

VAT Rates and Tax Evasion: Evidence from the Restaurant Industry in Greece

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Abstract

This paper examines the effect of Value-Added Tax (VAT) rate changes on tax evasion in an environment of limited tax-shifting opportunities. I focus on the recent VAT rate reduction in the Greek restaurant industry (August 2013) and implement a difference-in-difference methodology using large fast-food restaurants as the control sample, due to the fact that they exhibit high constraints on underreporting. I find that the reduction of the VAT rate for non-alcoholic sales from 23% to 13% increases the reported sales to inputs ratio, which is used as a measure of disclosure of hidden sales, by 11.8% on average. The effect is more pronounced in small firms and firms with less alcoholic sales. This result is consistent with VAT ratio targeting, the partial adjustment of VAT revenues to the lower tax rate, in order to maintain a reasonable VAT ratio (revenues to credits) and to avoid signaling evading behavior to tax authorities. I also document the reverse effect for the VAT rate increase in September 2011. Finally, I show that, accounting for the partial downward adjustment of VAT revenues and the higher direct taxes from the increase in reported sales, the overall fiscal cost from the rate reduction becomes minimal.

Keywords: Tax evasion, Value-added tax, Sales underreporting, VAT ratio targeting

JEL Classification: H25, H26, D78

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1 Introduction

The effect of tax rates on compliance is a topic of heightened significance to public finance, as evasion is related to economic distortions and government budget underfunding. The relationship is particularly salient for developing countries and economies with extensive shadow sectors which, according to Schneider et al. (2010), constitute the rule rather than the exception. However, the topic remains an open debate in the literature. Even in the case of direct taxes, theoretical predictions rely heavily on model assumptions, as shown in the seminal works of Allingham and Sandmo (1972), and Yitzhaki (1974), while empirical evidence is also mixed.¹ The empirical testing of the relationship between tax rates and indirect tax evasion is even more challenging as, in addition to substitution and income effects, it involves the possibility of transferring the tax-burden to consumer prices, namely tax-shifting.

In this study, I focus on indirect taxes and examine the effect of Value-Added Tax (VAT) rate changes on tax evasion. To reduce the complexity of the indirect evasion decision framework, I consider a setting in which tax-shifting opportunities are extremely limited, and in so doing examine the recent changes in VAT rates in the Greek restaurant industry. In September 2011, the VAT rate for non-alcoholic restaurant sales increased from 13% to 23%, and subsequently decreased back to 13% in August 2013. Throughout this period, the VAT rate for alcoholic sales remained unchanged at 23%.

Both tax rate changes were largely unanticipated. The initial rate increase was implemented at the peak of the Greek financial crisis, limiting the margin to pass the surplus tax-burden on consumer prices, due to the extremely weak demand. As a result, when the rate change was reversed, the majority of restaurants did not adjust their prices downwards, as they had already absorbed the prior increase. Eurostat reports that restaurant prices changed by only 2.4% and -1.4% following the increase and the reduction of the VAT sales rate, respectively,² while according to a campaign by the Greek restaurateur association nearly 90% of restaurants did not, even partially, pass-on the tax rate reduction to prices. This minimal effect on prices creates a unique setting that isolates the effect of VAT rates on tax evasion to a great extent.

¹For example Clotfelter (1983) reports significant, positive elasticities of underreporting with respect to marginal tax rates, whereas Feinstein (1991) finds a significant negative relationship, both examining TCMP data.

²To put these figures in perspective, a full pass-on of the rate change to prices would correspond to 11% (rate increase) and -8% (rate reduction).

According to existing literature, in the presence of evading opportunities, firms decide on the optimal level of underreporting by balancing the benefits of evasion with the expected cost of a penalty in case the violation is detected. The latter depends on the penalty amount and the probability of detection, which in the proposed framework is a non-increasing function of the VAT ratio (the ratio of VAT revenues to VAT credits). I show that in the case of a VAT rate reduction, the optimal level of underreporting decreases for two reasons; first it reduces the motive to evade, as the proceeds from underreporting decline; and second it lowers the VAT ratio for a given level of reported sales, implying a higher probability of detection. Similarly, an increase of the VAT rate is consistent with an increase in underreporting. In practice, firms respond to a VAT rate change by “adjusting” their reported sales and targeting a VAT ratio, which balances benefits incurred from evasion with the probability of being detected; a process I refer to as *VAT ratio targeting*.

I test these theoretical predictions empirically, using the recent reduction of the non-alcoholic VAT sales rate in the Greek restaurant industry in August 2013. I employ a difference-in-difference methodology using *large fast-food restaurants* as our control group, because of their limited opportunities to underreport sales. Large fast-food restaurants rely heavily on internal and external paper-trail that is embedded in the processing of a high volume of orders. In addition, as large firms they are subject to a higher level of third-party reporting. Both features have a significant role in increasing compliance, making evasion harder and the uncovering of violations easier (Kleven, Kreiner & Saez [2009], Kleven et al. [2011], Pomeranz [2015]). Furthermore, the majority of these firms belong to franchises, therefore they are subject to additional monitoring, reporting requirements, and penalties.

I hypothesize that, unless a significant shock in demand occurs (i.e. through a large change in prices), restaurant sales should not change due to a change in the VAT sales rate. Consequently, I focus on the effect of rate changes on reported sales. In the main analysis, I scale reported sales by reported inputs (Sales ratio), in order to control for possible growth effects, and treat changes in the Sales ratio as an indicator of changes in underreporting. For example, I interpret the increase of the Sales ratio following a tax rate reduction as disclosure of hidden sales.³ I then test the effect of a tax rate change on the Sales ratio for different treatment groups. Large and small firms are

³The use of financial ratios for the detection of fraud has a long tradition in forensics accounting and data-mining literature. Pomeranz (2015) also identifies firms with low sales to inputs ratios as suspected evaders.

examined separately. Furthermore, I consider separately groups with different levels of alcoholic sales as the tax rate for these sales remained the same (23%) throughout our sample period, and therefore these groups are exposed to rate changes in different degrees.

Results indicate that the VAT rate reduction for non-alcoholic sales, from 23% to 13% in August 2013, increases the Sales ratio across the industry by 11.8% on average (9.57% for the quantile specification). This estimate is conservative as the sample excludes seasonal and financially constrained firms, and entities that deliberately underreport inputs to retain an artificially high ratio. The effect is more pronounced for small firms and for firms with low levels of alcoholic sales, which collectively account for over 90% of the population and 75% of the turnover in the industry.

Turning to industry aggregates reveals that the actual adjustment in sales reporting may be even more impactful. Figure 1 presents the percentage change in reported sales and VAT revenues for the last six months of 2013, following the rate reduction. As a result of “adjustments” in underreporting, the rate reduction of the tax rate (-30%) is only partially reflected on reduced VAT revenues (-14.17%), as firms increase reported sales by 15.20%. This behavior is more evident among small firms that increase reported sales by 19.24% and reduce VAT revenues by just 10.8%.

[INSERT FIGURE 1 HERE]

The “adjustment” of sales reporting to tax rate changes provides an explanation for the failure of forecasts related to the efficiency of tax measures in Greece. In contrast to anticipated losses of 140 million euros for the first five months following the VAT rate reduction, actual VAT revenues declined by just half of this amount.⁴ Consistent to Lucas’ critique (1976) - that the effect of policies cannot be evaluated without considering the response of economic agents affected - tax rate changes induce Laffer-type outcomes for government revenues, which policymakers seem to consistently ignore.

Additionally, the increase of reported sales, following the rate decrease, may further decrease the overall fiscal cost through its impact on direct taxes. It is expected that the higher reported sales originating from the disclosure of hidden sales to be, at least partially, reflected on income,

⁴Similarly, the increase of the VAT rate in 2011 yielded just 160 million euros in additional revenues, instead of the forecasted 1 billion euros annually.

since they do not involve additional costs. Along this line of thought, given the 26% corporate tax rate, a portion of the additional 325 million euros of sales reported during the second half of 2013 can offset the realized losses in VAT revenues.

In additional tests, I document the reverse effect during the preceding increase of the VAT rate for non-alcoholic restaurant sales in September 2011. Consistent with the intuition behind the adjustment of sales reporting on tax rate changes, the increase of the base VAT sales rate from 13% to 23% is followed by a significant decrease of the Sales ratio (-5.11% on average, -9.02% for the quantile specification).

This paper empirically examines the relationship of indirect tax rates and compliance, which has been thoroughly investigated on the theoretical level by Marrelli (1984), and Cremer and Gahvari (1993). However, in this setting, the limited opportunities for tax-shifting enable us to focus on the effects of tax rate changes on tax evasion. The study contributes to the scarce empirical literature on VAT rates and compliance that mainly consists of cross-country studies (Agha & Haughton [1996], Matthews & Lloyd-Williams [2000], and Matthews [2003]), and cross-border transactions (Fisman & Wei [2004]). These studies typically predict a negative relationship between tax rates and compliance, consistent with my findings, but the novelty of this setting rests upon the fact that I use industry micro-data, and therefore avoid possible country (and industry) heterogeneities.⁵

These results also shed light on the relationship between compliance and firm size, implying that sales underreporting is predominately a feature of smaller firms, as indicated by their suspiciously low average Sales ratio and its sharper adjustment to tax rate changes. This finding is consistent with the U-shaped size and non-compliance rate relationship suggested by Slemrod (2007), and the insights of Porta and Shleifer (2008), and Hurst et al. (2011) regarding the informality of small firms. The “flexibility” of small firms in underreporting is also consistent with the enforcement role of third-party reporting and paper trails (Kleven, Kreiner & Saez [2009], Kleven et al. [2011]), which is more constraining for larger firms.

Finally, this study highlights the use of indicators of economic activity (Sales and VAT ratios) for detecting evasion. The proposed method depicts changes in underreporting for firms indirectly, via identifying changes in the Sales ratio compared to a benchmark value, in a similar way that

⁵More recently, evidence regarding the determinants of VAT compliance came from large-scale experiments (Naritomi [2013], Pomeranz [2015]).

past literature estimates income underreporting for individuals observing expenditure (Pissarides & Weber [1989], Hurst et al.[2014]) and credit capacity (Artavanis, Morse & Tsoutsoura [2015]) levels.

The paper proceeds as follows. Section 2 discusses the process of VAT ratio targeting and its theoretical predictions, and section 3 describes the dataset and methodology. Section 4 presents the empirical results regarding the effect of VAT rates on tax evasion, while section 5 discusses the fiscal cost of the rate reduction and its implications for policy-making. Finally, section 6 concludes the study.

2 VAT Evasion and VAT Ratio Targeting

2.1 The VAT System and the Restaurant Industry in Greece

As in most countries, value-added taxes represent a significant source of government revenue in Greece (on average 20%), with a VAT gap ratio of 39% (4.7% of GDP) in 2011, one of the highest in the European Union.⁶ During the sample period, the standard VAT rate in Greece was 23%. Moreover, a reduced rate of 13% applied to fresh food, groceries, medicine, and selected services, and a discounted rate of 6.5% applied to theater tickets, books, newspapers, and selected pharmaceutical products. For islands, excluding Crete, these rates were further reduced by 30% (16% for the standard, 9% for the reduced, and 5% for the discounted rate). The VAT registration threshold was set at a low level (9,000 euros 4,000 euros for services), but was nonetheless consistent with policies followed by countries with similar industry structure and evasion problems (Bird and Gendron (2007)). Finally, every business establishment in Greece, including restaurants, was subject to a 26% corporate tax rate on net income.

Restaurants are typically regarded as “problematic” from a compliance point of view, because of certain characteristics that facilitate evasion;⁷ they belong to the service sector, in which violations are difficult to prove after a transaction is completed, and they cater to customers with little or

⁶See “*Study to quantify and analyse the VAT Gap in the EU-27 Member States, Final Report*”, Taxation & Customs Union, European Commission (2013).

⁷Unfortunately, this is not specific to Greece, as enforcement in the restaurant industry has been challenging on an international scale due to the nature of the services provided and the ingenuity of the restaurateurs. Tait (1988) offers an amusing example from Italy, where escorts were hired to accompany customers to their cars and then discard receipts to avoid on-site audits.

no incentive to obtain a record of the sale. There is strong evidence that, in the past, restaurant owners in Greece have taken advantage of evading opportunities to the limit. Artavanis, Morse, and Tsoutsoura (2015) show, using bank micro-data, that Greek self-employed professionals in the restaurant and lodging industry underreport their true income by more than half. Furthermore, tax records indicate that the average reported income of restaurant owners was a mere 6,105 euros (or 509 euros per month) in 2011. To put this number in perspective, the minimum legal gross wage for the same year was 751 euros per month.

Before 2011, non-alcoholic restaurant sales were subject to the reduced VAT rate of 13%. In September 2011 the industry VAT sales rate increased to 23% (standard rate). The VAT rate applied to prepared food and non-alcoholic beverages was subsequently lowered back to 13% (reduced rate), in August 2013. Throughout the period the VAT rate for alcoholic sales remained unchanged at 23%. The changes of the VAT rate in the restaurant industry are presented in Figure 3. Both tax rate changes were legislated just a few weeks before the implementation dates, and were therefore largely unanticipated, a factor that is essential for treatment responses to converge to casual effects (see Hennessy & Strebulaev [2015]).

[INSERT FIGURE 3 HERE]

2.2 Dynamics of VAT Evasion

A key feature of the discussed setting, which allows us to focus on the impact of tax rate changes on underreporting, is the existence of limited opportunities to tax shift. Tax shifting refers to the transfer of the tax burden to consumers through prices, and adds complexity to the evasion decision framework in the case of indirect taxes. Marrelli (1984) extends the Allingham and Sandmo (1972) framework for indirect taxes and examines a risk averse, imperfectly competitive firm, concluding that the effect of a change in tax rates on evasion is ambiguous. Cremer and Gahvari (1993) show that for a risk neutral, competitive firm a tax rate increase decreases compliance.⁸

Collectively, the empirical literature suggests that rate changes in commodity taxes are, at least partially, reflected on consumer prices. However, the empirical evidence regarding whether indirect

⁸Additional models of indirect tax evasion are provided by Usher (1986) and Kaplow (1990).

taxes are undershifted, overshifted, or fully passed-on consumer prices is mixed (see Fullerton & Metcalf [2002]). Harju and Kosonen (2010) report that the decrease of the VAT rate on restaurant services in Finland from 22% to 13% in 2010 resulted to a decrease in final prices of just 2% on average, with large restaurants exhibiting a higher tendency to lower prices than smaller establishments.

In the case of Greek restaurants, the tax rate increase (from 13% to 23%) was implemented at the peak of the financial crisis. This combination of a significant tax rate increase and collapsing demand constitutes a rare setting that naturally limits the margin to pass-on the increased burden to customers.⁹ Two years later, when the initial increase was reversed, the majority of the establishments did not adjust their prices downwards, as most firms had already absorbed the prior increase.

Even though detailed information on price changes at the restaurant level is not available, there is strong evidence for the limitations on tax-shifting at the industry level. According to Eurostat, the tax rate increase was accompanied by an increase in restaurant prices of 2.4%, while the rate cut in August 2013 was followed by an anemic reduction in prices (-1.4%).¹⁰ An additional piece of evidence comes from a campaign organized by the Greek Ministry of Finance and the Greek restaurateur association aiming to pass the rate reduction on prices. Restaurants that partially reduced their prices (by more than 5%) were provided with a special badge indicating the change, along with priority access to government subsidies. For the reasons indicated above, only a small fraction of firms participated; nearly 90% of the establishments, mainly small restaurants, did not even partially pass the reduction on their prices.

I examine this setting assuming that tax authorities can perfectly observe paper-trail. Given the chain-structure of the VAT system, this assumption means that for an intermediate firm (supplier) tax authorities observe both incoming and outgoing paper-trail. For a retailer (restaurant) tax authorities observe the total incoming paper-trail (arm's length transactions), but only the transactions recorded by the final firm.¹¹ That is, if the restaurant does not provide a receipt for

⁹A similar setting occurred in New York during the period of the Great Depression with the introduction of sales taxes. Haig and Shoup (1934) report that a significant percentage of retailers, especially in small size firms, did not shift their prices upwards, due to the weak demand.

¹⁰"*Harmonized Index of Consumer Prices: Restaurants, cafés, and the like for Greece*", Eurostat.

¹¹Notice that this does not exclude the possibility of vertical integration (as described in Kopczuk & Slemrod [2006]), fraud collaboration between intermediate and final firms, the existence of non-registered suppliers or the deliberate under-statement of inputs (as in Carrillo, Pomeranz & Singhal [2014]). Rather than that, our model picks

a sale, then the sale will go unrecorded. However, the VAT structure puts some limits in these evading opportunities, because transactions are recorded at every stage of production, creating a chain of paper-trail. As a result, a low Sales (sales to inputs) or VAT (revenues to credits) ratio can signal evading activity and be used as a basis for targeted audits.

In this context, I examine the behavior of a risk neutral firm, assuming that the probability of detection is a non-increasing function of the VAT ratio.¹² The penalty structure consists of a lump sum amount that reflects common practice, as proceeds from VAT evasion of final firms, especially in the service sector, are typically not recoupable.

The proposed theoretical model, presented in detail in the Appendix, predicts that a VAT sales tax rate reduction decreases the optimal level of underreporting for two reasons; for a given level of reported sales, the rate cut reduces the motive to evade, by lowering the proceeds from evading activity, while it also decreases the VAT ratio implying a higher probability of detection. Similarly, the increase of the VAT sales tax rate decreases compliance. Finally, an increase of the penalty is consistent with a lower optimal level of sales underreporting.

2.3 VAT Ratio Targeting

In practice, firms with evading opportunities respond to tax rate changes by “adjusting” reporting in a way that balances the benefits incurred from evasion with the probability of detection, a process I refer to as *VAT ratio targeting*. My theoretical results predict that a reduction of the VAT sales rate is consistent with the disclosure of “hidden” sales, which implies that VAT revenues will only partially adjust downwards, since Sales and VAT ratios are related as follows:

$$\frac{\text{VAT revenues}}{\text{VAT credits}} = \frac{\bar{\tau}_s}{\bar{\tau}_i} * \frac{\text{Reported Sales}}{\text{Reported Inputs}} \quad (1)$$

Hence, for a given VAT inputs rate ($\bar{\tau}_i$) and reported level of inputs, a change in the VAT rate of sales ($\bar{\tau}_s$) is distributed between reported sales and VAT revenues. In the case of the rate reduction

up evading behavior in excess to these possibilities.

¹²Notice that in the case of a single VAT rate the VAT and Sales ratios coincide. However, I argue that in the existence of multiple VAT rates and pervasive evasion, tax authorities are more likely to focus on the former, as it provides a stronger signal of evading activity that is more closely related to government revenues.

of 2013, $\bar{\tau}_s$ and $\bar{\tau}_i$ converge (see Figure A.1); therefore it is expected for the Sales and VAT ratios to converge as well. More specifically, in the absence of a significant change in prices, or an external factor that affects sales, I expect the change in the VAT sales rate to be largely reflected on VAT revenues. However, following the rate reduction, convergence takes place along different patterns for small and large firms, as shown in Figure 2.¹³

[INSERT FIGURE 2 HERE]

For large firms the VAT rate reduction predominately affects the VAT ratio (-28%), while the Sales ratio (and reported sales) remains fairly stable. In contrast, in the case of small firms the VAT ratio only partially adjusts to the lower rate, and consequently the Sales ratio adjusts upwards reflecting a higher level of reported sales. Interestingly, these two adjustments, in the case of small firms, appear to be approximately of equal magnitude (14-15%).

The differential impact of the tax rate change on the Sales ratio of large and small firms suggests that the latter have higher relative “flexibility” to underreport sales and more actively engage in VAT ratio targeting. Figure 2(b) provides an explanation for this behavior; the dashed line projects the VAT ratio, had it completely adjusted to the rate reduction (as in the case of large firms). Under this scenario, the VAT ratio drops to extremely low levels (below 1.30) providing a strong signal of evasion, which makes an audit more probable. Instead, firms choose to *target* a more reasonable VAT ratio by only *partially adjusting* VAT revenues downwards, consequently increasing the level of reported sales.

3 Data and Methodology

3.1 Data and Samples

The dataset consists of the complete account of VAT reports for all establishments with restaurant services as their main activity, provided by the Greek tax authorities. The sample period is from January 2010 to December 2013. As mentioned before, two changes of the non-alcoholic sales VAT

¹³As a sidenote, I note the suspiciously low average Sales ratio, which range from 1.40 to 1.50 and are hard to justify (Sales ratios of large firms average between 2.40 and 2.50).

rate occurred in the industry during this period; an increase from 13% to 23% in September 2011 and a decrease from 23% to 13% in August 2013. Alcoholic sales were subject to a VAT rate of 23% throughout the period (Figure 3).

[INSERT FIGURE 3 HERE]

Firms are classified as *small* (Category C) and *large* (Category B) by the tax authorities based on their annual turnover (with a threshold of 150,000 euros). Large firms are subject to higher accounting standards and are required to file VAT reports monthly; small firms file VAT reports quarterly. The industry is heavily populated by small establishments (94.9%) that account for the 73.9% of the annual turnover on average. Since the majority of the establishments are of small size, I sum the monthly amounts reported by larger firms and observe all data on a quarterly basis.

The dataset includes a coded identifier that allows us to follow each firm across periods. Additionally, the location of the establishment (zip code and constituency) and a very detailed classification of the main activity are provided; the tax authority recognizes 132 different categories of restaurant services. I group these categories to eight sub-industries based on common features of the services provided, and in accordance with characteristics related to evasion opportunities.¹⁴

For each establishment exact amounts for both VAT credits (for inputs) and revenues (from sales) that apply to each VAT rate are reported, separately. Since claims and collections are reported by tax rate, I calculate the corresponding *Reported Inputs* and *Reported Sales* of each firm in each period.

Two filters are applied to data; it is required (i) that a firm reports at least 500 euros of inputs each quarter, and (ii) that the firm has no missing filings for the entire sample period. These filters aim to exclude firms that engage in unrecorded transactions with suppliers or deliberately underreport inputs in order to artificially keep a high VAT ratio and avoid audits. Additionally, they exclude seasonal firms, the behavior of which is difficult to be modeled in short horizons, and firms that enter/exit the industry during the sample period. Finally, taking into account that VAT liability was payable at the time of filing during the sample period, the filters also exclude firms

¹⁴These sub-industries are the following: restaurants, bars, hosted establishments, suppliers/catering, cafeterias, traditional coffee/pastry shops, fast-foods, take-aways, and others.

that skip a VAT report and file a cumulative report the following period due to financial constraints (a practice common in Greece).

Table 1 provides descriptive statistics for the retrieved sample that is used to examine the VAT rate decrease (August 2013). The sample includes 17,673 entities (732 large and 16,941 small firms). Large firms are over 10 times larger than their smaller peers, in terms of both reported sales and inputs. The vast majority of firms in the industry exhibit low levels of alcoholic sales (less than 25%), with larger firms being less dependent on alcoholic sales (19% as compared to 23% for small firms on average). Large fast-food restaurants (control group) is the least dependent group on alcoholic sales (5.46% of sales on average, 1.77% at the median).¹⁵

[INSERT TABLE 1 HERE]

3.2 Methodology

The aim of this analysis is to examine the effect of VAT rate changes on sales underreporting, therefore I focus on *Reported Sales* as the main variable of interest. But since compliance is not the sole determinant of the level of reported sales, I use the Sales ratio, defined as the ratio of reported sales to reported inputs, to control for possible growth effects. In this context, an increase in reported sales can be attributed to growth; however, an increase in the Sales ratio is consistent with sales disclosure, unless an exogenous shock is at work (e.g. a technological innovation).¹⁶ Additionally, the Sales ratio partially adjusts for seasonality, which is a prominent characteristic of the industry. Due to the fact that restaurants exhibit strong seasonality at the quarter level, I use the *percentage change of the Sales Ratio* (ΔSR) with respect to the same quarter of the previous year as our main dependent variable.

Ideally, one would like to use a set of firms with no evading opportunities as a benchmark, since for this group the effect of tax rate changes on underreporting should be zero. This is not feasible, therefore a group with low evading opportunities is chosen as the control sample, namely

¹⁵Table A.I in the Appendix reports descriptive statistics for the sample that examines the VAT rate increase of September 2011, and exhibits similar properties to the main sample.

¹⁶Note that such a change could be justified by an external shock (e.g. a technological innovation that increases the marginal productivity of inputs). However, the nature of the services provided by restaurants and the concurrent adjustment of the Sales ratio to tax rate changes suggest that such a shock is not at works here.

large fast-food restaurants. I focus on large firms, because of their higher intensity of third-party reporting and paper trail, which plays an important role in limiting evading behavior (Kleven, Kreiner & Saez [2009], Kleven et al. [2011]). Due to their size, the role of paper-trail in large firms is multi-dimensional; it is used to monitor employees, facilitate accounting, and organize supply orders. Specifically for large fast-food restaurants, internal and external paper-trail is embedded in the processing of a high volume of orders. Furthermore, since the majority of these firms belong to chains and franchises, they are subject to additional monitoring, reporting, and penalties, if a violation is realized, from franchisers.

I implement a difference-in-difference (DD) methodology, in order to assess the effect of VAT rate changes on sales underreporting, as captured by changes on the Sales ratio. In this analysis, I look into treatment groups with different characteristics; small and large firms are examined separately, and so are groups with different levels of dependence on alcoholic sales.¹⁷ Since the tax rate for alcoholic sales remains unchanged, these groups represent samples with different exposure to the policy changes. Specifically, I estimate the following equation:

$$\Delta SR_{it} = \beta_0 + \beta_1 \cdot I_{t>t_0} + \beta_2 \cdot I_{i \in B} + \tau \cdot I_{t>t_0} \cdot I_{i \in B} + X_{it} \cdot \beta + u_{it}, \quad (2)$$

where ΔSR_{it} is the main dependent variable, the percentage change of the Sales ratio, B is the treatment group, t_0 is the quarter of the VAT change, and X is a vector of control variables for sub-industries, geographies, and seasonality. The variable of interest in (2) is τ , which captures the treatment effect from the rate change. I additionally present results from quantile regressions that are less sensitive to outliers.

I also examine the effect of the rate reduction in greater detail by using a difference-in-difference specification, differentiated by quarter, as in Lefebvre et al. (2009), using

$$\Delta SR_{it} = \beta_0 + \beta_1 \cdot I_{t>t_0} + \beta_2 \cdot I_{i \in B} + \sum_{t=1}^n \tau_t \cdot I_t \cdot I_{i \in B} + X_{it} \cdot \beta + u_{it}, \quad (3)$$

where periods 1 to n refer to the quarters following the tax rate change.

¹⁷ I estimate the percentage of alcoholic sales for each firm as the percentage of sales subject to the high tax rate before the change in September 2011. Results presented here use the percentage of alcoholic sales of the second quarter of 2011. In robustness tests, I have used the average percentage of alcoholic sales over the period from January 2010 to June 2011, with no significant differences in the results.

4 Empirical Results

4.1 Effects of VAT Rate Decrease

Here, I examine the effects of the VAT sales rate decrease for non-alcoholic sales from 23% to 13% in August 2013. The relative stable macroeconomic conditions in Greece at the period of the rate reduction (the Greek GDP changed by -0.4% and -0.1% in Q3 and Q4 of 2013 respectively [OECD statistics]), and the strong evidence regarding the very limited pass-on of the reduced rate to consumer prices create an exemplary setting to examine the effect of the rate change on underreporting.

The control (pre-change) period consists of the first two quarters of 2013, while the last two quarters of 2013 are defined as the testing (post-change) period. Since the policy change occurred in August, the first quarter of the testing period includes a month (July) with the high rate in effect. The dependent variable is the percentage change of the Sales ratio from the respective quarter of 2012, when the high tax rate was in effect.

Figure 4 presents median changes of Sales ratio for the control (large fast-food restaurants) and treatment groups, before and after the policy change. The tax rate reduction in the third quarter of 2013 is followed by an increase of the dependent variable, which is particularly strong for small firms (Figure 4(b)). Figures 4(c)-(f) indicate an increase in the Sales ratio that is larger for firms that are more exposed to the policy change (lower levels of alcoholic sales).

[INSERT FIGURE 4 HERE]

In Tables 2 and 3 these trends are examined in greater detail. For the total sample retrieved the treatment effect is 8.54% (8.14%) and highly significant.¹⁸ The quarter decomposition shows that in the last quarter of 2013, when the lower rate applied to all three months of the quarter, its scale is significantly larger at 11.8% (9.57%). Analysis by firm size suggests that the effect is induced mainly by small firms. For large firms the treatment effect is small, 3.11% (4.35%), and statistically significant only in the case of quantile regressions, while for small firms it is substantially larger, 8.77% (8.62%), and highly significant in both specifications. The quarter decomposition shows a

¹⁸For robustness, I also report results from the *quantile* specification in parentheses.

gradual increase of the Sales ratio from 5.36% (7.45%) to 12.18% (10.17%) for Q3 and Q4 of 2013 respectively, consistent with the fact that the first quarter of the testing period includes a month, in which the high rate applies.

[INSERT TABLE 2 HERE]

The sharp increase of the small firms' Sales ratio, following the VAT rate decrease, is indicative of an increase in compliance. It is notable that large firms exhibit a comparably moderate response, despite the fact that they are more exposed to rate changes (lower percentage of alcoholic sales), thus reflecting higher constraints on underreporting.

[INSERT TABLE 3 HERE]

Table 3 presents results for groups formed on the basis of their dependence on alcoholic sales. Since the VAT sales rate for alcohol remained unchanged throughout the period, a higher percentage of alcoholic sales indicates lower exposure to the tax rate change. Consistent with this, a monotonic relationship between the treatment effect and the level of exposure to the rate reduction is observed. I find no significant treatment effect for firms in the high alcohol group and the mid-high alcohol group (except in the quantile specification (4.41%)); however, for firms that are less dependent on alcoholic sales, the increase of the Sales ratio is large and highly significant at 9.10% (7.53%) for the mid-low and 9.65% (9.32%) for the low alcohol group.

The fact that the increase of the Sales ratio is concentrated among firms with low alcoholic sales further alleviates concerns that the documented change is a result of an external factor that affects the industry (i.e. increased tax enforcement effort). This result is also consistent with active VAT ratio targeting; firms with high levels of alcoholic sales do not experience a significant change in their VAT sales rate, therefore they do not need to adjust their VAT ratio. On the contrary, firms with low alcoholic sales that are more exposed to the tax rate change proceed to more significant "adjustments".

4.2 Validity and Robustness

4.2.1 Effects of VAT Rate Increase

Next, I examine the impact of the VAT rate increase for non-alcoholic sales, from 13% to 23% (September 2011), which, according to the intuition behind the adjustment of underreporting, is expected to reduce sales reporting. I note that results here should be interpreted with caution due to the unstable macroeconomic environment (the Greek GDP declined by 8.9% in 2011 [OECD statistics]) and the relatively larger compared to the case of the rate reduction, but still small, tax shifting on prices. I maintain the same methodological framework used previously and define the second and the third quarter of 2011 as the control period, and the following three quarters (Q4 2011-Q2 2012) as the testing period. The last quarter of the control period includes a month (September) when the high standard rate was in effect.

The results are presented in Table 4. As in the case of the rate reduction, the increase of the VAT rate significantly affects the Sales ratio. The treatment effect is -5.11% (-9.02%) for the total sample and is limited for large firms (significant only in the case of quantile regressions). In contrast, the effect is -9.05% (-5.19%) and highly significant for small firms. Also consistent with previous findings, there is evidence of a monotonic relationship between the level of exposure and the treatment effect; the decrease of the Sales ratio is negligible for firms with high percentages of alcoholic sales, but the effect gradually becomes more significant as the percentage declines and reaches -5.86% (-9.96%) for the lowest alcohol group. Collectively, the results are consistent with previous findings, as well as with the intuition behind the adjustment of reported sales around tax rate changes.

[INSERT TABLE 4 HERE]

4.2.2 Placebo Tests

Finally, I implemented the test in a period that tax rates in the industry were immutable; the period before the initial increase of the VAT rate (Q1 2010-Q3 2011). I follow the exact same methodology as previously and define the first two quarters of 2011 as the control period and the

third quarter of 2011 as the testing period. The results of the placebo tests are reported in Table 5. As shown in Table 5 the treatment effect is statistically insignificant for all treatment groups (total, large, small, and groups on percentage of alcoholic sales).

[INSERT TABLE 5 HERE]

5 Fiscal Cost and Policy-making

In this section I discuss the overall fiscal cost and policy implications of the rate reduction. Both aspects are particularly important in order to evaluate the overall impact of the measure. Here, I work with aggregate amounts of reported sales and VAT revenues (Table 6), in order to quantify the total effects of the rate reduction on the industry and the economy.

The increase of compliance as a result of the tax rate reduction has two important implications for the total fiscal cost of the measure. First, due to the fact that firms with “flexibility” in under-reporting adjust the level of sales disclosure to tax rate changes, VAT revenues are only partially adjusted downwards. In Table 6 the VAT revenues decline by just 69.8 million euros compared to the previous year, almost half the amount of the initial predictions (140 mil. euros). This adjustment originates predominately from smaller firms that adjust their VAT revenues downwards by just -10.80%, in contrast to large firms for which the rate reduction is almost totally reflected on revenues (-24.16%). Because of the dominant role of small firms in the industry, the total losses in VAT revenues, from the 30% decrease of the tax rate, are limited to -14.17%.

[INSERT TABLE 6 HERE]

The second implication relates to the effect on direct taxes that follow from a higher level of reported sales. Table 6 shows that small firms increase reported sales by 19.24% following the tax rate reduction, while large firms by just 2.93%. Across the industry, sales reporting increases by 15.20% or 352 million euros during the last two quarters of 2013. To the extent that this increase comes from the disclosure of “hidden” sales, which do not involve additional production costs, it is

expected that it will be reflected on the firms' annual results, at least partially.¹⁹ Given the 26% direct tax rate, just a fraction of this amount could potentially offset a significant part of the initial losses in VAT revenues (69.8 mil. euros).

It follows that the total fiscal cost from the implementation of the rate reduction is significantly reduced as compared to original estimates, which failed to factor in the response of affected entities. This cost should be weighted against long-term benefits provided by a lower tax rate. The results suggest that the VAT rate reduction increases compliance, especially for firms that are more prone to underreporting; thus, it also increases competitiveness not only with respect to foreign competitors,²⁰ but also within the industry.

These findings offer critical insights for policy-making and enforcement. The results provide an explanation for the large discrepancies between forecasts and realized results for the fiscal impact of tax measures. The rate increase of 2011 provided only 160 million euros of additional revenue, in contrast to expectations for an additional one billion euros of revenues annually.²¹ Similarly, initial predictions regarding the rate decrease of 2013 estimated the losses in VAT revenues at 140 million euros for the first five months of implementation, but actual losses were in reality less than half of this amount (see Table 6). Much in the spirit of Lucas' critique (1976), policymakers seem to consistently fail to account for the response of affected entities, which in this case materializes through adjustments in sales reporting.

Furthermore, my analysis demonstrates the importance of VAT and Sales ratios as enforcement tools in identifying evaders and constraining their activities. If used as a base for targeted audits, these ratios can uncover evaders through a comparison to industry benchmarks, after tailoring to specific characteristics such as location, size and type of service.

Finally, the results suggest that the problem of sales underreporting is more pronounced in smaller firms, a finding consistent with the insights of Porta and Shleifer (2008), and Hurst et al. (2011). The flexibility on sales reporting can be related to the enforcement role of paper-trail

¹⁹Carrillo, Pomeranz & Singhal (2014) suggest that evading firms that increase reported sales may also increase reported costs to limit their tax liability. However, I do not find evidence of such behavior for two reasons; first, it contradicts the notion of VAT ratio targeting that motivates the increase in compliance. Second tax authorities in Greece, recognizing the limits of enforcement on restaurants' final sales, tend to focus their audits on incoming paper-trails of inputs.

²⁰At the time that the high VAT rate was implemented, the restaurant of the main competitors of Greece in the tourism sector were subject to significantly lower VAT rates, ranging from 5.5% in France to 13% in Italy.

²¹"*Why VAT rate for restaurant services should be reduced*", Christos Staikouras & Stauros Petsas, Kathimerini, April 21, 2013. The data are from the VAT revenue office of the Ministry of Finance.

intensity and third-party reporting (Kleven, Kreiner & Saez [2009], Kleven et al. [2011], Pomeranz [2015]), which is typically more constraining for larger firms. On the other hand, Hanlon, Mills, and Slemrod (2005) argue that non-compliance of large firms is related to the existence of more complex operations that facilitate income under-reporting. The different origin of evasion for small and large firms suggests that enforcement efforts should be differentiated by size; concentrated on indirect tax evasion for small firms and on direct tax evasion for larger ones.

6 Conclusions

This paper examines the effect of VAT rate changes on tax evasion in an environment with limited tax-shifting opportunities. The empirical evidence suggests that a reduction of the VAT sales rate significantly increases compliance, especially for firms with more evading opportunities. This result is consistent with VAT ratio targeting, the active effort to maintain a reasonable VAT ratio (revenues to credits), in order to avoid signaling evasion to the tax authorities. As a result of this process, a rate reduction is followed by the partial adjustment of VAT revenues downwards and the corresponding increase in reported sales (thus disclosing “hidden sales”). I also document the reverse effect in the case of a VAT rate increase.

These findings offer substantial impetus from a policy-making point of view. I show that in an environment of pervasive evasion, the reduction of the VAT rate not only reduces underreporting, but also benefits compliant firms, thus improving competitiveness within the industry. Furthermore, to estimate the fiscal cost of these measures one should take into account the response of affected entities as suggested by Lucas (1976); the partial adjustment of VAT revenues by evaders and the impact of changes in compliance on direct taxes. Depending on the incidence and distribution of underreporting, I show that, by accounting for these effects the final fiscal cost of a rate reduction can be minimal compared to its benefits.

My findings suggest that in environments where enforcement is challenging, the reduction of tax rates may be beneficial, as it increases compliance at a small fiscal cost. Both results stem from the fact that evasion is bounded by indicators of economic activity (VAT and Sales ratios), which constitute powerful tools for detecting non-compliance.

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Figures

Figure 1: Percentage Change of Reported Sales and VAT Revenues

The figure presents the percentage change of reported sales and VAT revenues for Q3 & Q4 of 2013 (after the rate reduction) as compared to the same period of the previous year (Q3 & Q4 2012). The sample includes all firms in the industry (complete sample). Large and small firms are classified according to the tax authority definition.

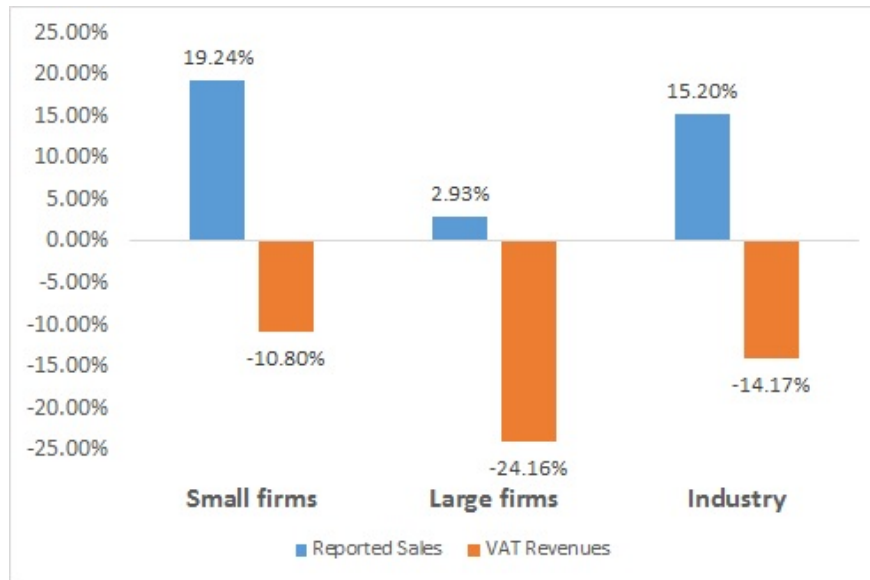
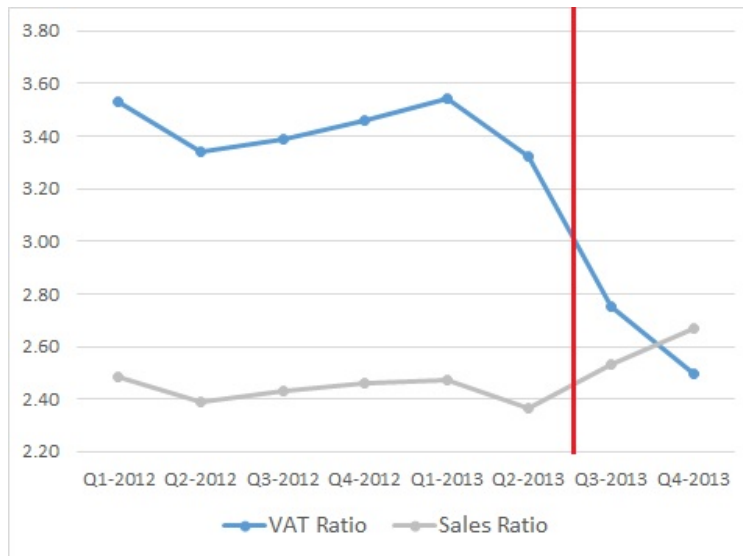
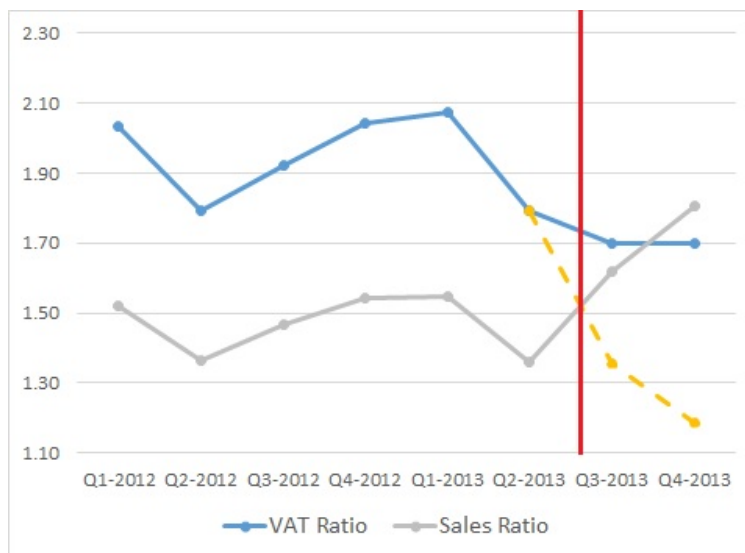


Figure 2: Sales & VAT Ratios of Small and Large firms

The figures present average Sales (reported sales to reported inputs) and VAT (VAT revenues to VAT credits) ratios for the period between Q2 2012 and Q4 2013. Figure 2(a) refers to large firms and Figure 2(b) to small firms. Firm size is defined by the tax authorities on the basis of annual turnover. The dashed line in Figure 2(b) projects the VAT ratio reduced by the percentage decrease of the effective VAT sales rate, with respect to the same quarter of the previous year (2012). The red lines indicate the time of the VAT sales rate reduction. The samples include all firms in the restaurant industry with no missing VAT reports during the sample period that report at least €500 of inputs per quarter.



(a) Large Firms



(b) Small Firms

Figure 3: Sales VAT Rates in the Restaurant Industry (2010-2013)

The figure presents the VAT rates that applied to alcoholic and non-alcoholic sales in the restaurant industry from January 2010 to December 2013.

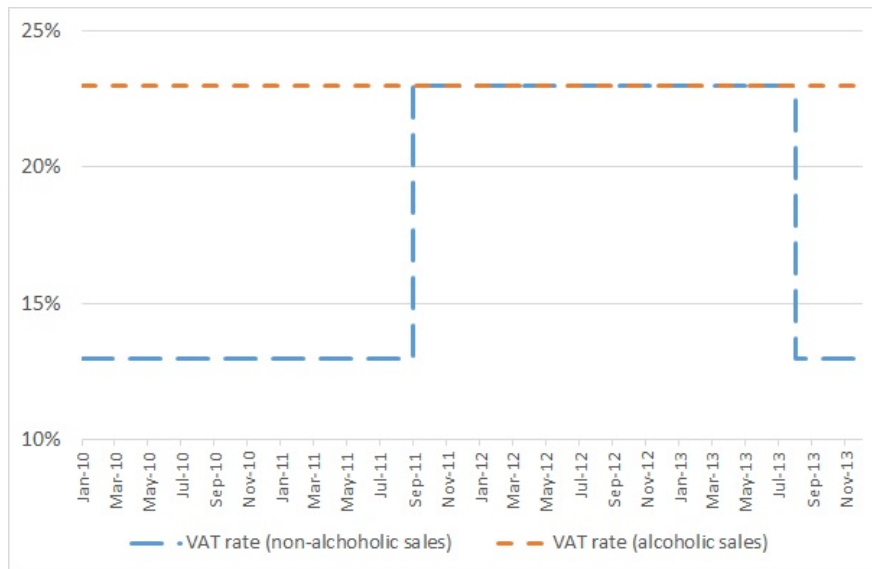
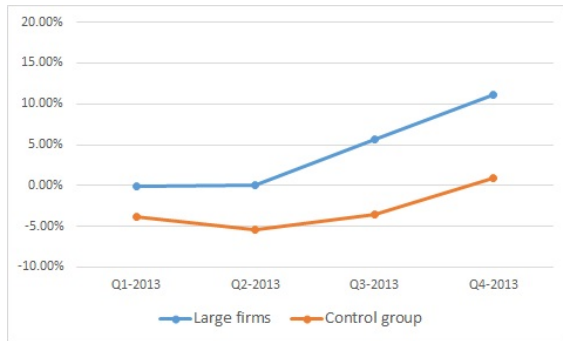


Figure 4: Sales Ratio and VAT Rate Reduction

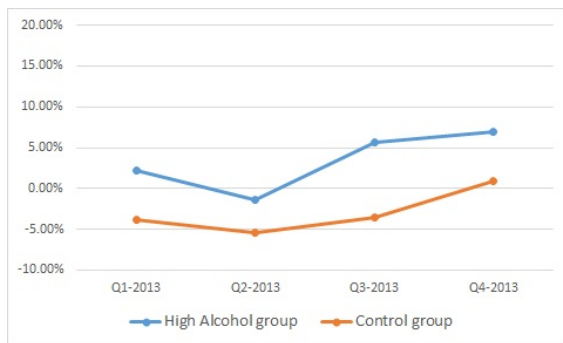
The figures present median percentage change of the Sales ratio with respect to the same quarter of the previous year for the control group (large fast-food restaurants) and the treatment groups. Figures 4(a) and (b) refer to large and small firms, as defined by the tax authorities, based on annual turnover. Figures 4 (c), (d), (e), and (f) refer to groups of firms with alcoholic sales over 75%, 50-75%, 25-50%, and less than 25% of the turnover, respectively, in the second quarter of 2011. The policy change occurred in August 2013. The control and testing periods include Q1 & Q2 and Q3 & Q4 of 2013, respectively.



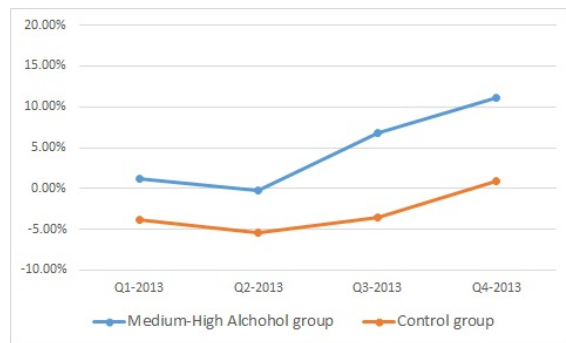
(a) Large Firms



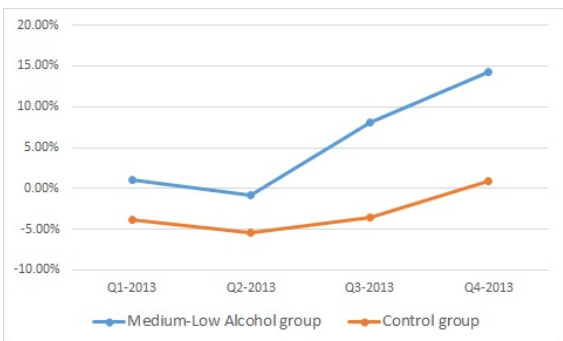
(b) Small Firms



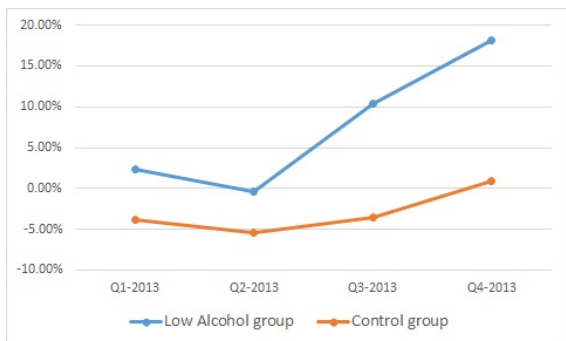
(c) High Alcoholic sales (>75%)



(d) Medium-High Alcoholic Sales (50-75%)



(e) Medium-Low Alcoholic sales (25-50%)



(f) Low Alcoholic Sales (<25%)

Tables

Table 1: Sample Descriptive Statistics

The table presents summary statistics, averages and medians (in parentheses), of the main variables across the sample period (Q1 2012-Q4 2013), for the VAT rate decrease sample. All figures refer to euros per quarter, except the *Percentage of Alcoholic Sales* that refers to the percentage of sales subject to the high VAT rate in the second quarter of 2011 (before the initial increase of the standard industry VAT rate). The control group consists of large fast-food restaurants and is not included in the Total group. Size is defined by the tax authorities based on annual turnover. High, Mid-High, Mid-Low, and Low Alcohol groups include firms with alcoholic sales over 75%, 50-75%, 25-50% and less than 25% of the turnover, respectively, in the second quarter of 2011. The samples include all firms in the restaurant industry with no missing VAT reports during the sample period that report at least €500 of inputs per quarter. *VAT Revenues* refer to the total VAT collected from sales per quarter. *VAT Credits* refer to the total VAT claimed for inputs per quarter. *Reported Sales* and *Reported Inputs* are calculated based on the VAT figures, using the applicable rates.

	Panel A: VAT rate decrease (Q1 2012-Q4 2013)							
	Total	Control	Large	Small	High Alcohol	Mid-High	Mid-Low	Low Alcohol
Reported Sales	28,345 (9,285)	253,572 (185,696)	236,018 (107,842)	19,371 (8,694)	25,153 (8,439)	14,075 (5,089)	17,020 (6,035)	34,104 (12,214)
Reported Inputs	16,279 (6,640)	99,709 (74,032)	104,260 (49,512)	12,477 (6,268)	17,229 (6,369)	8,743 (3,929)	10,302 (4,357)	19,141 (8,460)
VAT Revenues	5,380 (1,757)	48,539 (36,380)	45,151 (20,749)	3,662 (1,646)	5,492 (1,789)	2,911 (1,046)	3,373 (1,187)	6,347 (2,228)
VAT Credits	2,574 (1,078)	15,327 (10,988)	16,561 (7,800)	1,970 (1,023)	3,617 (1,330)	1,686 (782)	1,846 (803)	2,856 (1,251)
% of Alc. Sales	22.82% (14.21%)	5.46% (1.77%)	18.93% (11.03%)	22.99% (14.37%)	90.29% (91.52%)	60.65% (59.52%)	36.03% (35.19%)	8.85% (8.02%)
Number of Firms	17,673	184	732	16,941	784	1,625	3,642	11,622

Table 2: Sales Ratio and VAT Rate Reduction by Size

The table presents the results for the VAT rate reduction of August 2013 using equation (2),

$$\Delta SR_{it} = \beta_0 + \beta_1 \cdot I_{t>t_0} + \beta_2 \cdot I_{i \in B} + \tau \cdot I_{t>t_0} \cdot I_{i \in B} + X_{it} \cdot \beta + u_{it}$$

Treatment effects are reported for the total sample and sub-samples of large and small firms, according to the tax authorities' specification. The control group includes all large fast-food restaurants. Sales ratios are winzorized at the 1% level for the total sample, per quarter. The samples include all firms in the restaurant industry with no missing VAT reports during the sample period that report at least €500 of inputs per quarter. Model (1) presents the results of OLS regressions, while Model (2) refers to quantile regressions. Models (1a) and (2a) decompose the treatment effect to the two quarters of the testing period (Q3 & Q4 2013) using equation (3). All specifications include sub-industry, region, and quarter fixed effects. Heteroscedasticity robust standard errors, clustered by firm, are reported in brackets. Significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

Panel A: Total Sample				
	(1)	(1a)	(2)	(2a)
τ	0.0854*** [0.0248]		0.0814*** [0.0125]	
τ_1		0.0527** [0.0229]		0.0703*** [0.0154]
τ_2		0.1180*** [0.0337]		0.0957*** [0.0143]
Panel B: Large Firms				
	(1)	(1a)	(2)	(2a)
τ	0.0311 [0.0307]		0.0435*** [0.0150]	
τ_1		0.0327 [0.0300]		0.0411** [0.0175]
τ_2		0.0296 [0.0415]		0.0513*** [0.0183]
Panel C: Small Firms				
	(1)	(1a)	(2)	(2a)
τ	0.0877*** [0.0248]		0.0862*** [0.0118]	
τ_1		0.0536* [0.0229]		0.0745*** [0.0159]
τ_2		0.1218*** [0.0337]		0.1017*** [0.0145]
Sub-ind. FE	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes

Table 3: Sales Ratio and VAT Rate Reduction by Alcoholic Sales

The table presents the results for the VAT rate reduction of August 2013 using equation (2),

$$SR_{it} = \beta_0 + \beta_1 \cdot I_{t>t_0} + \beta_2 \cdot I_{i \in B} + \tau \cdot I_{t>t_0} \cdot I_{i \in B} + X_{it} \cdot \beta + u_{it}$$

Treatment effects are reported for treatment groups formed on the basis of dependence on alcoholic sales; High, Mid-High, Mid-Low, and Low groups include firms with a percentage of alcoholic sales (as of Q2 2011) greater than 75%, 50-75%, 25-50%, and less than 75%, respectively. The control group includes all large fast-food restaurants. Sales ratios are winzorized at the 1% level for the total sample, per quarter. The samples include all firms in the restaurant industry with no missing VAT reports during the sample period that report at least €500 of inputs per quarter. Model (1) presents the results of OLS regressions, while Model (2) refers to quantile regressions. Models (1a) and (2a) decompose the treatment effect to the two quarters of the testing period (Q3 & Q4 2013) using equation (3). All specifications include sub-industry, region, and quarter fixed effects. Heteroscedasticity robust standard errors, clustered by firm, are reported in brackets. Significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively.

	Panel A: High Alcohol				Panel A: Mid-High Alcohol			
	(1)	(1a)	(2)	(2a)	(1)	(1a)	(2)	(2a)
τ	0.0080 [0.0410]		0.0023 [0.0195]		0.0303 [0.0326]		0.0441*** [0.0164]	
τ_1		0.0140 [0.0415]		0.0236 [0.0206]		0.0083 [0.0305]		0.0370** [0.0177]
τ_2		0.0015 [0.0523]		-0.0088 [0.0252]		0.0523 [0.0447]		0.0539** [0.0216]
	Panel C: Mid-Low Alcohol				Panel A: Low Alcohol			
	(1)	(1a)	(2)	(2a)	(1)	(1a)	(2)	(2a)
τ	0.0910*** [0.0271]		0.0753*** [0.0134]		0.0965*** [0.0250]		0.0932*** [0.0131]	
τ_1		0.0686*** [0.0253]		0.0622*** [0.0147]		0.0567*** [0.0230]		0.0780*** [0.0162]
τ_2		0.1195*** [0.0370]		0.0802*** [0.0175]		0.1364*** [0.0340]		0.1128*** [0.0151]
Sub-ind. FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6: Aggregate Reported Sales and VAT Revenues (Q3-Q4, 2012 & 2013)

The table presents aggregate reported sales and VAT revenues for the third (Q3) and fourth (Q4) quarters of 2012 (high base rate) and 2013 (reduced base rate). The third quarter of 2013 includes a month (July), during which the high standard rate was in effect. Amounts are presented for small and large firms according to the tax authorities' classification, along with industry totals. Percentage changes [Δ (%)] are calculated over the respective amount of the previous year. All figures are measured in thousands of euros ('000).

	Reported Sales			VAT revenues		
	Q3	Q4	Q3 & Q4	Q3	Q4	Q3 & Q4
<u>Small</u>						
2012	1,121,517	630,730	1,752,247	231,907	136,689	368,596
2013	<u>1,265,873</u>	<u>823,480</u>	<u>2,089,353</u>	<u>205,637</u>	<u>123,150</u>	<u>328,786</u>
Δ (%)	12.87%	30.55%	19.24%	-11.33%	-9.90%	-10.80%
<u>Large</u>						
2012	315,224	261,716	576,940	66,891	57,254	124,144
2013	<u>307,860</u>	<u>285,956</u>	<u>593,816</u>	<u>51,493</u>	<u>42,656</u>	<u>94,150</u>
Δ (%)	-2.34%	9.26%	2.93%	-23.02%	-25.20%	-24.16%
<u>Industry</u>						
2012	1,436,741	892,446	2,329,187	298,798	193,943	492,740
2013	<u>1,573,733</u>	<u>1,109,436</u>	<u>2,683,169</u>	<u>257,130</u>	<u>165,806</u>	<u>422,936</u>
Δ (%)	9.53%	24.31%	15.20%	-13.95%	-14.51%	-14.17%

Appendix

A Model of VAT Evasion without Tax-Shifting

In the theoretical model, I define true sales as s^T , reported sales as s^R , and sales understatement as $u = s^T - s^R$. Since firms are subject to different VAT rates, I use the effective VAT rates of sales (τ_s) and inputs (τ_i), defined as the weighted averages of the applicable rates, weighted by the respective amounts reported. I treat τ_s and τ_i as exogenous, similarly to inputs (i), due to the assumption that tax authorities perfectly observe incoming paper-trail for retailers.

The tax authorities use the VAT ratio (r), defined as the ratio of VAT revenues to VAT credits, in order to detect non-compliance. Thus, the VAT ratio can be written as,

$$r = \frac{\tau_s \cdot s^R}{\tau_i \cdot i} = \frac{\tau_s \cdot (s^T - u)}{\tau_i \cdot i}, \text{ with } r'(u) = -\frac{\tau_s}{\tau_i \cdot i} < 0 \quad (4)$$

The probability of detection is endogenous and is a non-increasing function of the VAT ratio (r); $p(\text{audit}) = p(r)$, where $p'(r) \leq 0$. It follows from (4) that the detection probability is a non-decreasing function of sales underreporting. The penalty for a VAT violation is a significant lump-sum amount, denoted by T .

Following Cremer and Gahvari (1993), I examine the behavior of a risk-neutral firm. Therefore, the typical entrepreneur attempts to maximize the expected payoff from engaging in VAT-evasion activities, subject to the tax penalty:

$$P = (\tau_s \cdot u) + p(r)(-T)I_v, \quad (5)$$

where I_v is an indicator function that takes the value 1 if the firm underreports sales, and 0 otherwise.

Notice that the proceeds from evasion ($\tau_s \cdot u$) are realized even in the case of detection, reflecting the fact that usually revenues from VAT evasion cannot be recouped. In order to examine the optimal level of underreporting, I define the following functional form for the probability of detection:

$$p(r) = \begin{cases} 1, & \text{if } r < 1 \\ \frac{1}{r^n}, & \text{if } r \geq 1 \end{cases} \quad \text{with } n \geq 1, \quad (6)$$

According to (6), the tax authorities audit all firms that report a VAT ratio less than one, thus resulting to a negative VAT liability. Firms that report a VAT ratio greater than one have a probability of detection that decreases at an increasing rate, as r increases ($p'(r) < 0$, $p''(r) > 0$). The probability of detection is inversely related to parameter n , which is determined by the tax authorities and depends on its budget, the cost of audits, and the distribution of r .

The optimal level of underreporting is derived by the first order conditions of (5):²²

$$\frac{dP}{du} = 0 \Rightarrow \tau_s - T \cdot \frac{\theta p}{\theta r} \cdot \frac{\theta r}{\theta u} = 0 \quad (7)$$

Using (4) and (6), we have

$$u^* = s\tau - \sqrt[n+1]{T} \cdot \frac{(\tau_i \cdot i)^{\frac{n}{n+1}}}{\tau_s} \quad (8)$$

From (8), it follows that

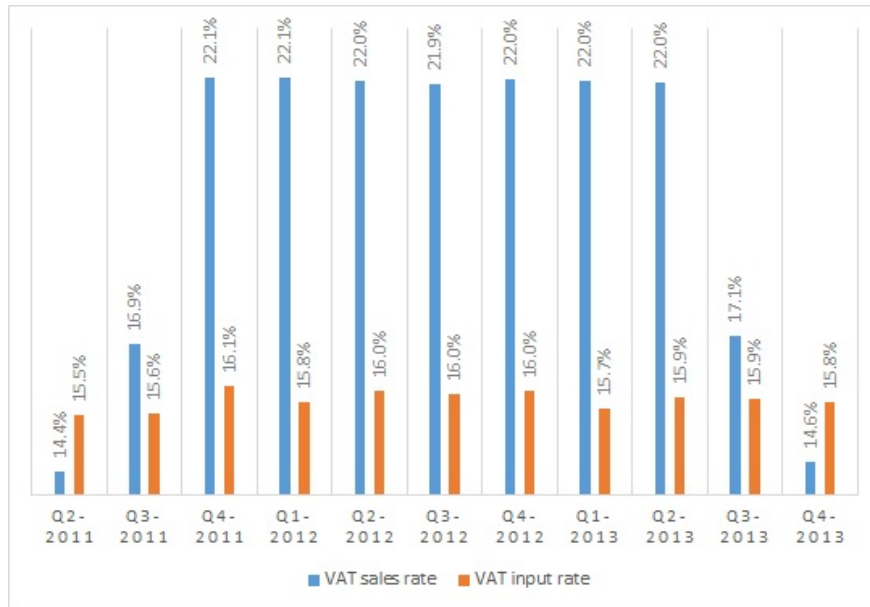
$$\frac{\theta u^*}{\theta \tau_s} > 0 \qquad \frac{\theta u^*}{\theta \tau_i} < 0 \qquad \frac{\theta u^*}{\theta T} < 0$$

Therefore, according to the model, a decrease in the sales VAT rate (τ_s) reduces the optimal level of underreporting, since it simultaneously decreases the benefit from evasion and increases the probability of detection. In contrast, a decrease in the input VAT rate (τ_i) increases optimal underreporting, since a greater understatement of sales can be “hidden” under the lower denominator of the VAT ratio (r). Notice that from (8) it follows that the effect of τ_s is stronger than the effect of τ_i ; an increase (decrease) in both VAT rates of equal magnitude will result to an increase (decrease) of the optimal level of underreporting. This reflects the dual impact of τ_s in (5), whereas τ_i only affects the objective function through r . Finally, an increase of the penalty T is consistent with lower levels of underreporting.

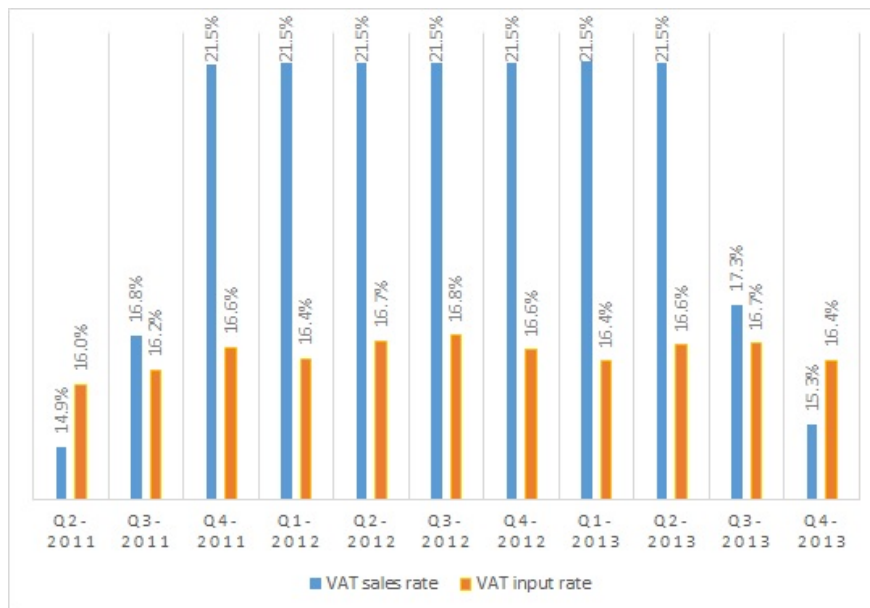
²²Note that the second order conditions are also satisfied, as $\frac{d^2 P}{du^2} < 0$.

Figure A.1: Effective VAT Rates of Inputs and Sales

The figure presents quarterly averages of the effective VAT rates for reported inputs and sales from small and large firms from Q2 2011 to Q4 2013. Effective VAT rates are defined as the weighted average of the applicable rates weighted by the respective amounts reported. Firm size is defined by the tax authorities on the basis of annual turnover.



(a) Large Firms



(b) Small Firms

Table A.I: Sample Descriptive Statistics

The table presents summary statistics, averages and medians (in parentheses), of the main variables of the VAT rate increase sample, across the sample period (Q1 2010-Q1 2012). All figures refer to euros per quarter, except the *Percentage of Alcoholic Sales* that refers to the percentage of sales subject to the high VAT rate in the second quarter of 2011 (before the initial increase of the standard industry VAT rate). The control group consists of large fast-food restaurants and is not included in the Total group. Size is defined by the tax authorities based on annual turnover. High, Mid-High, Mid-Low, and Low Alcohol groups include firms with alcoholic sales over 75%, 50-75%, 25-50% and less than 25% of the turnover, respectively, in the second quarter of 2011. The samples include all firms in the restaurant industry with no missing VAT reports during the sample period that report at least €500 of inputs per quarter. *VAT Revenues* refer to the total VAT collected from sales per quarter. *VAT Credits* refer to the total VAT claimed for inputs per quarter. *Reported Sales* and *Reported Inputs* are calculated based on the VAT figures, using the applicable rates.

	VAT rate increase (Q1 2010-Q1 2012)							
	Total	Control	Large	Small	High Alcohol	Mid-High	Mid-Low	Low Alcohol
Reported Sales	33,581 (10,242)	291,369 (214,392)	236,658 (121,229)	20,374 (9,388)	32,778 (8,885)	16,892 (5,355)	21,232 (6,701)	39,773 (13,559)
Reported Inputs	17,473 (6,551)	112,116 (81,092)	100,156 (50,205)	12,095 (6,053)	23,551 (6,237)	9,696 (3,922)	11,511 (4,564)	19,931 (8,179)
VAT Revenues	5,589 (1,695)	46,489 (33,763)	39,730 (20,190)	3,369 (1,552)	7,212 (1,859)	3,303 (1,041)	3,831 (1,195)	6,326 (2,057)
VAT Credits	2,787 (1,049)	17,206 (12,204)	15,925 (7,862)	1,933 (980)	5,101 (1,243)	1,851 (774)	2,056 (836)	2,967 (1,185)
% of Alc. Sales	22.94% (13.95%)	4.50% (1.70%)	20.38% (11.83%)	23.10% (14.17%)	90.39% (92.19%)	60.53% (59.38%)	35.99% (35.13%)	8.56% (7.71%)
Number of Firms	12,610	206	770	11,840	630	1,147	2,558	8,275