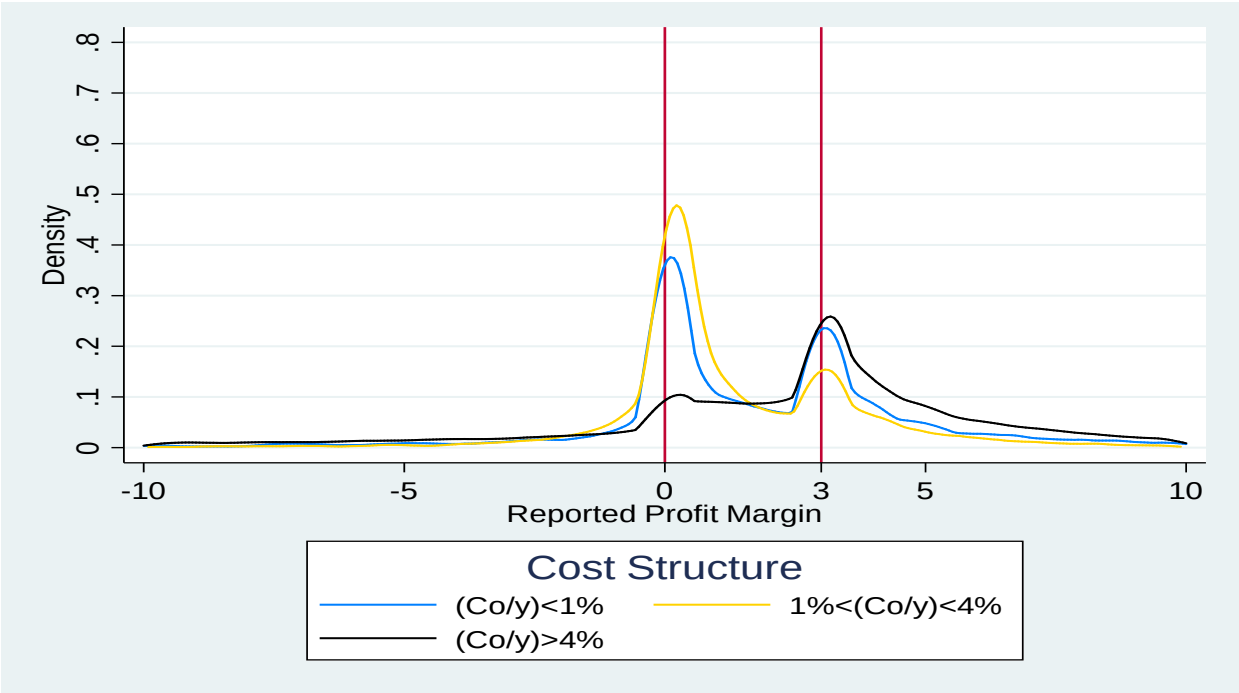


Figure 6 – Kernel density distributions of reported profit margin. – <u>*Panels (a) and (b)*</u> – Panel (a) shows the kernel density distribution of reported profit margin for exempt and non-exempt firms. As expected, exempt firms bunch at $\hat{p} = 0\%$, while non-exempt firms do so at $\hat{p} = 3\%$. Panel (b) displays the corresponding distributions for low-turnover and high-turnover firms. Low-turnover firms are those reporting less than Q8 million turnover annually – about US$1 million–, and high-turnover firms include those reporting more than this amount. The evidence is consistent with the existence of fix costs for claiming the exemption, as the behavior of high turnover exempt firms is substantially different than that of low turnover exempt firms. The bin size used in the kernel densities is 0.25.

Panel (c) – By cost structure



Panel (d) – By cost structure and turnover

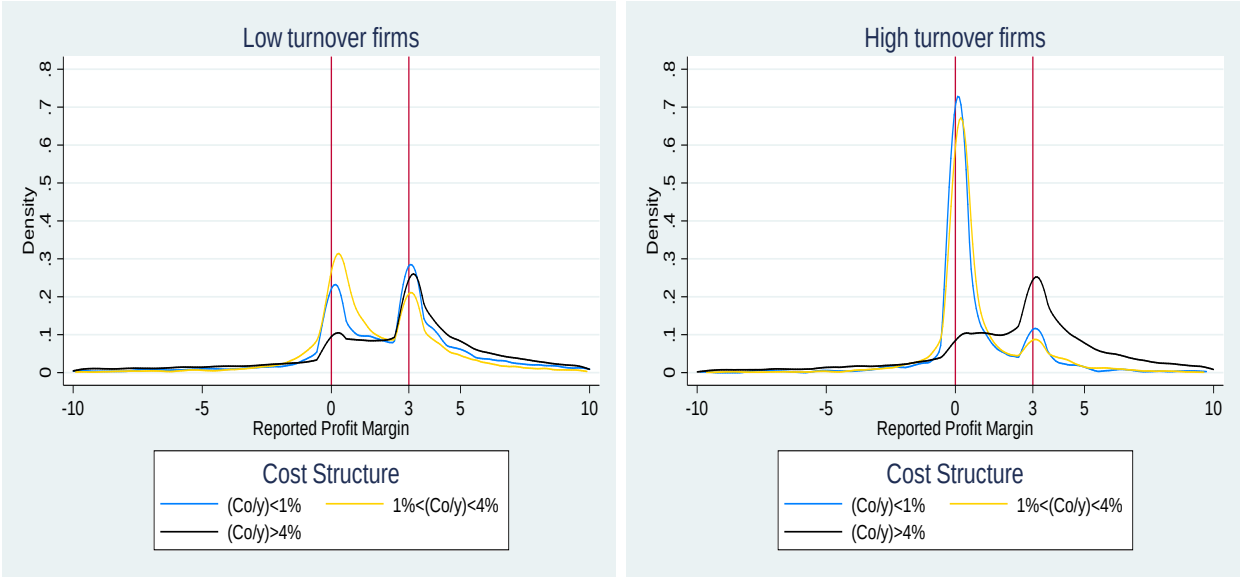


Figure 6 – Kernel density distributions of reported profit margin. – *Panels (c) and (d)* – Panel (c) presents the kernel density distribution of reported profit margin for firms according to their cost structure. As expected, firms with $\frac{\hat{c}_o}{y} > 4\%$ bunch at the MTS payment threshold, while firms with lower other costs ratio have a stronger tendency to bunch at $\hat{p} = 0\%$. Panel (d) shows the respective distributions for low-turnover and high-turnover firms. As in panel (b), the graphic evidence is consistent with the existence of fixed costs of claiming the exemption. The bin size used in the kernel densities is 0.25.

with $1\% < \frac{\hat{c}_o}{y} \leq 4\%$ behave in a similar fashion as the previous group, suggesting that misreporting incentives are strong for this group. Instead, firms with $\frac{\hat{c}_o}{y} > 4\%$ do not show any differentiated behavior, a pattern consistent with the fixed-costs hypothesis.

5.2. Evidence of gross margin misreporting

As explained earlier in this paper, the income tax scheme under *Regimen Optativo* creates incentives for some firms to bunch below the gross margin exemption threshold, with the intention of avoiding the minimum tax. Figure 7 shows evidence that firms behave according to what is predicted by the theoretical model. Panel (a) displays the density distributions for firms with incentives to misreport the gross margin and those without these incentives.[39] As expected from Predictions 3 and 4, the first group shows significant bunching at the MTS exemption threshold, while the latter group does not. The two points of observed bunching for the group without incentives to misreport correspond to the kinks in the tax liability function, but not to the notch.[40]

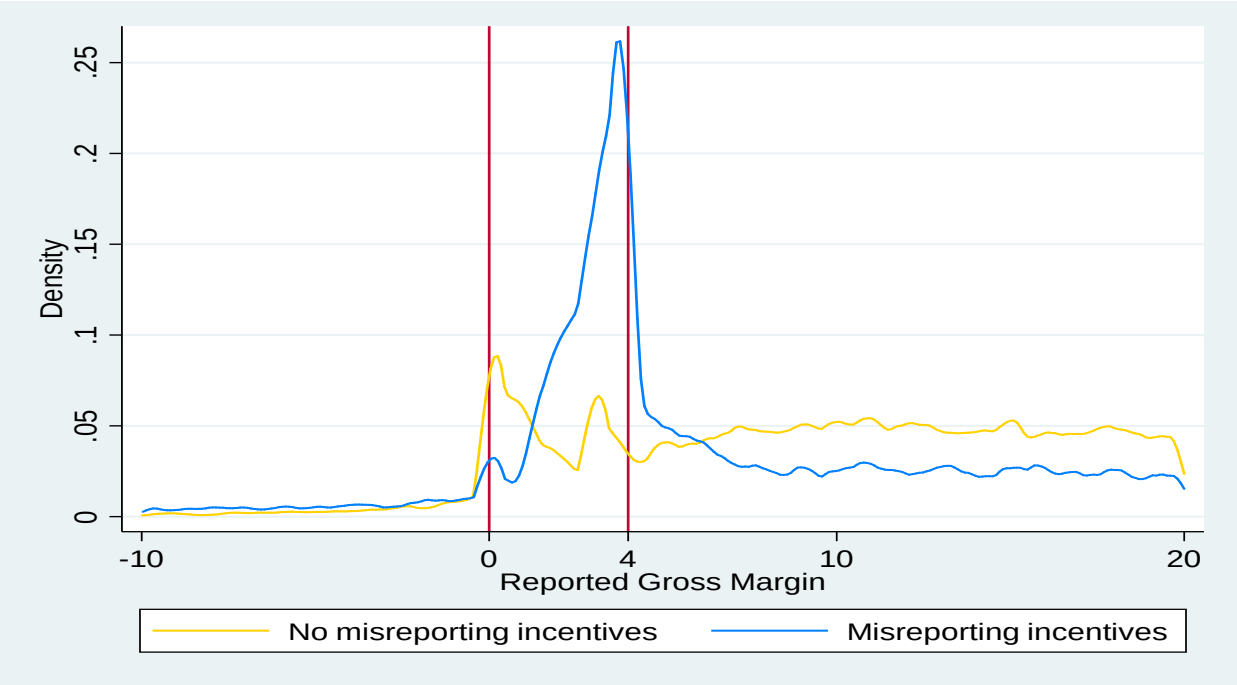
Panel (b) of Figure 7 also provides strong evidence in favor of the theoretical predictions. First, it can be seen that firms reporting losses show large bunching at the MTS exemption threshold. This is important because these firms do not face a local kink in their tax liability function, indicating that their bunching behavior at that point can only be reconciled with gross margin misreporting. Moreover, firms reporting a non-negative profit margin below 3% also bunch significantly at the MTS exemption threshold. Once again, this is consistent with the theory, as this group faces strong incentives to misreport their gross margin. Finally, firms with a reported profit margin above 3% provide a placebo test, as they should not bunch at the MTS exemption threshold. This is because they do not face the minimum tax, given that their reported profit margin is above the MTS payment threshold. Indeed, the figure shows that there is no observed bunching in this group.

Additionally, panels (c) and (d) in Figure 7 offer graphical evidence of gross margin misreporting for merchandise and services firms. Two features are significant in these graphs. On the one hand, firms with misreporting incentives bunch at the MTS exemption threshold, while those without these

[39] See Table 3 for the definition of which firms have incentives to misreport their gross margin and which do not.

[40] The reported profit margin can be expressed as $\hat{p} = \hat{g} - \frac{\hat{c}_o}{y}$. Hence, for firms with a small value of $\frac{\hat{c}_o}{y}$, we get that $\hat{p} \approx \hat{g}$. This means that the observed bunching at $\hat{p} = 0\%$ and $\hat{p} = 3\%$ in Figure 6 will be partially visible around $\hat{g} = 0\%$ and $\hat{g} = 3\%$, as seen for firms without incentives to misreport in panel (a) of Figure 7.

Panel (a) – By misreporting incentives



Panel (b) – By profitability

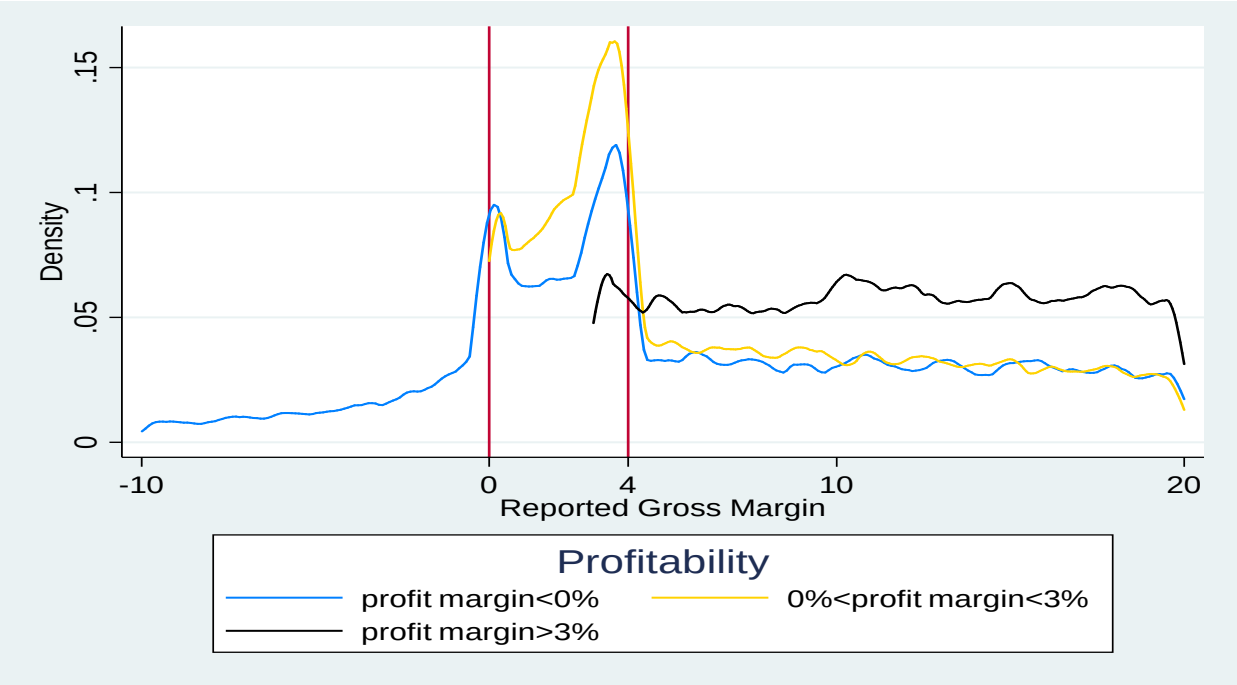
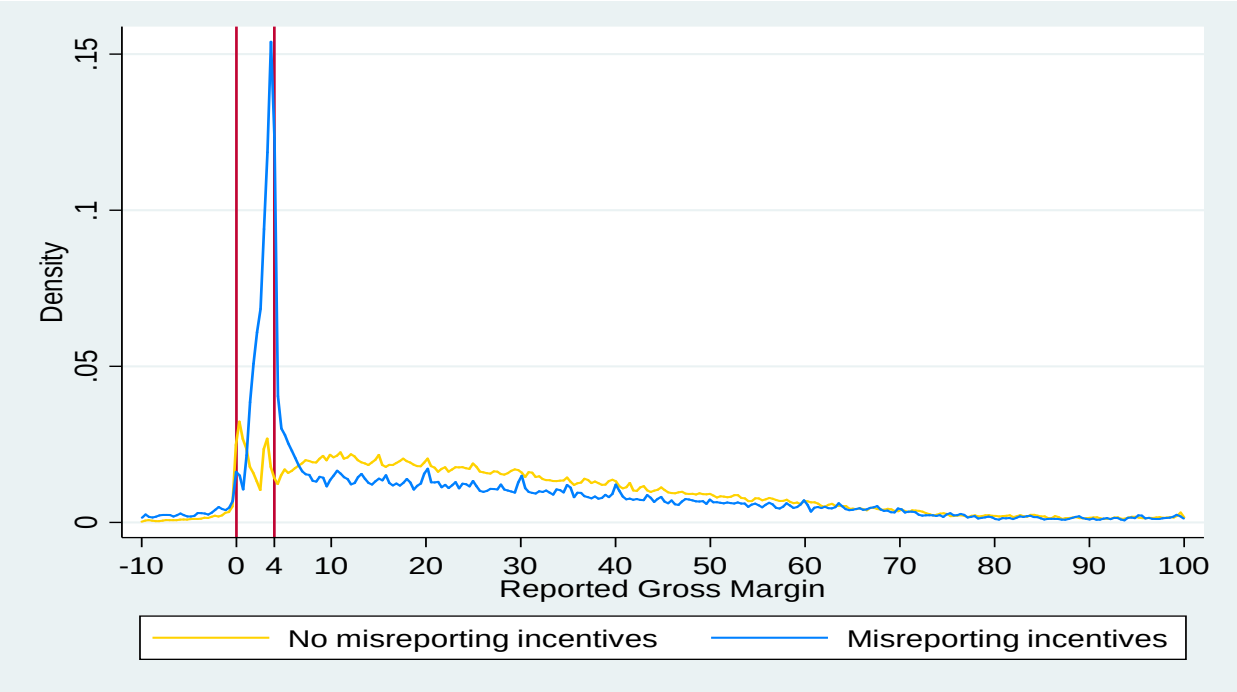


Figure 7 – Kernel density distributions of reported gross margin. – *Panels (a) and (b)* – Panel (a) shows the density distribution of the reported gross margin for firms with and without misreporting incentives. For those with misreporting incentives, bunching occurs at the MTS exemption threshold. In contrast, firms with no misreporting incentives, do not show bunching at the same threshold. Panel (b) presents the density distribution for firms with different profit margin ranges. Firms with a reported profit margin below 3% show significant bunching, but those with a larger profit margin do not. This behavior is consistent with differentiated misreporting incentives.

Panel (c) – Merchandise firms, by misreporting incentives



Panel (d) – Services firms, by misreporting incentives

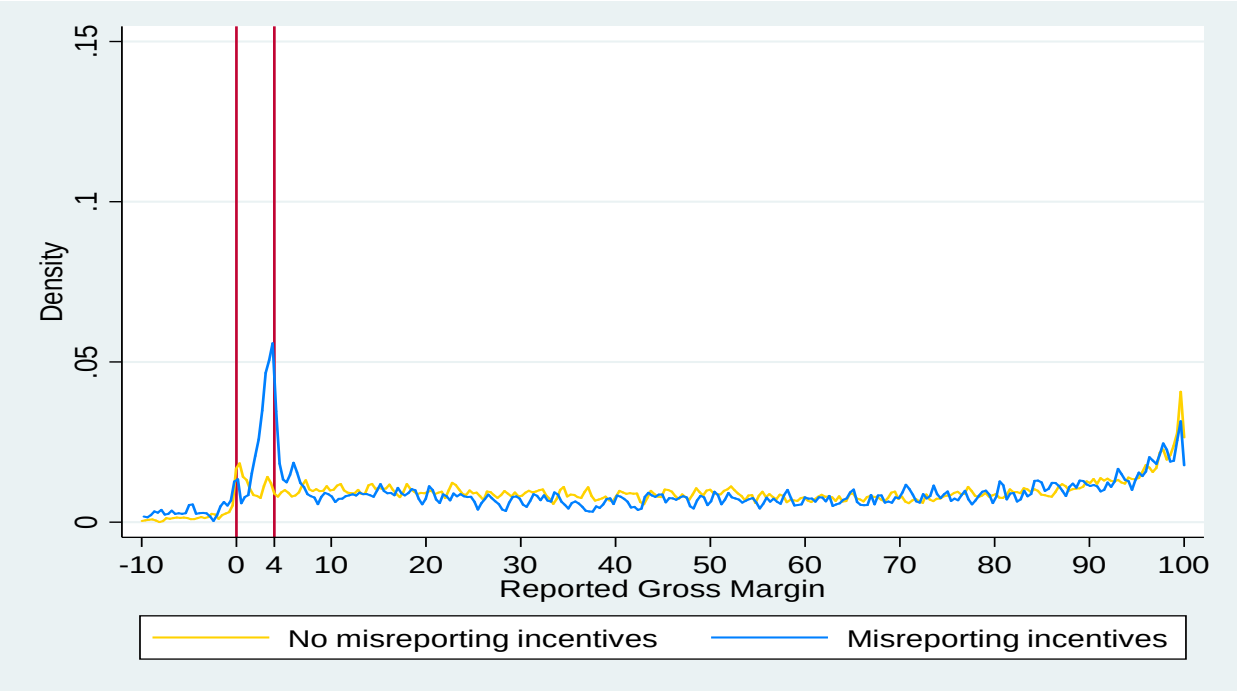


Figure 7 – Kernel density distributions of reported gross margin. – *Panels (c) and (d)* – Panel (c) illustrates the density distribution of the reported gross margin for merchandise firms with and without misreporting incentives. As expected, significant bunching occurs at the MTS exemption threshold for the group with misreporting incentives only. Panel (d) displays a similar pattern for services firms. Moreover, it shows that the intensity of the bunching is weaker for services firms in comparison to merchandise firms, as predicted by the theory. The bin size used in the graphs is 0.2.

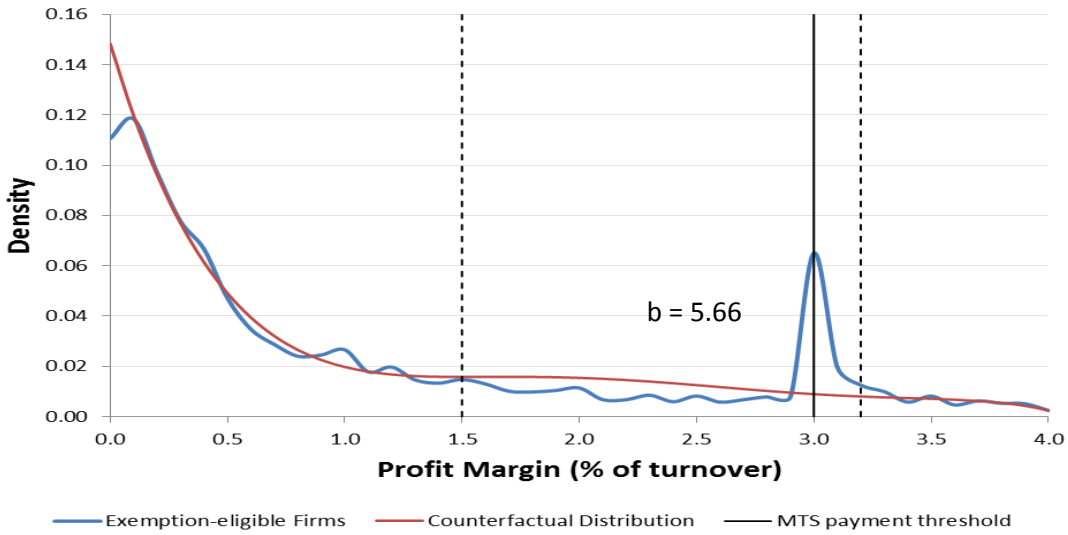


Figure 8 – Bunching Estimation for Exemption-eligible Firms at the MTS payment threshold. The figure illustrates the empirical density of the profit margin (in % of turnover) and the estimated counterfactual density for exemption-eligible firms. The counterfactual density is estimated from the empirical density, using a fifth-order polynomial, excluding data around the threshold where bunching is visible, and imposing that the excess area created by this bunching be equal to the missing area in the affected region to the left of the threshold. The excluded area is delimited by the two dashed vertical lines. A bin size of 0.1 is used to plot the graph. Since firms in this group are eligible to claim the minimum tax payment exemption, the bunching at the MTS threshold arises from the existence of fixed costs and other frictions that prevent firms from claiming this exemption.

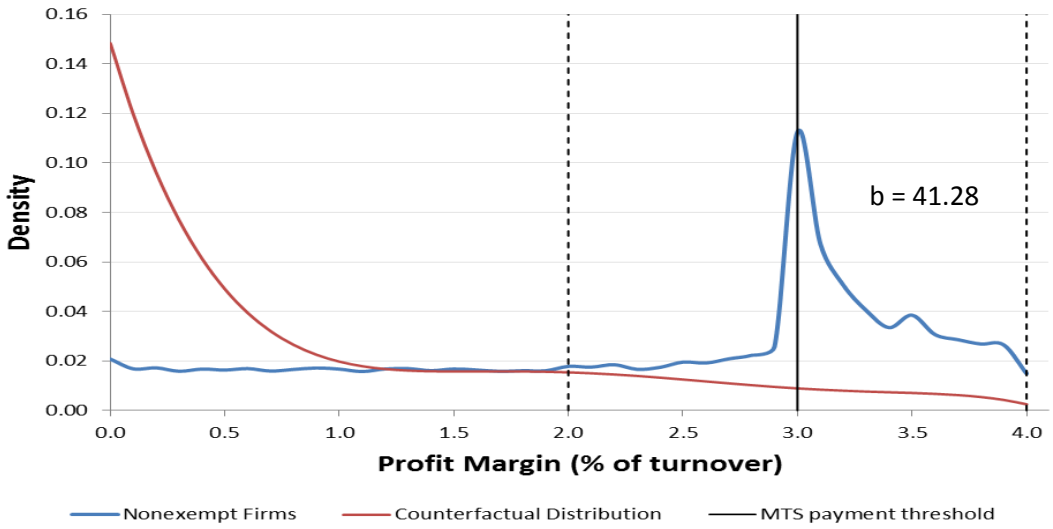


Figure 9 – Bunching Estimation for Non-exempt Firms at the MTS payment threshold. The figure above illustrates the empirical density of the profit margin (in % of turnover) for non-exempt firms, using a bin size of 0.1. The counterfactual density shown corresponds to that estimated from the empirical density of exempt firms as in Figure 1. This counterfactual density captures the fact that non-exempt firms would face similar incentives to exemption-eligible firms if they were not subject to pay the minimum tax. The estimated excess mass in this figure comes from the difference between the depicted densities in the range enclosed by the dashed vertical lines.

incentives do not bunch. This pattern, consistent with Predictions 3 and 4, occurs independently of whether the firms are merchandise or services firms. On the other hand, the intensity of the bunching at the critical threshold is weaker for services firms, a feature consistent with Prediction 5. In all, this pattern is suggestive of services firms facing, on average, higher costs of gross margin misreporting than merchandise firms.

5.3. Bunching responses estimates

The previous results provided evidence of firms' bunching responses and their consistency with the theoretical framework. This subsection builds on that behavior in order to calculate estimates of the bunching response, applying the methodology detailed in Section 4. The analysis focuses on firms with a reported profit margin between 0% and 4%, for two reasons. First, in this range there is a common support between exemption-eligible and non-exempt firms, allowing for meaningful comparisons of the two groups. Second, restricting the analysis to firms not reporting losses facilitates a better fit of the counterfactual distributions, which in turn results in better estimates of the bunching response at the minimum tax kink.

Figure 8 displays the empirical density distribution of the profit margin for exemption-eligible firms. It also presents the estimated counterfactual density for this group. Using these two distributions, the estimated excess bunching, b, caused by the fixed-costs of claiming the exemption is calculated at 5.66.[41] Table 4 provides details of this estimation. For instance, the implied average profit margin response at the MTS payment threshold consistent with this level of bunching is 0.57 percentage points. If this response was only driven by a real adjustment (i.e. no evasion response), the estimated output elasticity would be 20.28, a value well above the typical range found in the literature.[42] Instead, imposing more reasonable output elasticity values —from 0 to 10— yields estimated evasion responses ranging from 9.56% to 18.36% of reported profits.

A more dramatic picture is given by non-exempt firms. Figure 9 illustrates the empirical density distribution for this group and compares it to the estimated counterfactual distribution of exemption-eligible firms. As argued earlier in this study, the latter distribution is the appropriate counterfactual for non-exempt firms, due to the existence of the no loss carryforward rule. For this reason, in this context,

[41] As in Best et al. (2015), the value of the excess bunching presented here is scaled by the average counterfactual density around the kink. Formally, $b = \hat{B}/E(\hat{d}_j | j \in [p_L, p_U])$, where $\hat{d}_j$ represents the estimated counterfactual density at j, and $[p_L, p_U]$ defines the excluded range.
[42] See, for example, Gruber and Rauh (2007), Devereux et al. (2014), and Patel et al (2017).

the estimation procedure refrains from using the typical polynomial regression, which would fit data from non-exempt firms.[43] In its place, the bunching response is calculated by comparing the empirical density of non-exempt firms and the counterfactual distribution estimated with data from exemption-eligible firms.

Given the above procedure, the estimate of b is much larger than in the preceding case, at 41.28. The implied average profit margin response is 4.13 percentage points, more than seven times larger than the equivalent response for exemption-eligible firms. In itself, the difference in estimated values for the profit margin response provides an interesting comparison of the impact that the minimum tax scheme has on firms' reporting. This difference is even more striking when contrasting estimates of the real and evasion responses. Assuming no evasion, the estimated output elasticity for this group is a massive 147.96, a value that can be safely disregarded as unrealistic. When imposing reasonable output elasticities, the evasion response still shows disproportionate values, ranging from 128.30% to 137.60% of reported profits.

The key to reconciling such large values with meaningful estimates of evasion is to note that this response, in terms of *reported* profits, can be linked to the firm's response in terms of *actual* profits via,

$$\frac{d(\hat{c}-c)}{y-c} = \left(\frac{y-\hat{c}}{y-c}\right)\frac{d(\hat{c}-c)}{y-\hat{c}}.$$

The ratio of reported-to-actual profits, $(y-\hat{c})/(y-c)$, is unobserved. However, in a tax system with no loss carryforward, it is possible to estimate an upper-bound for this ratio. Since reported profits can be expressed as, $(y-\hat{c}) = (y-c) - (\hat{c}-c)$, then the ratio of reported-to-actual profits can be written as,

$$\left(\frac{y-\hat{c}}{y-c}\right) = 1 - \left(\frac{\hat{c}-c}{y-\hat{c}}\right)\left(\frac{y-\hat{c}}{y-c}\right).$$

Solving for the variable of interest yields,

$$\left(\frac{y-\hat{c}}{y-c}\right) = \frac{1}{1+\left(\frac{\hat{c}-c}{y-\hat{c}}\right)}.$$

[43] For comparison purposes, the estimation results derived from fitting a flexible polynomial to the density distribution of non-exempt firms are shown in Table C.1 in the appendix.

While the ratio of reported costs to reported profits is also unobserved, in the absence of loss carryforward the model predicts that the absolute value of the evasion response cannot be larger than total misreporting. This is because there is no benefit of reporting losses if they cannot be carried forward to the next fiscal year. Using this fact, we can obtain an upper-bound for the ratio of reported-to-actual profits as follows,

$$\left(\frac{y-\hat{c}}{y-c}\right) \leq \frac{1}{1+\left|\frac{d(\hat{c}-c)}{y-\hat{c}}\right|}.$$

The above formula is very useful, as it allows us to obtain an estimate of the minimum level of evasion (as a proportion of actual profits), directly from the estimated evasion response. In the context of a minimum tax scheme, this estimate should be interpreted as the ratio of reported-to-actual profits that would be observed in the absence of the minimum tax.

Table 4 – Estimated evasion responses at the MTS payment threshold

	Observed responses		**Model without Evasion**	**Model with Evasion (values show change in misreporting in % of reported profits)**				
	Bunching (b)	Profit Margin Response ($\Delta\hat{p}$)	Estimated Output Elasticity (ε_y)	Given $\varepsilon_y = 0$	Given $\varepsilon_y = 0.5$	Given $\varepsilon_y = 1$	Given $\varepsilon_y = 5$	Given $\varepsilon_y = 10$
Exemption-eligible Firms	5.66	0.57	20.28	18.86	18.39	17.93	14.21	9.56
Ratio of reported-to-actual profits (upper-bound)				0.84	0.84	0.85	0.88	0.91
Non-Exempt Firms	41.28	4.13	147.96	137.60	137.14	136.67	132.95	128.30
Ratio of reported-to-actual profits (upper-bound)				0.42	0.42	0.42	0.43	0.44

Note: Evasion response estimates of more than 100 imply that the estimated cost misreporting is larger than *reported* profits. These values can be reconciled theoretically, insofar as reported profits are expected to be *lower* than actual profits in the presence of evasion. The reported estimates for the upper-bound of the ratio of reported-to-actual profits, $(y-\hat{c})/(y-c)$, are calculated as described in Section 5.3.

Table 4 summarizes the estimates of the evasion response and the ratio of reported-to-actual profits for the Guatemalan case. As it can be seen, the data suggests that evasion is a big concern, with estimates of the average ratio of reported-to-actual profits ranging between 0.42 to 0.91. Such magnitudes are indicative of an environment where tax enforcement is weak, creating strong incentives for firms' misreporting.

While the implied levels of evasion derived from these estimates seem high when compared with expected levels of evasion in developed economies, these numbers are not entirely surprising for developing countries. For instance, Bachas and Soto (2017) estimate that evasion could be as large as 70% of actual firm profits in the case of Costa Rica. Similarly, Pecho et al. (2012) present estimates for income tax non-compliance in several Latin American countries during the period 2000-2010; their estimates range from 34.5% in Colombia to 72% in Guatemala.

6. Conclusions

This paper studies firm responses under a minimum tax in the context of a developing country. The study of such behavior is important for societies in the developing world for two reasons. First, many of these countries collect lower tax revenues than advanced economies, despite similar statutory rates. Second, in environments with weak enforcement, governments are inclined to use production-inefficient taxation, such as minimum tax schemes, in order to increase revenues. Recent work by Best et al (2015), suggests that these policies can improve social welfare through their effect on the government's revenue efficiency.

Besides the behavioral consequences of the kink created by minimum taxes in the tax liability function, the present study also analyses the implications of exemption rules in this framework. As shown in the paper, the revenue effectiveness of minimum tax schemes is negatively affected by the existence of exemption rules allowing firms to avoid the minimum tax. Depending on their specification, these exemption rules can create *firm-specific* upward or downward notches in the tax liability function faced by firms. The resulting incentives on firms' reporting behavior run contrary to the government's objective of increasing tax collection.

The empirical evidence from Guatemalan corporate income tax returns provides strong support to the paper's theoretical predictions. As expected, firms facing the upward notch created by *Regimen*

Optativo's exemption rule respond by significantly bunching below the exemption threshold. Interestingly, this behavior is also salient in firms reporting negative profits, despite the fact that it implies an overstatement of their losses. Additionally, the analysis finds differentiated responses for merchandise and services firms, with the former group showing stronger bunching behavior. This is consistent with the fact that, on average, merchandise firms face lower marginal costs of crossing the exemption threshold than services firms.

The empirical results also suggest that the Guatemalan minimum tax scheme contributes considerably to the reduction of tax evasion among firms that cannot avoid this scheme. Non-exempt firms bunch significantly at the minimum tax kink, a behavior consistent with a reduction in firms' misreporting. Estimates of the evasion response in this group suggest a reduction in misreporting of as much as 137% of *reported* profits. Using this estimate, the paper exploits the no loss carryforward rule of *Regimen Optativo* to calculate an upper bound for the ratio of reported-to-actual profits. According to these computations, firms report, on average, no more than 42% of their true profits in the absence of the minimum tax scheme. This number implies that evasion arising from profit misreporting would be at least 58% of actual profits if this scheme was not in place. Hence, the results provide empirical support to the view that minimum taxes can be an effective mechanism to lower tax evasion in environments with limited enforcement capabilities.

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Appendix

A. Model with turnover and cost misreporting

A.1. Profit maximization under a pure profits tax

The basic model presented in Section 2 can be extended to account for turnover misreporting. In this case, the tax liability faced by firms, $T(\hat{y}, \hat{c})$, depends on both reported turnover, $\hat{y}$, and reported cost, $\hat{c}$. Private costs of evasion, $h\big(y - \hat{y},\ \hat{c} - c(y)\big)$, depend on misreported turnover and misreported costs. Hence, the firm's problem is now,

$$\max_{y,\hat{y},\hat{c}}\ \ y - c(y) - T(\hat{y}, \hat{c}) - h\big(y - \hat{y},\ \hat{c} - c(y)\big). \tag{A1}$$

For the case of a pure profits tax, the tax liability function becomes $T(\hat{y}, \hat{c}) = \tau_\pi(\hat{y} - \hat{c})$. The firm's first order conditions for an interior solution are,

$$c'(y)\big[1 - h_{\hat{c}-c}\big(y - \hat{y},\ \hat{c} - c(y)\big)\big] = 1 - h_{y-\hat{y}}\big(y - \hat{y},\ \hat{c} - c(y)\big) \tag{A2}$$

$$h_{y-\hat{y}}\big(y - \hat{y},\ \hat{c} - c(y)\big) = \tau_\pi \tag{A3}$$

$$h_{\hat{c}-c}\big(y - \hat{y},\ \hat{c} - c(y)\big) = \tau_\pi. \tag{A4}$$

Optimal turnover misreporting is governed by equation (A3), while optimal cost misreporting is determined by equation (A4). Combining all the conditions above yields,

$$c'(y) = 1. \tag{A5}$$

This condition keeps the feature of a non-distortionary pure profits tax.

A.2. Profit maximization under a turnover tax

In the context of turnover and cost misreporting, the tax liability function takes the form $T(\hat{y}, \hat{c}) = \tau_y \hat{y}$. The first order conditions for an interior solution to this problem are,

$$c'(y)\big[1 - h_{\hat{c}-c}\big(y - \hat{y},\ \hat{c} - c(y)\big)\big] = 1 - h_{y-\hat{y}}\big(y - \hat{y},\ \hat{c} - c(y)\big) \tag{A6}$$

$$h_{y-\hat{y}}\big(y - \hat{y},\ \hat{c} - c(y)\big) = \tau_y, \tag{A7}$$

$$h_{\hat{c}-c}\big(y - \hat{y},\ \hat{c} - c(y)\big) = 0, \tag{A8}$$

which together imply,

$$c'(y) = 1 - \tau_y. \tag{A9}$$

As in the simplified model, a turnover tax has a distortionary effect, since equation (A9) relates the optimal output level to the tax rate. Thus, output will be lower than under a profits tax, and so will total evasion. The main difference with the simplified model is that now turnover misreporting still occurs, despite cost misreporting being zero. However, given that $h\big(y - \hat{y},\ \hat{c} - c(y)\big)$ is a convex function of the amount being evaded, and as long as $\tau_\pi > \tau_y$, a firm facing a turnover tax will be expected to misreport a lower amount of turnover than under a pure profits tax. In practice, this condition is often verified. For instance, for the Guatemalan setting $\tau_\pi \gg \tau_y$, since $\tau_\pi = 31\%$ and $\tau_y = 0.93\%$.

A.3. Profit maximization under a minimum tax

With turnover misreporting, the typical income tax liability function under a minimum tax has the form,

$$T(\hat{y}, \hat{c}) = \max\ \big\{\tau_\pi(\hat{y} - \hat{c}), \tau_y \hat{y}\big\}. \tag{A10}$$

Equation (8) indicates that a firm faces the largest tax liability between a profit tax and a turnover tax. For a given combination of reported turnover and reported cost, $(\hat{y}, \hat{c})$, the two liabilities are equal when,

$$\tau_\pi(\hat{y} - \hat{c}) = \tau_y \hat{y} \qquad \Leftrightarrow \qquad \hat{p} \equiv \frac{(\hat{y} - \hat{c})}{\hat{y}} = \frac{\tau_y}{\tau_\pi}. \tag{A11}$$

Hence, $\hat{p}$ is now defined in terms of reported turnover and reported cost, instead of actual turnover, as before. Given this threshold, firms with a reported profit margin above or equal to τ_y/τ_π will face the incentives shown in section A.1, while firms with a reported profit margin below this threshold will behave as described in section A.2.

B. Optimality conditions under *Regimen Optativo*

Equation (16), copied below, states the firm's problem under *Regimen Optativo*,

$$\max_{y,\,\hat{c}_{COGS},\,\hat{c}_o}\ \ y - c_{COGS}(y) - c_o(y) - T(y, \hat{c}_{COGS}, \hat{c}_o) - h\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big).$$

In this setting, firms choose output, reported COGS and reported other costs to maximize their after-tax profits. The cost of evasion function, $h\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big)$, considers misreporting of both types of cost. Assuming that the total cost function can be expressed as $c(y) = c_{COGS}(y) + c_o(y)$, this model yields the following optimality conditions,

$$\begin{aligned} &c'_{COGS}(y)\left[1 - h_{\hat{c}_{cogs}-c_{cogs}}\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big)\right] \\ &+ c'_o(y)\big[1 - h_{\hat{c}_o - c_o}\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big)\big] = 1 - T_y(y, \hat{c}_{COGS}, \hat{c}_o) \end{aligned} \tag{B1}$$

$$h_{\hat{c}_{cogs}-c_{cogs}}\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big) = -T_{\hat{c}_{cogs}}(y, \hat{c}_{COGS}, \hat{c}_o) \tag{B2}$$

$$h_{\hat{c}_o - c_o}\big(\hat{c}_{COGS} - c_{COGS}(y), \hat{c}_o - c_o(y)\big) = -T_{\hat{c}_o}(y, \hat{c}_{COGS}, \hat{c}_o), \tag{B3}$$

which are similar in nature to those shown in the theoretical section. The main difference arises from the fact that there are now two optimality conditions regarding cost misreporting.

Under a pure profit tax, the optimality conditions imply,[44]

$$c'(y) = c'_{COGS}(y) + \ c'_o(y) = 1, \tag{B4}$$

while under turnover taxation, this changes to,

$$c'(y) = c'_{COGS}(y) + \ c'_o(y) = 1 - \tau_y. \tag{B5}$$

Therefore, the general conclusions of the analysis of firms' responses, described in Section 2, remain largely unchanged.

[44] This is because, under a pure profit tax, $T_y(y, \hat{c}_{COGS}, \hat{c}_o) = -T_{\hat{c}_{cogs}}(y, \hat{c}_{COGS}, \hat{c}_o) = -T_{\hat{c}_o}(y, \hat{c}_{COGS}, \hat{c}_o) = \tau_\pi$.

C. Supplementary Tables and Figures

Table C.1 – Estimated evasion responses at the MTS payment threshold using Non-exempt firms to derive the counterfactual density distribution

	Observed responses		Model without Evasion	Model with Evasion (values show change in misreporting in % of reported profits)				
	Bunching (b)	Profit Margin Response ($\Delta\hat{p}$)	Estimated Output Elasticity (ε_y)	Given $\varepsilon_y = 0$	Given $\varepsilon_y = 0.5$	Given $\varepsilon_y = 1$	Given $\varepsilon_y = 5$	Given $\varepsilon_y = 10$
Non-Exempt Firms	5.69	0.57	20.38	18.95	18.49	18.02	14.30	9.65
Ratio of reported-to-actual profits (upper-bound)				0.84	0.84	0.85	0.87	0.91

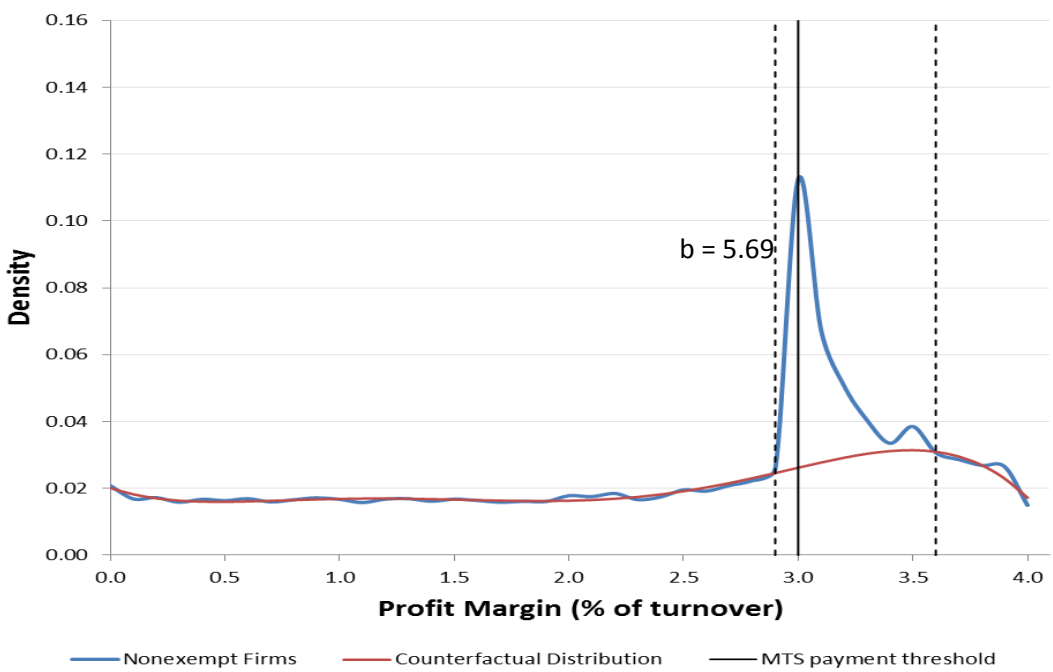

Figure 10 – Bunching Estimation for Non-exempt Firms at the MTS payment threshold using the standard bunching methodology. The figure above illustrates the empirical density of the profit margin (in % of turnover) for non-exempt firms, using a bin size of 0.1. The counterfactual density shown corresponds to that estimated from the empirical density of non-exempt firms, as opposed to exemption-eligible firms. The estimated excess mass in this figure comes from the difference between the depicted densities in the range enclosed by the dashed vertical lines.