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Improving VAT Compliance by Switching Who Remits the Tax: Evidence from Construction Firms*

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Abstract

Many countries use a reverse charge mechanism (RC) in value added tax (VAT) to combat tax evasion in specific high-risk sectors. The RC shifts the liability to remit VAT from the seller to the buyer. We study the adoption of RC in 2011 in the construction sector in Finland using tax return data on the universe of Finnish firms. Using a difference-in-differences design, we find that reported net VAT liabilities in the construction sector increased by 5% compared to unaffected firms. The results show that the remittance policy can be effective in decreasing VAT evasion by subcontractors that provide services for large firms.

Keywords: *tax compliance; value added tax; reverse charge mechanism; firm behavior.*
JEL Classification: *H25; H26; L74; O17; Z18.*

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1 Introduction

In the presence of tax evasion, the efficiency of a tax system may be affected by who remits the taxes (Slemrod, 2007). Value added tax (VAT), the consumption tax in most countries, is considered a particularly efficient consumption tax precisely for this reason. Sellers remit VAT on their sales but deduct VAT on their purchases. This creates incremental payments in the production chain and a paper trail on transactions, as businesses hold on to receipts to claim the deductions. These reduce the opportunities for tax evasion compared to a sales tax where the final seller is liable for the entire tax (Keen, 2008; Pomeranz, 2015). However, more than 50 countries have adopted a reverse charge (RC) mechanism, which reverses the remitting liability, in sectors with a high risk of tax evasion. RC transfers the VAT liability to the buyer in business-to-business transactions, effectively making the final seller liable for the total VAT payment. Despite its widespread adoption, research on the effects of reverse charge policies is very limited.

In this paper, we study how reverse charge impacts VAT compliance in the construction sector using data on the population of tax returns in Finland. Finland adopted a reverse charge mechanism in the construction sector in 2011. RC applies when i) a firm sells construction services to ii) a firm that regularly sells construction services. The construction sector is characterized by extensive use of subcontractors and increasing firm size along the production chain. By changing the VAT remittance to the purchaser, RC removes the opportunity for subcontractors, often small firms that sell services to main contractors, to evade VAT. With no evasion, the question of who remits the tax would only impact the timing of the payment, leaving the tax revenue unchanged.

Following adoption of the policy, about 20% of all sales in the construction sector were under RC and over half of firms had some sales under RC. By analyzing which firms have RC-covered sales and purchases in the data, we observe that large firms tend to be the main contractors that buy construction services under

RC: a few large companies with annual sales of over €10 million report 67% of all reverse charge payments. There is little difference in the share of sales covered by RC by firm size, indicating that all types of firms sell to other businesses.

We use a difference-in-differences design to study the effects of the policy on reported VAT. We compare the development of firms in the construction sector after the RC reform to firms in other sectors that continue under the normal VAT system. A potential threat to the identification strategy is that the construction sector may differ from other sectors. Despite this, the differences in trends before the reform are small. We improve the comparability using coarsened exact matching (CEM). After the CEM procedure, we retain all construction firms and nearly all comparison firms. The main contribution of CEM is to produce regression weights that make the size and age distribution of the comparison firms more similar to construction firms. After CEM, the trends before the policy are parallel.

We find that the policy increased sales and tax liabilities reported by construction firms. On average, reported net VAT increased by 5% compared to the year before the policy was enacted. This is a substantial impact when considering that RC covered only 20% of sales in the sector. The estimated effect suggests a yearly tax revenue increase of approximately €90 million in value added tax. The results hold under a battery of robustness checks.

The increased tax liabilities suggest an improvement in tax compliance. As we observe increases in both reported sales and deductions, the results suggest that RC reduced under-reporting of sales as a mechanism of tax evasion rather than reducing over-reporting of costs. Over half of the increase in gross VAT liabilities is offset by a simultaneous rise in reported deductions. This response is in line with previous literature, where policy interventions are also followed by an unexpected increase in declared tax deductions (Carrillo et al., 2017; Konda et al., 2022). The increase in deductions can be explained by reduction in under-reporting of scale as a strategy of tax evasion, an increase in false claiming of deductions or if firms increase input sales prices to regain some of the losses from the reduced tax

evasion.

The results suggest that the policy reduced tax evasion by subcontractors by reducing the opportunity to evade VAT payments. The reduction is not offset by an increase in tax evasion by main contractors. This finding is supported by our heterogeneity analysis: the VAT accrued from small firms increases relatively more while there is a negligible effect on the largest firms, which tend to work as main contractors. This can be rationalized if the tax evasion opportunities for the main contractors did not increase because of the reform. In fact, a key feature of the initial reform was that it did not change the reporting practices. Therefore, the policy only changed the remittance practices and not the paper trail generated by the VAT system. Furthermore, the main contractors are typically large firms that tend to be more compliant in the baseline as they may face higher costs from tax evasion.[1]

We then investigate spillovers to reporting labor costs as well as subsequent tax enforcement policies implemented in the construction sector that increased contractor's reporting liabilities in 2013 and 2014. Together with RC, these policies increased the third-party information available to the Tax Administration on subcontractors' sales and employment. First, we observe an increase in payroll tax and withholding of personal income tax after the adoption of RC. This suggests spillovers of VAT enforcement to other tax bases. In particular, under-reporting of scale potentially requires under-reporting of employment or vice versa. Second, we find that increasing the amount of third-party reporting after adopting RC further increases the reporting of payroll taxes and withholding of personal income tax, but it does not increase the accrued VAT.

The main contribution of our paper is to provide evidence that a reverse charge policy, which switches the VAT remittance liability, can improve tax compliance.

[1] Large firms tend to face stricter monitoring by the tax authority, and there is an increased risk of whistleblowing for large firms (Almunia & Lopez-Rodriguez, 2018; Kleven et al., 2016). In addition, tax evasion may cause reputational harm.

This paper is one of the first to evaluate the effects of RC using firm-level tax data[2]. In particular, we show improved compliance due to RC in the construction sector, where 29 countries have implemented a reverse charge system (EY, 2024).[3] Previously, Buettner and Tassi (2023) study the impact of RC using industry-level data in Germany, where it was implemented in different sectors to fight VAT fraud.[4] They estimate revenue losses of 5% due to tax fraud pre-RC. They argue that RC reduced VAT fraud, where firms over-claimed VAT deductions as they find a decrease in reported sales and deductions. In contrast, our results are consistent with RC reducing so-called *cross-invoicing*, where subcontractors invoice the VAT but do not remit it, while contractors still deduct the VAT based on their purchase receipts. Our contribution is to show that RC is effective not only for VAT fraud, but a more traditional form of domestic tax evasion. While the particular setting may impact which type of evasion is impacted the most, we argue that RC is more effective in fighting traditional non-compliance because VAT fraud can relatively easily switch the sector of activity and thereby avoid sector-specific policies, as suggested by Buettner and Tassi (2023).

We also contribute to previous studies on VAT enforcement and compliance. Waseem (2022) shows how the built-in withholding feature of VAT is significant in increasing reported sales, making VAT particularly suitable in environments where the upstream firms are more formal. This is often the case in developing economies. We add to this literature by documenting a case where the built-in withholding feature becomes a drawback and transferring remittance liabilities downstream improves tax compliance. The impact we find is solely due to the change in remittance as there were no changes to reporting requirements. We ar-

[2]A recent working paper by Cipullo et al., 2024 studies RC in the Italian construction sector using balance sheet data and also finds a positive effect on VAT revenues.

[3]Based on our reading of the Ernst and Young Worldwide VAT, GST and Sales Tax Guide. According to our calculations, 52 countries have implemented a domestic reverse charge for some good or service. For a complete list, see Table A1.

[4]VAT can be vulnerable to tax fraud, including invoice mills (Carrillo et al., 2023; Waseem, 2023) and missing trader fraud (Heinemann & Stiller, 2023). In these cases, firms falsify invoices to claim false deductions or to avoid output VAT. In extreme cases, the fraud gains are the sole purpose of the firm.

gue that RC can improve VAT compliance in settings where i) firms that sell inputs to other firms evade taxes by under-reporting sales and ii) the tax evasion opportunities of downstream firms do not increase, for example when the downstream firms are large, formal companies. Furthermore, we contribute to the existing literature on the self-enforcement properties of value added tax. Pomeranz (2015) and Naritomi (2019) study the significance of third party information and Pomeranz (2015) also studies the role of asymmetric incentives to cheat.

Finally, our paper relates to several studies that document the significant role of remittance policies in tax compliance. Garriga and Tortarolo (2024) show how appointing large firms to remit turnover tax on behalf of small businesses in Argentina led to significant improvement in tax reporting by small business partners. We show a similar result in the context of business-to-business transactions in a VAT regime where a reverse charge mechanism effectively transferred VAT liabilities from small to large firms. To our knowledge, our study is one of the first to address these enforcement properties in a high tax-capacity setting. Other studies that document how changing the remittance policy improves tax compliance include Bibler et al. (2021), studying the effects of shifting tax liability from individual renters to the platform in the short-term rental market, and Kaçamak et al. (2023), studying shifting the tax liability from consumers to online retailers.

The rest of the paper is structured as follows. In the next section, we present the conceptual framework describing VAT evasion in the conventional versus a reverse charge system. In Section 3, we discuss the institutional details of the Finnish VAT regime, the construction industry, and we describe the adoption of the reverse charge. We also describe the data used. The empirical strategy and the results are discussed in Section 4. Finally, Section 5 concludes.

2 Conceptual Framework

2.1 VAT System and Reverse Charge

Value added tax is an ad valorem tax that is included in all transactions of goods and services. VAT plays a central role in state funding and, on average, contributes a fifth of total tax revenue in OECD countries[5] (OECD, 2023). Businesses pay VAT on their sales and can deduct the VAT that is included in their input costs. This ensures that the tax is revenue-neutral as each company pays VAT based on its own value added. The VAT system is preferred by many governments due to its self-enforcing features (Pomeranz, 2015) and generation of incremental payments throughout the value chain.

A reverse charge (RC) mechanism transfers the tax liability to the buyer in business-to-business transactions. A reverse charge policy has been adopted in multiple countries to curb tax evasion and fraud. EU member states have been allowed to implement reverse charge in sectors that are susceptible to VAT non-compliance since 2006 (Directive 2006/112/EC3). Member states can choose which groups of producers and customers RC applies to.

The self-enforcing nature of conventional VAT stems from how VAT is paid and deducted in business-to-business transactions. Table 1 describes VAT payments under the conventional system in column (1) in a short value chain. The upstream firm u sells production of value s_u to the intermediary, adding VAT at rate τ on the sales price, and pays $\tau * s_u$ in taxes, which is the VAT accrued from the transaction in column (3). The intermediary sells s_i to the downstream firm, creating value added of $s_i - s_u$, pays $\tau * s_i$ in VAT but deducts $\tau * s_u$, with net payments of $\tau * s_i - \tau * s_u$. The total VAT accrued up to this transaction is $\tau * s_i$. Finally, the downstream firm sells value $\tau * s_d$ to final consumers with net VAT payments of $\tau * s_d - \tau * s_i$. The total VAT accrued is $\tau * s_d$, which is collected incrementally in

[5]The United States remains the only OECD country that employs a sales tax as its primary tool for taxing consumption.

Table 1: VAT payments and deductions in a value chain under conventional VAT and reverse charge

		(1) Conventional VAT	(2) Reverse Charge	(3) Accrued VAT
Upstream	Value added	s_u	s_u	
	VAT payment	$\tau * s_u$	0	
	VAT deduction	0	0	
	Net VAT	$\tau * s_u$	0	$\tau * s_u$
	Evasion	$\tau * e_u$		
Intermediary	Value added	$s_i - s_u$	$s_i - s_u$	
	VAT payment	$\tau * s_i$	$\tau * s_u$	
	VAT deduction	$\tau * s_u$	$\tau * s_u$	
	Net VAT	$\tau * s_i - \tau * s_u$	0	$\tau * s_i - \tau * s_u$
	Evasion	$\tau * e_i$		
Downstream	Value added	$s_d - s_i$	s_d	
	VAT payment	$\tau * s_d$	$\tau * s_d + \tau * s_i$	
	VAT deduction	$\tau * s_i$	$\tau * s_i$	
	Net VAT	$\tau * s_d - \tau * s_i$	$\tau * s_d$	$\tau * s_d - \tau * s_i$
	Evasion	$\tau * e_d$	$\tau * e_d^{RC}$	
Total		$\tau * s_d$	$\tau * s_d$	$\tau * s_d$
		$\tau * (\overline{s_d} - e_u - e_i - e_d)$	$\tau * (\overline{s_d} - e_d^{RC})$	

Notes: The table shows VAT liabilities in a value chain with upstream, intermediary and downstream firms under conventional VAT in column (1) and a reverse charge mechanism in column (2), and how much value added tax is accrued from each transaction in column (3), and the total collected VAT in the last row. The downstream firm sells the final good or service to consumers and uses inputs sold by the intermediary. The intermediary buys inputs from another upstream firm. Reported sales are s_f for firm f, evasion is $e = v_f - \overline{v_f}$ where $v_f = s_f - c_f$ is the reported value added, i.e. sales minus costs, and $\overline{v_f}$ is the true value added.

the value chain.

Column (2) in Table 1 describes VAT payments under an RC mechanism. The upstream firm or intermediary (seller) sells the good or service, but does not invoice or pay VAT. The purchaser must then remit the VAT to the authorities. This payment is referred to as the reverse charge. As with regular VAT, the reverse charge VAT is tax deductible. At the final sale, the downstream firm is liable to remit VAT on its total sales, and pays the total VAT accrued in the value chain. The net VAT payments of the upstream and intermediate firms are zero, and the net payments of the final seller are the entire value added $\tau * s_d$.

The penultimate row in Table 1 shows that the total VAT paid under the conventional system and reverse charge is the same without tax evasion. However, as with a sales tax, the full tax liability is paid at the final sale under an RC mechanism.

2.2 VAT Evasion and Fraud

Firms can engage in VAT evasion by misreporting value added. Let $\overline{v}$ equal the true and v the reported value added. Tax evasion is $\tau * e = \tau * (\overline{v} - v)$ where value added is sales minus costs or $v = s - c$. Consider a simple model of tax evasion in the style of Allingham and Sandmo (1972) and Kleven et al. (2011) where a firm maximizes after tax value added[6] given a perceived detection probability $d(R, e)$, where $R = (s, c, v)$ is the vector of items reported to the tax authority, with a penalty θ:

$$\overline{s} - \overline{c} + \tau(\overline{s} - s) - \tau(\overline{c} - c) - d(R, e)(1 + \theta)\tau(\overline{v} - v) \tag{1}$$

Under-reporting value added increases the after-tax benefits if the evasion is not detected, but the penalty and the detection probability reduce the expected benefits from evasion. From equation (1) it is clear that firms can evade VAT by i) under-reporting sales ($s < \overline{s}$) or ii) over-reporting costs ($c > \overline{c}$). The total VAT collected is shown in the last row of Table 1 and equals the true value of final sales minus the evasion by each firm in the value chain.

The incentives for upstream firms to evade VAT are constrained by the behavior of intermediate and downstream firms. In order to claim the tax deduction on their costs, buyers need to acquire and store receipts for sales by the upstream firms. Collusion is unlikely, since upstream and downstream firms have asymmet-

[6]We only focus on VAT evasion, abstracting from other tax liabilities of firms such as business income tax on profits or payroll taxes on labor inputs. More realistically, firms choose a bundle of tax evasion on different bases to maximize the total after tax benefits. The reporting requirements and evasion decisions for other taxes may also affect the choice to evade VAT. For simplicity, we do not consider these incentives here.

ric incentives for misreporting. This generates a paper trail for the transactions that can be accessed by the tax authorities in a tax audit. This paper trail increases the probability of detection for the seller, which creates a self-enforcing feature in the VAT system.

However, the self-enforcing mechanism is weaker when the supply chains are complex and long, and the transactions become hard to track. This can create opportunities for firms to engage in so-called *cross-invoicing*, which refers to a type of tax evasion where an upstream firm invoices the VAT, entitling the buyer to deductions, but does not remit the VAT to the tax authority. In other words, the seller and buyer send conflicting tax returns, and the government ends up reimbursing the buyer for unpaid taxes. Consider the value chain in Table 1 if the upstream firm does not comply. The intermediate firm still deducts $\tau * s_u$ and the total collected VAT is now $\tau * s_d - \tau * s_s$. The authorities may observe that the value of goods and reported taxes does not add up, but identifying evaders in complex supply chains is costly.

There are also types of tax fraud related to cross-invoicing. *Fake receipts* can be used to over-report costs. Their purpose is to reduce the risk of detection: in a tax audit undocumented costs are easy to discover. The difference between cross-invoicing and fake receipts is that the sole purpose of the transaction is tax evasion. VAT systems are known to be vulnerable to so-called *invoice mills* or *missing traders* that produce false receipts for tax deductions (Carrillo et al., 2023). These are ghost firms with no real business activity that sell fake receipts to businesses, which claim deductions on them, but do not pay tax on their sales.

Firms can also *under-report scale*, i.e. under-report both sales and costs. This strategy aims to decrease the probability of detection, as larger firms tend to face higher audit rates and monitoring. By under-reporting size firms appear smaller to the tax authority and face a lower detection rate, decreasing the expected costs of tax evasion.

2.3 Effect of Reverse Charge

Evasion by each firm in the value chain is depicted in Table 1. The last row shows that evasion by each firm in the value chain reduces the total VAT collected under the conventional system, while in the reverse charge system there is only evasion by the final seller.

Effect on tax payments. We argue that RC can increase total VAT by increasing the VAT accrued from upstream firms (but remitted by buyers). Comparing the total VAT collected under the conventional and RC systems, we get the following sufficient condition for larger tax revenue under RC:

$$e_d^{RC} - e_d \leq e_u + e_i \tag{2}$$

where e_d^{RC} is the evasion of the downstream firm under RC. Namely, RC increases VAT revenue if tax evasion by downstream firms increases less than upstream (and intermediary) firms evaded in the conventional system.

Effect on upstream firms. Reverse charge decreases VAT evasion by firms that sell RC-covered goods or services to other firms, essentially by removing the opportunity of the seller to evade taxes by cross-invoicing. Consequently, RC likely increases reported sales by these upstream firms as they gain less from under-reporting and may still face penalties for misreporting.[7] It also removes the incentives for false receipts, as the buyer is liable for the tax on the purchase. With RC the expected benefit of the seller in equation (1) becomes:

$$\overline{s} - \overline{c} - \tau(\overline{c_t} - c_t) - d(R, e)(1 + \theta)\tau(c_t - \overline{c_t}) \tag{3}$$

leaving only over-reporting of costs c_t, which are not under RC, as a channel of VAT evasion.[8] But, because the detection probability likely increases if a firm reports

[7] Firms may still reduce business tax base by under-reporting sales.

[8] Or under-reporting sales that are not under RC, but here we only discuss the simplified case with all sales under RC.

negative taxable value added, the firm now has lower expected benefits from tax evasion when $e = c_t - \overline{c_t}$ [9]. Upstream firms may try to increase prices to account for the lost benefits of evasion.

Effect on downstream firms. The effect on tax payments is essentially dependent on the effects on downstream firms. We argue that RC is not likely to have an effect on compliance by downstream firms, although it increases the tax liabilities. The potential to increase evasion is mitigated by the reporting requirements and audit policy. Consider the expected benefit under RC for a firm that sells to final consumers:

$$\overline{s} - \overline{c} + \tau(\overline{s} - s) - \tau(\overline{c_t} - c_t) - d(R, e)(1 + \theta)\tau(\overline{v_t} - v_t) \tag{4}$$

where $v_t = s - c_t$ is the VAT base, consisting of the value of total sales minus costs that are not under RC. As the tax base is increased, higher e is possible without ending up with a negative taxable value added. However, the firm still has the liability to report total costs $c = c_t + c_r$ including c_r, costs under RC, and little incentive to under-report costs since costs also reduce the business income tax base. Note that the probability of detection depends on the total reporting of the firm. The risk of audit can be higher for firms that report a low total value added compared to total costs, which reduces the incentives to under-report sales. Consider, for example, an audit policy where $d(R, e|v) = d(R, e|v_t)$ and plug in $e = \overline{s} - s - (\overline{c_t} - c_t)$ in equation (4) and equation (1). Then the firm's expected benefit is

$$\overline{s} - \overline{c} + \tau * e - d(R, e|v)(1 + \theta)\tau * e \tag{5}$$

under both conventional VAT and RC, resulting in no compliance effect of RC on the downstream firm. Consequently, RC has no effect on compliance by down-

[9] This holds if the perceived risk of detection is higher when firms report negative value added. For example, Waseem (2022) argues that expanding the VAT net increases VAT compliance downstream by increasing reported deductions, and hence sales by downstream firms, as firms avoid reporting less sales than costs.

stream firms in this case. However, if the detection probability is very low for downstream firms, they may use the opportunity to evade more. For example, if there are many small downstream firms, monitoring them may be difficult for the tax authority. The effect on downstream firms is, consequently, dependent on the ability of the tax authority to monitor downstream firms. If downstream firms increase evasion enough, as they perceive more opportunity for evasion, tax payments may decrease under RC.

Effect on costs. The effect on deductible costs is ambiguous. RC may decrease over-reporting of costs by decreasing the opportunities for fake receipts. However, if firms use under-reporting of scale as a tax evasion strategy, RC may increase both sales and costs. In addition, costs may increase if upstream firms increase prices to account for lost benefits from evasion. Hence the effect on costs is indicative of the relative magnitudes of these opposing effects.

Spillovers to other tax bases. Firms may evade taxes on other tax bases including business income tax or employee payroll taxes. Reporting of sales may affect how much firms can, for example, under-report labor. Consequently, RC may increase reporting in other tax bases.

3 Institutional Context and Data

3.1 Key Details of the Finnish VAT Regime

Finland is a developed economy witha tax-to-GDP ratio of 42%, which is one of the highest in the OECD (OECD, 2024), and little perceived corruption (Transparency International, 2023). VAT accounts for 22% of tax revenue (OECD, 2023). Finland has one of the smallest estimated VAT gaps in the European Union, with a 7.5% gap against a median gap of 10.3% (Poniatowski et al., 2019).

All businesses that sell goods or services in Finland are required to report and pay value added taxes, with exemptions for small firms. Following the EU stan-

dard, Finland has a common VAT rate that applies to the majority of goods and services, and two lowered and zero rates for specific product types. In 2011 the common rate was 23%.[10] VAT law also exempts sales of medical services, financial services, and the sale or rental of real estate from the tax. Businesses or other entities producing these services do not have to register with the VAT register.

Companies in the VAT register file VAT returns with different frequencies, depending on their annual sales. Until 2010, all firms filed VAT returns on a monthly basis. Since 2010, firms with annual revenues below €50,000 have been able to opt to file returns quarterly, and firms with revenue below €25,000 can file annually. Businesses with annual revenue below a threshold of €8,500[11] are exempt from value added taxes. These firms are not required to register for VAT but can do so voluntarily. When their sales cross the VAT threshold, they pay VAT on all of their sales but are entitled to partial relief. If a firm in the VAT register is inactive during in a tax period, it is still required to file a "zero return".

Finland does not have transaction VAT reporting. Hence relatively little information is sent to the tax authority through VAT returns. The VAT form is a stripped-down document that requires no information about trading partners or individual transactions. Firms report their aggregate taxes, sales and deductions. No additional information is sent to authorities, but firms must hold on to their receipts for at least six years. An example of the Finnish VAT form is given in Appendix A.2. The self-enforcing mechanism of VAT is based on the threat of discovering the transaction data (receipts) in the event of a tax audit.

3.2 The Finnish Construction Industry

Between 2008 and 2015, around 50,000 businesses registered their main industry as construction each year. Industries are reported based on Statistics Finland's classi-

[10] The common rate started at 22% in 1994, was increased by a percentage point in both 2010 and 2013 and in 2024 to 25.5%.

[11] From 2004 to 2016, the threshold was at €8500 and was subsequently raised to €10,000 in 2016 and to €15,000 in 2021, but these are after our study period.

fications.[12] The Finnish construction industry features long and sprawling contract chains that create opportunities for tax evasion. The industry's cyclical nature and project-focused structure discourage the retention of an extensive in-house workforce. In addition, large construction projects may require many different types of specialized labor. Firms and workers are contracted on a project-by-project basis. Construction projects often include multiple contractors and agency-hired labor. Due to the structure of the value chains, a handful of large downstream firms account for a large fraction of total sales: the top 1% of firms had 52.0% of sales, whereas 96.8 % of firms had annual revenues below €2 million.

Cross-invoicing and other forms of VAT non-compliance are present in the construction industry. According to tax authorities, VAT evasion is often a byproduct of other types of evasion. Companies that employ undocumented labor aim to hide their true sales since otherwise it might suggest a larger workforce than that reported. Fabricated receipts produce financial gains, but they are also used to claim that the company's workforce is contracted from other providers. Appearing smaller on paper enables non-compliant companies to avoid a considerable amount of payroll taxes as well as direct taxes. Another more minor form of misconduct is wrongful own use, which occurs when a firm, usually a sole entrepreneur, consumes a good itself but still applies deductions.

3.3 Reverse Charge and Other Policies in the Construction Industry

Finland adopted a reverse charge policy in construction services in 2011 with the goal of reducing tax evasion by subcontractors. Consequently, the policy was tar-

[12]Statistics Finland classifies construction as "[...] the creation, management, renovation, repair, or extension of fixed assets in the form of real estate, land improvements of civil engineering nature and other constructions such as roads, bridges, and dams. This also includes related installation and assembly work, site preparation and general construction, as well as specialized services such as painting, plumbing, and demolition." Statistics relating to the construction industry use this definition unless stated otherwise. The definition covers a wide variety of construction activities from painting to groundwork.

geted at transactions between firms in the construction industry. Liability for value added tax was switched from the seller to purchaser when the following conditions are met: **i) construction services are sold ii) the purchaser is a business that sells construction services on a regular basis and iii) the service is sold in Finland**. The RC policy always applies if the business purchasing construction services has registered its main industry as construction. In practice, "regular basis" means annual basis. Vendors not registered for VAT were not affected by the policy. Renting labor for construction purposes is considered to be a construction service. Sales of construction materials and tools remain under traditional VAT unless they are bundled with services.

Reverse charge was adopted in the construction industry in April 2011 and the policy was immediately applied to any new contracted work. The transition to the new system was somewhat staggered, as reverse charge did not apply to contracts that started before the policy adoption and firms completed existing projects at different times. Firms deemed to provide construction services on a continuous basis had to apply reverse charge immediately. The switch to the reverse charge mechanism was pre-announced well in advance. The law was passed in July 2010 nine months before it came into force, the Finnish Tax Administration held briefings around Finland on the policy and increased its phone helpline services during the transition period.

When RC is applied, the purchaser is liable for the tax but both parties must record the value of the transaction in their VAT returns. Subcontractors itemize their sales under reverse charge separately from other sales. Purchasers also report the construction services they have bought under the reverse charge mechanism. In addition, purchasers calculate and remit the reverse charge. The VAT tax form and notes on its use are presented in A.2.

The Finnish Tax Administration conducted an auditing project in the construction industry in 2008-2012, with increased tax auditing and a report on tax evasion in the industry. This means that the reverse charge reform was accompanied by

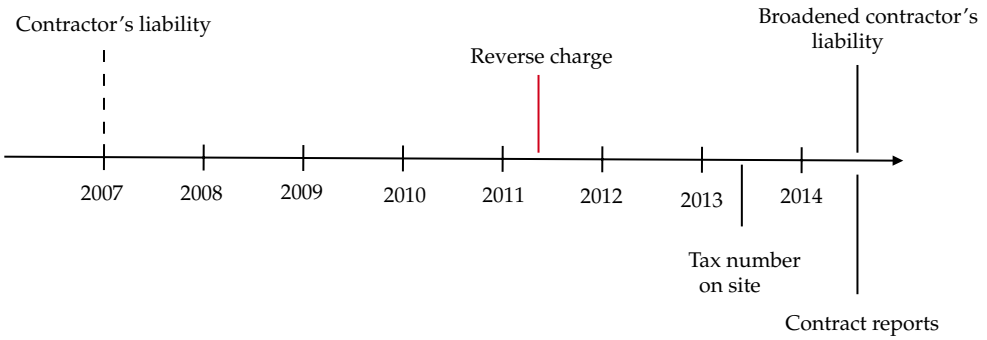


Figure 1: Timeline of new tax policies in the Finnish construction industry. Solid lines show construction-specific reforms.

a period of higher tax enforcement effort. Because the higher auditing activity started before the RC reform, it does not bias our results. However, the increased monitoring effort may have increased the effectiveness of RC due to higher monitoring during the transition period. The project revealed €200.7 million in unpaid taxes, of which unpaid VAT accounted for €62.1 million (Karvonen & Muinonen, 2014).

In addition to reverse charge VAT, various other policies have been implemented to prevent the gray economy activities in the construction sector. These policies limit the time period where the effects of reverse charge can be identified, but we study the additional impact of the subsequent policies in Section 4.4. Figure 1 plots a timeline of the reforms.

Already before the start of our examination period in 2008, a law on contractors' obligations and liability for hired labor was introduced in 2007. The policy was implemented for the whole economy but affects construction in particular. The policy applies when an enterprise hires temporary workers for more than 10 days or more than €9,000. A contractor is obligated to ensure that their business partner has registered with the appropriate tax registers, including the VAT register. Contractors must also verify that vendors have no outstanding tax debt.

In 2013 and 2014 additional policies increased the information reporting requirements for construction firms. First, from 2013 onwards, all workers at shared

construction sites have been required to wear a tag with their photo, name, and tax number to show that they are a registered taxpayer. The year before, a public register of construction workers was introduced for this purpose. Second, since July 2014, anyone who contracts construction services valued above €15,000 is required to file a report to the tax authorities. The purchaser must report information including the contractor's name, the amount invoiced, and details of the worksite. In addition, the project supervisor - most often the project's main contractor - is required to report information on the workers at the site. Failure to comply with the information reporting requirements results in fines. We analyze the additional impact of these later enforcement policies in Section 4.4.

3.4 Data Description and Summary Statistics

We use the universe of tax returns in Finland from 2008 to 2017. After the sample restrictions, we retain a panel of 726,345 unique firms. From here on, this panel is referred to as the full sample. To get the sample, we start with the universe of VAT returns. We exclude firms that have not reported their industry at any point, returns with a missing ID, and tax returns that have been filed by the tax administration on behalf of the firms.[13] After this, we link the VAT returns to each firm's annual business income tax returns using pseudonymous identifiers to obtain more background information such as company form, labor costs and number of employees. We are able to link 93.9% of the entities that have filed VAT returns to business tax returns. After this, we drop non-business company forms.[14] We also link the monthly employer returns that include wage costs, payroll taxes and withholding of workers' personal income tax.

As mentioned in section 3.1, companies have filed VAT returns with different frequencies depending on their annual sales since 2010. We aggregate the data to

[13]These are produced when a firm has not filed its tax return or has been audited.

[14]We include sole proprietors, partnerships, co-operatives and corporations. VAT register also includes other types of legal units such as decedent's estates, municipalities, public sector entities, non-profits and housing associations, which we exclude.

Table 2: Sample Summary Statistics

	Full Sample		Weighted		Pruned
	Construction	Comparison	Construction	Comparison	
	(1)	(2)	(3)	(4)	(5)
Panel A. VAT items in 2010					
Sales	448,045	833,974	448,045	644,892	146,575,613
	(6,602,798)	(43,899,357)	(6,602,798)	(16,138,540)	(906,294,516)
Net VAT	35,152	26,232	35,152	26,109	2,000,392
	(405,461)	(2,268,636)	(405,461)	(948,087)	(44,968,192)
Gross VAT	100,416	144,682	100,416	120,068	21,373,429
	(1,490,983)	(5,896,579)	(1,490,983)	(2,480,970)	(115,595,918)
Deductibles	65,238	118,418	65,238	93,913	19,373,037
	(1,130,116)	(5,275,921)	(1,130,116)	(2,553,892)	(103,457,465)
Panel B. Age distribution in 2010					
$\leq$ 3 years old	0.27	0.15	0.27	0.24	0.19
4-10 years old	0.28	0.16	0.28	0.25	0.33
10+ years old	0.45	0.69	0.45	0.51	0.48
Observations	49,086	414,134	49,086	413,300	834
Panel C. Number of employees in 2010					
Employees	4.5	7.4	4.5	4.5	625.3
	(40.2)	(117.3)	(40.2)	(41.9)	(1,783.4)
Observations	46,134	241,574	46,134	240,740	834
Panel D. RC Coverage 2011 - 2015					
Share of sales	0.26	0.01	0.24	0.01	0.01
Any sales	0.55	0.03	0.55	0.05	0.12

Notes: Columns (1)-(2) show firm-level mean (standard deviation), aggregated to the annual level for the full sample. Columns (3)-(4) show the same with CEM weights from our preferred specification. Column (5) shows summary statistics for companies that receive zero weight. Construction refers to companies that belong to the construction industry. Comparison refers to the rest of the firms in the register. Age distribution describes the proportion of each age group within the comparison group. Share of sales is the proportion of sales covered by the reverse charge mechanism of all sales, each year, between 2011 and 2015. Any sales is an indicator of the firm conducting any sales transaction covered by reverse charge during the year. Descriptions of the variables are given in Table A2.

the annual level for comparability. This also helps to deal with seasonal trends. In the regression analysis, continuous variables are winsorized at 1% at the top and the bottom to deal with extreme outliers.

Table 2 presents summary statistics on the full sample in the construction sector in column (1) and other industries in column (2). Construction firms are smaller when measured by average annual sales or employee count. On average, construction firms have 4.52 employees and €448,000 of sales versus 7.40 employees and €834,000 of sales in other sectors. Notably, construction firms report more net

VAT liabilities on average. This reflects the fact that construction is labor-intensive, so input costs are driven by wages, rather than VAT-deductible purchases. The construction sector is also composed of younger firms, highlighting the fact that firms' turnover in the sector is relatively higher. Less than half of the construction firms are more than 10 years old, while two thirds of the comparison firms have operated for more than ten years in 2010.

The reverse charge reform mechanically reduces the VAT liabilities of upstream firms since they are no longer liable for the tax. Correspondingly, the liabilities of downstream firms are mechanically increased by reverse charge. Without compliance effects, RC only affects who remits the tax, not the amount of tax collected. To disentangle the effect on compliance from the mechanical reporting effect, we construct a variable to measure VAT liability under the conventional system. This allows us to identify the effect on VAT accrued from a firm, regardless of who is responsible for paying the tax. This is possible because firms must report their sales of construction services under reverse charge and reverse charge separately from other VAT items. This allows us to observe their overall sales.

In the following analysis, each firm's VAT liabilities are calculated as if they were under the traditional VAT regime. This is done by adding the VAT liabilities from reverse charge sales to the vendor. Correspondingly, reverse charge remittances are deducted from purchasers' returns. Otherwise, the remittances would be counted double. This strategy allows for a one-to-one comparison between VAT returns in a traditional VAT regime and a reverse charge regime.

3.5 Scope of the Reform

Reverse charges contribute 19.7% of the annual gross VAT reported in the industry after the reform. The left panel in Figure 2 depicts the evolution of the total amount of VAT in the construction industry divided into traditional and reverse charge. In 2010, total VAT is approximately €4.9 billion. In 2012, this is approximately €5.7

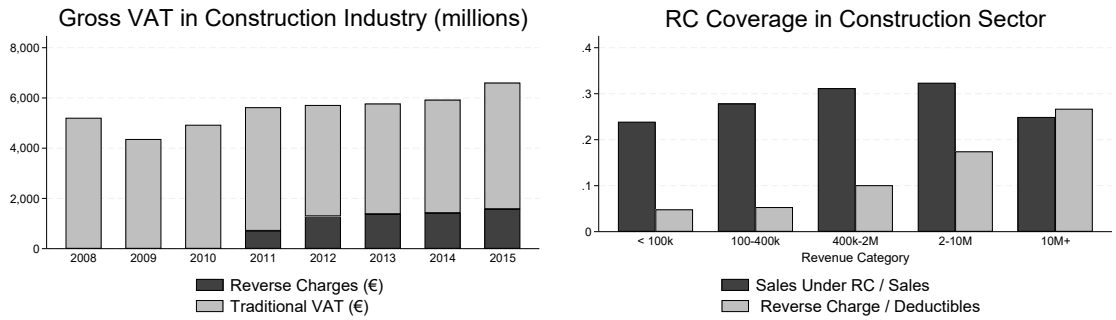


Figure 2: The left panel presents the evolution of aggregate gross VAT in the construction industry from 2008 to 2015. The right panel depicts the coverage of RC in the construction industry from 2011 to 2015. Construction firms are divided into size categories based on their annual sales. The dark-shaded bars show annual firm-level averages for the proportion of RC sales of the firm's total sales. The gray bars show the annual firm-level averages of RC of the firm's overall deductibles.

billion of which approximately €1.3 billion is reverse charge payments. The share of reverse charge payments is smaller in 2011, when not all contracts were under reverse charge, but the share is steady after 2012.

The reform targeted sales of construction services, which limits its coverage to the construction sector and some adjacent sub-industries such as landscaping and renting of labor in the construction sector. Three quarters (76.1%) of all reverse charge payments are remitted by firms registered as being in the construction industry. On average, 56.7% of the firms registered in the construction sector report some sales covered by the policy.

The right panel of Figure 2 illustrates the coverage of reverse charge of firms' sales and costs by firm size as measured by revenue category. On average, RC applies to about a quarter (26%) of the annual sales of a firm. Taking into account the fact that final sales to consumers are not affected by the reform, the scope of the policy is wide. The coverage of sales is similar across the size distribution, varying between 24 and 31% by size category. Consequently, firms that sell construction services to other firms are in all size categories. The coverage is different for costs. Reverse charge deductibles account for 6% of deductions on average, but there are large differences by firm size: reverse charges make up less than a tenth of VAT deductions claimed by firms with annual sales below €2 million but about

a quarter for firms with revenue above €10 million. This indicates that the small firms typically act as subcontractors, while the large firms act as contractors. The largest firms purchase more construction services in both relative and absolute terms. Two thirds of all reverse charges are paid by a handful of companies with more than €10 million in annual revenues.

4 Empirical Strategy and Results

4.1 Identification Strategy

We estimate the effect of reverse charge on firms in construction using a difference-in-differences (DD) method with firms in other sectors as the comparison group. This approach identifies the intent to treat (ITT) effect of the policy. From a policy perspective, this is the relevant estimate, as it reflects the overall effectiveness of the policy. When interpreting the results, it should be kept in mind that the policy only affects the fraction of construction services sold to businesses that sell construction services regularly.[15]

To quantify the effects of the policy, we estimate the following regression:

$$Y_{it} = \alpha_i + \lambda_t + \beta \times (\textit{Post} \times \textit{Construction}_i) + \epsilon_{it} \tag{6}$$

where Y_{it} is the outcome of interest for firm i at time t, α_i the firm fixed effect, λ_t the year fixed effects and ϵ_{it} the error term. *Construction* takes a value of one if a firm i is in the construction industry and *Post* takes a value of one if $t \geq 2011$. The effect of the reverse charge policy is captured by β under parallel trends. In addition, we trace out the dynamics of the policy intervention using a dynamic difference-in-differences design:

[15] We cannot estimate the effect within the construction sector on sales of firms subject to reverse charge, because we do not observe which firms were subcontractors before the reform. In addition, the post-reform data shows that firms' positions in production chains are not fixed.

$$V_{it} = \alpha_i + \lambda_t + \sum_{t=2008}^{2013} \beta_t \times \textit{Construction}_i + \epsilon_{it} \tag{7}$$

that allows us to assess the plausibility of similar time trends. The model's coefficients of interest, β_t, are difference between the construction industry and the comparison group relative to the baseline year 2010 (one year before the policy). We cluster the standard errors at the one-digit industry level.

The main threat to the validity of the design is the comparability of firm trends between the construction sector and other sectors. For one thing, the composition of the construction sector is different from other sectors. Construction companies are comparatively younger, smaller and more labor-intensive. Secondly, construction projects may be more responsive to business cycles and the availability of credit. RC was implemented after the Finnish economy had recovered from a recession, which had momentarily reduced the demand for construction. For these reasons, the between-industry parallel trends assumption is likely violated. We plot the Dynamic DD estimates for the full sample of firms in Appendix A.5.1. The graphical evidence suggests that there are differences in trend before the reform, although they are rather small and only marginally significant.

We address the issue of parallel trends violation by assigning regression weights using coarsened exact matching (CEM). After this, the pre-reform trend differences disappear. The specifics are discussed below. Moreover, we study the sensitivity of the estimates to possible violations of the parallel trends assumption following Rambachan and Roth (2023) in Section 4.6.

Other identifying assumptions include no spillovers to the comparison group and no other simultaneous policy changes. As the policy is limited to the construction services supply chain, it has negligible spillover effects on firms in other sectors. Only a small fraction of firms in the comparison group are directly affected by the policy: just 1% of sales outside the construction industry are covered by the reverse charge mechanism. As discussed in Section 3.3, in 2014 several new

reporting obligations were adopted in the construction industry. Consequently, for the main estimation results we limit the data up to 2013. We explicitly assume that the subsequent policies do not induce anticipatory behavior that affects VAT returns. This assumption is somewhat strengthened by the fact that compliance and monitoring of the subsequent policies were limited when they were first introduced. We investigate the impact of the additional enforcement measures using data until 2017 in Section 4.4. As the policy is enacted at the same time for all firms, heterogeneous treatment effects do not pose a threat to identification.

We estimate the models described in equations (6) and (7) for net VAT, sales, gross VAT and deductibles. The dependent variables are in euros, as they are frequently zero or negative, and for a large number of small firms changes in VAT liabilities between tax periods can be large in relative terms, but not economically significant. Recall that the data is transformed to be comparable with the previous VAT regime. In other words, we estimate the changes in how much taxable value added businesses claim to generate, or how much VAT is accrued from firms. The estimates partly represent how firms change their reporting behavior when they are not liable for paying the tax themselves.

CEM and parallel trends. We address the concern of parallel trends violation by producing regression weights with coarsened exact matching (CEM), as described by Iacus et al. (2012). CEM weighting accounts for common trends that affect firms with similar matching variables non-parametrically. Still, it is possible that we are unable to account for potential shocks that only affect construction. In CEM, firms that belong to exactly the same bins of all matching variables form a stratum, and then only firms in strata with both treated and control firms are used. The weighting method produces weights such that the number of treated firms in a stratum equals the weighted number of control firms.

We match the firms based on three pre-policy variables in 2010: number of employees, mean salary, and a dummy variable for zero revenue. Data descriptions for the matching variables are given in Table A2. Employee bins are coarsened

according to Statistics Finland's size classifications. Zero sales is matched exactly. Mean salary is coarsened by following Sturge's rule for the optimal number of bins.

After matching, we retain all 49,086 of the firms that were registered as being in the construction industry in the year prior to the reform. The comparison group retains 99.8% (413,300) of the firms registered in other industries. Summary statistics for the weighted sample are shown in columns (3) and (4) of Table 2 and for pruned firms in column (5). Since we match based on 2010 characteristics, firms that are not in the VAT register that year are also excluded from the matched sample.

With weighting, differences in means of sales, gross VAT and deductibles are smaller. Pruning removes the largest firms from the comparison group as similar companies do not exist in the construction sector. Intuitively, the re-weighting process shifts the size distribution of comparison firms towards that of firms in the construction sector.

Matching changes the industry composition of the comparison group by decreasing the share of firms in the agricultural sector. Correspondingly, firms in industries such as retail trade, manufacturing and the professional services sector receive extra weight. The composition of industries in the comparison group is shown in Figure A.2.

4.2 Results

Figure 3 plots the development of the VAT items during the examination period for the construction industry and the comparison group.[16] The construction sector and the comparison group appear to follow similar trajectories in the pre-reform period. After the reform there is an increase in VAT for both groups, but there is a clear jump higher in the level for the construction sector.

Figure 4 plots the corresponding dynamic DD coefficients. Graphical evidence

[16]We additionally plot quarterly dynamic estimates with a sample that excludes annual returns in Figure A.5.

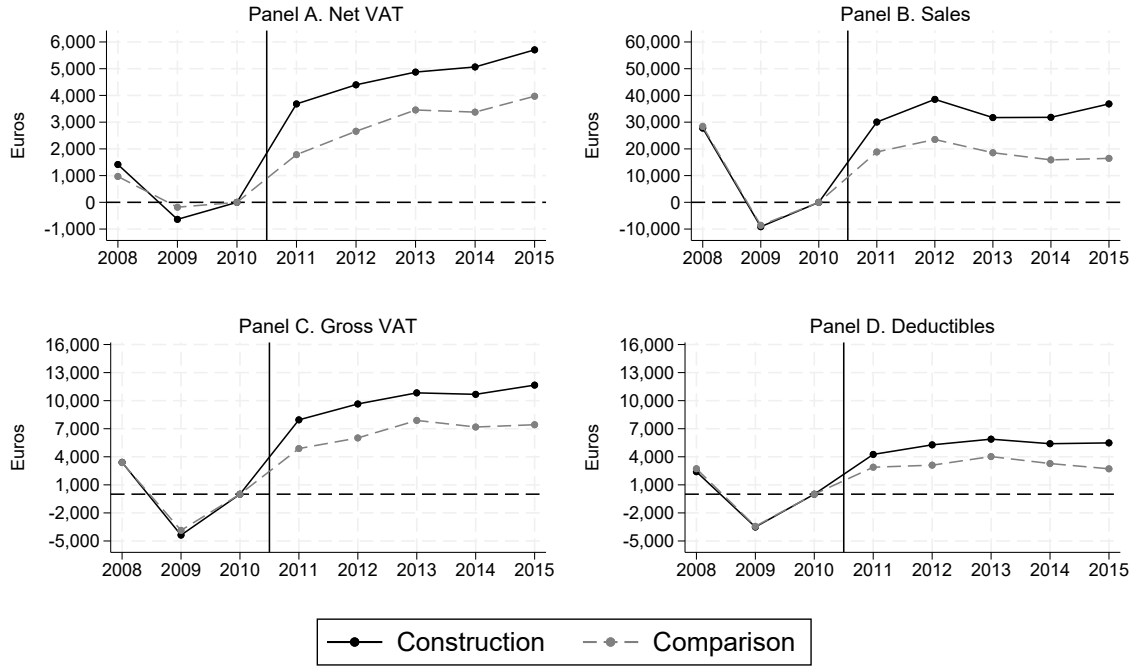


Figure 3: Annual trends for the weighted samples, estimated by regressing the dependent variable on a year dummy on the dependent variable separately for both groups and controlling for firm fixed effects. The coefficients are in relation to the last year before the reform (2010), which is normalised to zero. Dependent variables are winsorized at 1% at both tails.

in the figure reveals that no pre-treatment coefficient alone is statistically different from the baseline. In addition to visual inspection, we assess the plausibility of parallel trends by running a Wald test on the pre-treatment coefficients. We test whether the pre-treatment coefficients are different from the baseline difference in 2010. The joint hypothesis that the coefficients are zero is maintained for gross VAT, deductibles, and sales. However, it is rejected for net VAT at $p < 0.05$. Below, we study the sensitivity of the result for various magnitudes of violations of exact parallel trends.

The discontinuous jump in comparison to the baseline in all of the outcome variables in Figure 4 suggests that the adoption of the reverse charge policy had a positive effect on VAT reported by construction firms. The main outcome of interest is the treatment effect on net VAT, which is shown in Panel A of Figure 4. In line with our hypothesis that RC increases reported VAT, there is a clear increase of about €2,000 in reported net VAT after the reform. A clear increase is observable for other dependent variables. The dynamics indicate that the policy

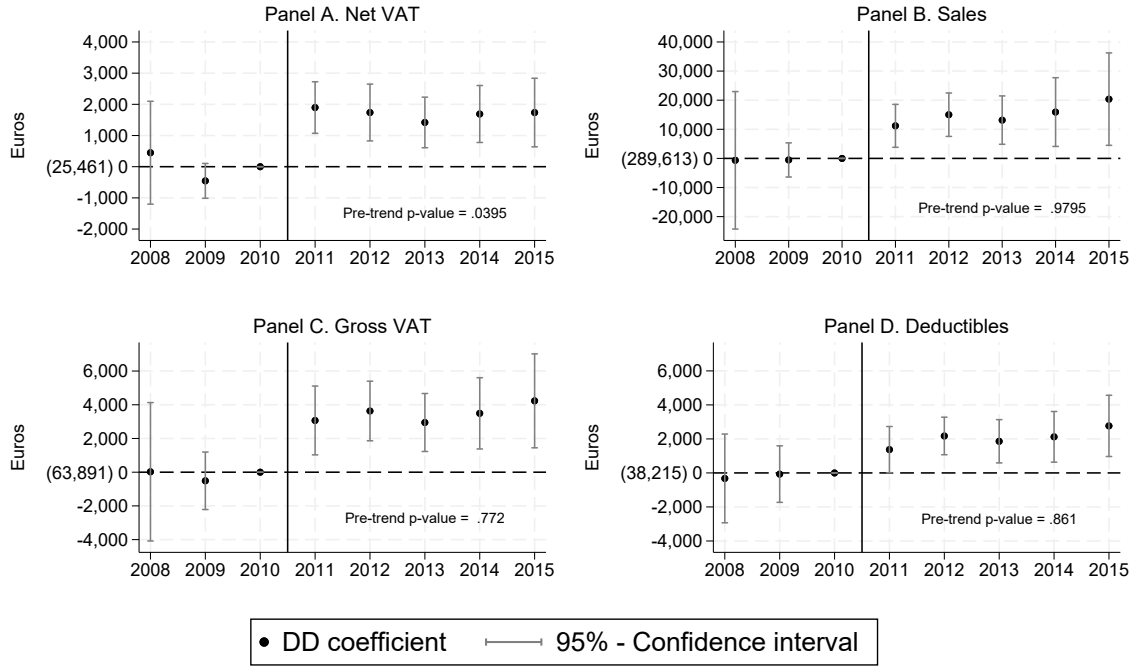


Figure 4: Dynamic DD with the weighted sample. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The pre-trend p-value is from a Wald test for pre-policy effects. Standard errors are clustered by one-digit industry codes and dependent variables are winsorized at 1% at both tails.

takes full effect in 2011. This might be because most subcontractors do not have long contracts continuing under traditional VAT past the first year.

The figure also shows that reported sales and gross VAT increase discontinuously after the reverse charge mechanism is introduced. A similar, but comparatively smaller, increase in deductions (panel D) dampens the net increase in tax remittances.

The graphical evidence suggests that the reform causes companies to increase their reported levels of value added. Table 3 shows the estimation results of equation (6) for the key outcomes. Annual VAT accrued from construction firms increases by €1,781.9 on average. This result is statistically significant at $p < 0.001$. This translates into an increase of 5.07% relative to the mean net VAT of €35,152 in the treatment group in the year before the policy. Sales increase by €13,829 and gross VAT by €3,494. In Section 4.6 we show that the findings are robust to alternative sample selections and matching specifications.

Table 3 also shows an increase of €1,962 in VAT deductions. This means that

Table 3: Impact of Reverse Charge on VAT Returns

	(1) Net VAT	(2) Gross VAT	(3) Sales	(4) Deductibles
Construction × *Post*	1,781.9***	3,494.4***	13,828.5**	1,961.7**
	(449.2)	(866.9)	(4,280.1)	(583.4)
Observations	2,516,771	2,516,771	2,516,771	2,516,771
R^2	0.89	0.94	0.94	0.93
Construction average (2010)	35,152.2	100,415.8	448,044.8	65,238.1
Scaled estimate	0.0507	0.0348	0.0309	0.0301

Notes: Estimations for equation (6), data covering years 2008–2013. Dependent variables are winsorized at 1% at both tails. Standard errors clustered by one-digit sector industry codes in parenthesis. Scaled estimate shows the treatment effect divided by the average outcome of a construction firm in 2010. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

firms partly offset the increase in value added by reporting more VAT deductions. Increases in tax deductions offset 56.5% of the increases in gross VAT. There are many potential explanations for the increase. For one, non-compliant firms may have previously under-reported actual expenses in order to under-report the scale of their operations and escape detection by the tax authority. Second, the reverse charge may have formalized contracting grey labor and made it deductible. A third possible explanation is in a traditional VAT system some contract work is under-priced because both parties understand that the vendor fails to remit the VAT included in the invoice. If reverse charge disrupts this practice, it might increase the prices of construction services, resulting in increases in all the variables of interest. According to this interpretation, the reverse charge mechanism breaks collusive agreements between firms. Lastly, firms could also be making up expenses to improve their profit margins. Whatever the mechanism is, the overall increase in deductibles shows that reducing receipt fraud is not the dominant response to adopting reverse charge, as that would show as a reduction in deductibles.

4.3 Effects by Firm Size

The effects of RC on firms likely depend on firm size because RC mainly affects the evasion opportunities of subcontractors. Small firms are presumably more affected because i) they may be less compliant in the baseline and ii) they are more likely to work as subcontractors. Compliant contractors and those who serve consumers are essentially unaffected. However, the exposure to RC does not seem to depend on firm size, as the share of sales covered by RC varies little by size.

Here we study how the effects depend on the size of the firms. Firms are assigned to size categories according to their level of sales in 2010. Category-specific effects are estimated with the following specification:

$$Y_{it} = \alpha_i + \lambda_t + \eta_{qt} + \sum_{q=1}^{k} \beta_q(\{Q_q = q\} \times \textit{Post} \times \textit{Construction}) + \epsilon_{it} \tag{8}$$

where q denotes the category a firm belongs to. We capture category-specific time trends with η_{qt}. Now, β_q identifies the policy's effect on construction firms in a given category, in relation to the comparison firms in the same category.

The level of the outcomes varies between firm categories. We scale the estimates to make the effects comparable across categories by dividing the estimate and the confidence interval by the 2010 average outcome for construction firms in the category. Consequently, the scaled effect corresponds to the effect relative to the mean in the category.

Figure 5 plots the scaled estimates by sales categories. In line with our predictions, the relative effects of the reverse charge reform are decreasing in size. The effect on micro firms, those with sales below €100,000, are large in relative terms (13.7% increase in net VAT), but smaller than the average ITT effect in absolute terms (€599.3 increase in net VAT). The most significant effect financially is from firms with sales between €400,000 and €2M. On average, VAT from these firms increases by €6,024, which is 7.6% of the group mean and amounts to a €33.7 million aggregate annual increase in value added taxes.

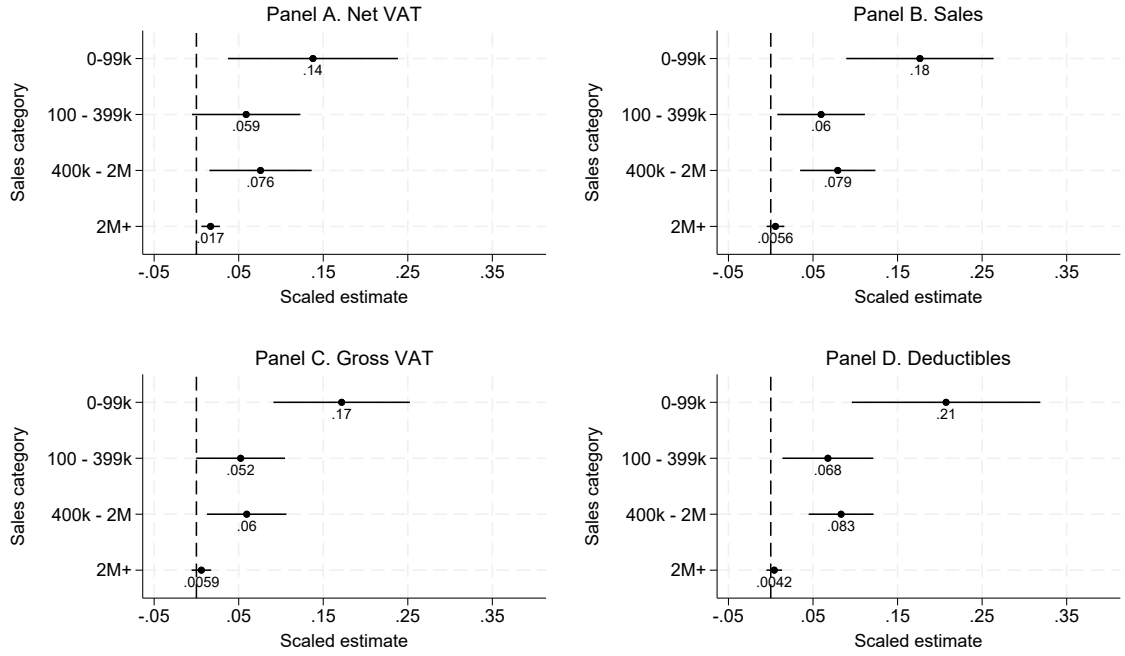


Figure 5: Heterogeneity in the relative response to the reform by sales category. The horizontal lines represent the 95% confidence interval. Point estimates and confidence intervals are scaled by the group average in 2010 for comparability. Standard errors clustered by one-digit industry codes and dependent variables are winsorized at 1% at both tails.

As expected, the policy does not affect the largest construction firms with estimates close to zero and statistically insignificant, with the exception of net VAT, which is 1.7% and statistically significant. The fact that large firms do not decrease their reported VAT, although they are now liable for the VAT accrued in the whole production chain, is key for the reform being effective in improving aggregate tax revenues. These construction firms in the largest revenue category in Figure 5 are liable for 86.5% of the reported reverse charges. This means that VAT remitted by these firms includes most of the taxable value added created in the supply chain.

4.4 Impact of Additional Policies

We leverage the addition of new policies targeted at construction firms to study how information reporting interacts with changes to remittance rules. Additionally, we investigate the spillover effect of RC on payroll taxes and employees' personal income tax remitted by the employer. Firms may engage in schemes

Table 4: Impact of Bundling Policies on Tax Returns

	(1) Emp. Remittance	(2) Net VAT	(3) Gross VAT	(4) Sales	(5) Deductions
RC Only	662.1**	1,783.7***	3,412.3***	13,084.6**	1,844.1**
	(214.2)	(441.6)	(865.1)	(3,841.5)	(561.9)
Policy Bundle	1,047.2**	1,742.4**	4,670.5**	21,801.1.6*	3,225.6**
	(347.7)	(605.2)	(1,499.1)	(9,416.3)	(989.2)
Observations	3,842,868	3,842,868	3,842,868	3,842,868	3,842,868
R^2	0.91	0.86	0.91	0.91	0.91
Construction average (2010)	24,409.4	35,152.2	100,415.8	448,044.8	65,238.1
Policy bundle - RC	385.0*	-41.3	1,257.6	8,716.4	1,381.5
	(160.2)	(290.0)	(1,057.1)	(6,354.5)	(786.3)

Notes: Firm responses to tax policies 2008-2017. *RC Only* takes a value of one if the firm is in the construction industry and the year is 2011 or 2012. *Policy bundle* takes a value of one if the firm is in the construction industry and the year $\geq$ 2013. Policy Bundle - RC is the estimated difference between the estimates. Emp. Remittance refers to payroll taxes and employees' personal income tax remitted by the firm. Dependent variables are winsorized at 1% at both tails. Standard errors clustered by one-digit sector industry codes in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

where their employees provide work through self-employment to avoid income taxes and collect additional income from VAT evasion, or collude in evading labor taxes. Closing this avenue of evasion could encourage workers to provide work as salaried employees and increase taxes remitted by employers.

In the final quarter of 2012, a tax number register for construction workers was established, and by the May of 2013 workers at shared construction sites were mandated to wear an identification card that included their tax number. As discussed in Section 3.3, starting in 2014, new laws required purchasers of construction services to send information about their contracts and worksites to the tax authorities.

Figure 4 already plots the yearly coefficients until 2015. There is no further increase in reported VAT items after 2013. We compare the effects of policies by dividing the *Post* variable from equation (6) into two separate indicators. The first variable indicates the first two years after the reverse charge policy was implemented, while the latter indicates the years when construction-specific information policies were put in place (after 2013). The first period dummy identifies the effect of RC alone and the latter the combined effect of RC and the subsequent policies.

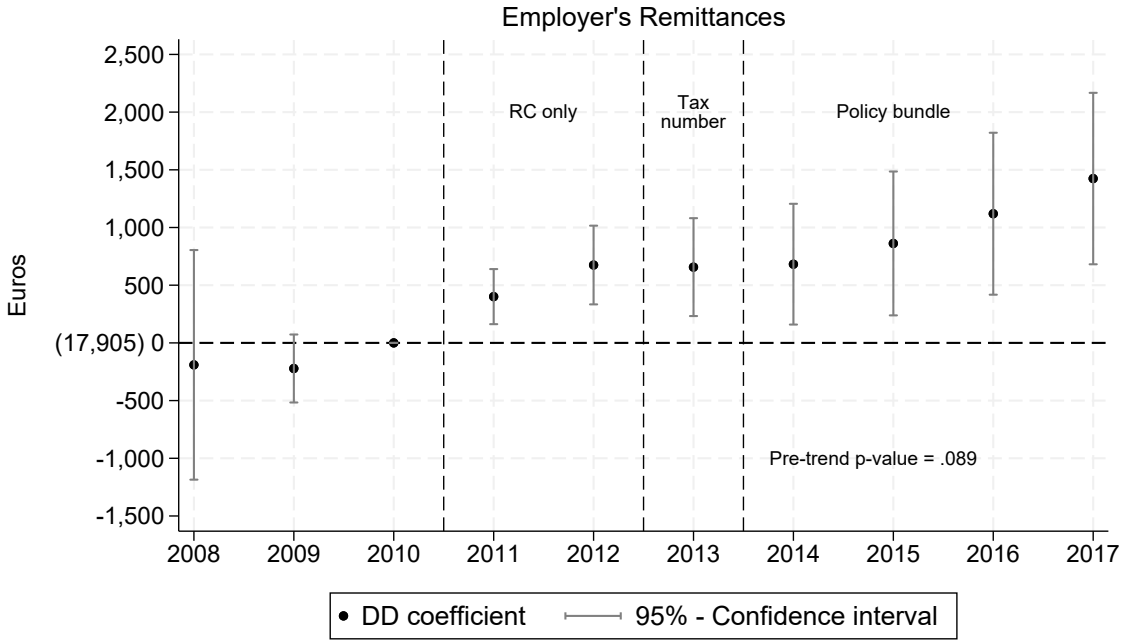


Figure 6: Dynamic DD with the weighted sample. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The pre-trend p-value is from a Wald test for pre-policy effects. Standard errors are clustered by one-digit industry codes and dependent variables are winsorized at 1% at both tails.

Estimates for the impacts of bundling compliance policies are reported in Table 4. Since we explicitly measure the impact of other policies on VAT compliance, we utilize the data from 2008 to 2017.

Our key finding is that additional policies do not affect net VAT liabilities. Column 2 shows that differences in net VAT between compliance regimes are negligible. Increases in additional gross liabilities are offset by deductions. When a reverse charge is implemented first, additional policies do not increase the VAT revenue collected by the government.

Figure 6 plots the DD coefficients on employer's remittances. First, they increase at a magnitude of €500 in 2011-2012, when RC is adopted. This suggests a spillover effect on taxes remitted by employers. Second, employer's remittances start to increase after 2014 when additional policies are implemented. We cannot, however, rule out that the effect observed in 2012 is not an anticipatory response to other policies. Column (1) in Table 4 shows that the estimated differences between RC and the policy bundle on payroll taxes (and withholding of personal income

tax) are around half of the spillover effect of RC (58.1% increase) and the effects of RC alone and with the policy bundle are statistically different at $p = 0.02$.

4.5 Analysis of Firm Exits

We will now examine the impact of the policy on firm exits. A marginally profitable firm may exit when RC reduces its benefit from tax evasion. We define exit year as the last observed non-zero return.

To analyze exit rates, we aggregate the full sample to the stratum-level and compare exit rates between strata in the construction and other sectors before and after the policy. In the preferred analysis above, we considered firms that are matched based on their returns in 2010. By definition, these firms have survived until then, and we cannot establish a baseline pre-policy exit rate for the matched sample.

First, we assign each annualized return to a corresponding CEM stratum generated for the matching procedure. Then we separate the treatment groups to produce a repeated cross-section of annual exit rates for each group-stratum combination. Exit rates are defined as the number of exits divided by the number of firms that remain or exit.

We estimate the following linear probability model to assess whether RC causes exit rates to change.

$$\textit{Exit Rate}_{st} = \alpha_s + \lambda_t + \sum_{t=2008}^{2013} \beta_t \textit{Construction}_s + \epsilon_{it} \tag{9}$$

Where α_s captures the group-stratum fixed effects, λ_t controls for common time trends and $\textit{Construction}_t$ is one when the cell consists of construction firms. The model is weighted analogously to the preferred specification. The control strata are weighted by dividing the number of treated remainers by the number of comparison remainers in the corresponding stratum in 2010. Then the weights are normalized to add up to the number of control firms in 2010. The error term is ϵ_{it}.

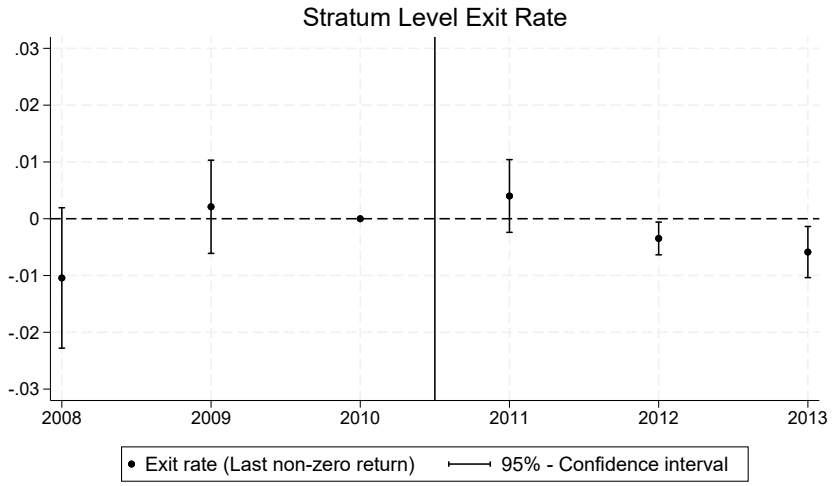


Figure 7: Dynamic DD estimates of stratum-level exits. "Exit rate" shows the mean difference to the 2010 baseline, after controlling for stratum and year fixed effects. Standard errors are clustered by one-digit industry codes.

We find essentially a null effect on the exit decisions of construction firms. Figure 7 depicts a small uptick in exit rates in 2011 that is not statistically significant and the coefficients for 2012 and 2013 are negative. The point estimate in 2011 corresponds to excess exits of around 250 firms, but otherwise there is no evidence that the reform causes construction firms to exit the industry. After the year when the reform is enacted, we can reject the hypothesis that reverse charge causes construction firms to exit the industry.

4.6 Sensitivity Analysis and Robustness Checks

It is unlikely that the parallel trends between the treated and comparison groups hold exactly. After all, the policy intervention is not randomly assigned. This section first probes the sensitivity of the main outcome to the parallel trend assumption. Then we discuss the robustness of the results to alternative regression specifications.

We construct consistent confidence intervals to account for violations of the exact parallel trends assumption following Rambachan and Roth (2023). Rather than assuming that differences between weighted groups remain exactly constant, we

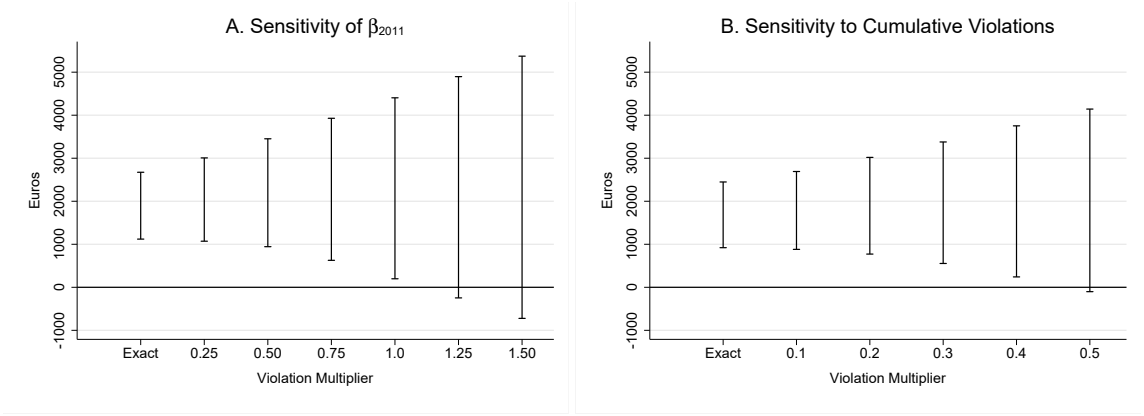


Figure 8: Sensitivity tests for dynamic DD parameters with Net VAT as the outcome. The x-axis shows violation multipliers for maximum pre-trend violations. Panel A shows the sensitivity ofβ_{2011} and Panel B shows the sensitivity of our mean causal effect under consecutive shocks. The confidence intervals include a true parameter 95% of the time when the parallel trends violation is bounded within a given magnitude. Standard errors are clustered at the one-digit industry level. "Exact" shows the 95% CI with exact parallel trends.

ease the assumption and define bounds for maximum violations of parallel trends. This allows us to quantify the uncertainty from different growth patterns as well as the statistical uncertainty of the estimates. Following the recommendations of Rambachan and Roth (2023), we report confidence intervals that restrict violations of parallel trends in a post-treatment estimate to be no larger than the maximum violation found in pre-trend estimates. In other words, we present confidence intervals that include a true dynamic DD parameter 95% of the time, assuming trends that do not differ more than some multiple of a maximum pre-trend violation.

We focus on the sensitivity of the causal estimates for net VAT since the Wald test rejects the hypothesis of parallel pre-trends. We test the sensitivity of the previous results with various magnitudes of violations by multiplying the maximum discrepancies by $\bar{M}$. Panel A in Figure 8 presents confidence intervals for DD coefficients after the treatment is first introduced, $t = 2011$, with varying magnitudes of maximal pre-trend violations.

We observe that the null hypothesis (reform has no effect) is rejected up to $\bar{M} = 1.25$, when the policy is first enacted. In other words, if the parallel trend violations are similar in magnitude to that observed in 2009, the confidence intervals do not

include zero. The housing market experienced a significant slump in 2009, so it is unlikely that trend violations in the post-treatment period would be as large. Sensitivity analysis shows that a deviation from exact trends in 2011 would have to be 25% *larger* than during the recession before the positive effect from the reform is rejected. Considering a deviation in trend of 50% of the pre-trend violation, we can still reject an effect smaller than €1,000, which is 2.8% of the outcome mean.

Panel B in Figure 8 presents the sensitivity of mean causal effect for each post-treatment period. Setting bounds for consecutive periods means that the confidence interval includes cumulative parallel trend violations. As a result, the confidence intervals for later years are much wider. The observed breakdown point appears at $\bar{M} = 0.5$. This means that if true time trends add 50% of the maximal pre-trend violation to differences between groups in each post-treatment period, the null effect cannot be rejected. Since the dynamic estimates in Figure 4 appear relatively stable, it is unlikely that the weighted groups have a great magnitude of divergence in trends.

Sensitivity analysis shows that the estimated net effects are relatively robust to relaxing the parallel trends assumption. Modest differences in growth trends or stronger recovery from the recession period add more uncertainty to the effectiveness of the policy, but we can still reject a null effect.

We now turn to test the robustness of the main results to alternative sample and weighting specifications. In the main analysis, the intention-to-treat group is constructed from companies that were registered in the construction industry in 2010. The panel is not balanced. A notable characteristic of the Finnish construction industry is that its tax base is relatively young. The bottom rows of Table 2 highlight the fact that before the reform was enacted, less than half of the companies had operated for over 10 years. The company base of the construction industry renews faster as a higher share of firms exit the sector annually than in most other indus-

tries[17]. This leads to more attrition in the ITT group.

The estimates are robust to restricting to a balanced sample of companies that remain in the sample from 2008 to 2015. We report the results for this specification in column (3) of Table A4. We also examine how differences in firm exits affect the main estimates when zero returns are imputed for firms after they leave the register. The mechanical effect of attrition is visualized in Figure A.7. Since construction firms exit the industry more often, artificially setting differences to zero mechanically reduces the dynamic DD estimates over time. We show that the RC reform's effects last as the company base renews, by producing a stratum-level cross-section of VAT returns. This estimation strategy allows for market entries and exits after the policy is enacted. We plot the Dynamic DD coefficients and describe the estimation strategy in more detail in A.8. ITT effects remain stable, which confirms RC's lasting effects on public finances.

We test that the identification strategy does not capture changes in real demand for construction by means of a falsification study in A.9. Removing construction firms from the full sample and appointing real estate activities as a placebo treatment group yields a null effect on sales and gross VAT and statistically insignificant increases in net VAT.

The preferred results are relatively robust to changes in the matching specification and levels of winsorizing. Difference-in-differences estimates for alternative CEM specifications are presented in Table A4 and sensitivity to alternative winsorizing levels is presented in Table A5. Recall that the motivation for the CEM-weighting procedure is to account for differences in size distribution between the treatment groups. We show that the results hold when company size is matched by sales instead of employee count and average salaries. Dynamic coefficients for the alternative weighting scheme are shown in Figure A.10. Changing the matching year to an earlier year yields point estimates that are at the lower bound of

[17]In 2008 and 2010, an average of 6.65% of construction firms exited the VAT register against 4.73% for the rest of the sample. Overall, the number of construction firms increased each year from 2008 to 2015.

the preferred results. Nevertheless, we observe that the dynamics are analogous to the main specification. Results for the alternative matching years are presented in A.11.

4.7 Implications for Tax Revenue

We provide back-of-an-envelope-type calculations to assess how RC affects public finances and the extent of VAT evasion in the construction industry before the reform. We make a rough extrapolation from the matched sample and multiply the average increase in net liabilities by the number of construction firms in the entire VAT register. There are on average 50,456 firms in the industry between 2011-2015 and an intention-to-treat effect of €1,781.9 in net VAT. Extrapolating from these yields an increase of €89.9 million in annual net liabilities reported. The same calculation on the impact of the policy bundle on payroll taxes and employee's withheld income tax adds an additional €50.4 million to the government's tax revenues.

We cannot confirm whether the increases in taxable value added translated into equivalent increases in tax revenue, so a more robust way to interpret the results is to look backward. The weighted sample includes every construction firm that filed a VAT return in 2010. We observe that, on average, construction firms in the matched sample evaded at least 5.07% of their VAT liabilities in the year before the treatment came into effect. This represents €86.6 million in missed tax revenues before the reform. For comparison, the construction industry contributed €1.8 billion in value added taxes in the same year.

5 Conclusion

The self-enforcing features of VAT have persuaded a majority of countries to adopt VAT as their primary consumption tax. However, even in countries with well-

developed tax systems, tax evasion persists. More than 50 countries have adopted a reverse charge mechanism to combat tax evasion in specific high-risk sectors. RC shifts the liability for remitting VAT from the vendor to the purchaser. When RC is applied to a majority of transactions in a supply chain, firms are essentially acting under a sales tax regime with additional reporting requirements. This study leverages the introduction of a sector-level reverse charge mechanism to study whether tax compliance can be improved with this tool.

Our analysis shows that adopting a reverse charge mechanism has a sharp and lasting effect on the reporting behavior of construction firms. The average effect is around a 5% increase in net VAT, which is both economically and statistically significant. The relative responses decrease with firm size. The main results hold under a battery of robustness checks and alternative matching specifications, and the policy's null effect can be rejected under reasonable violations of parallel trends. Finally, we demonstrate that a subsequent implementation of an information reporting policy does not change net VAT liabilities, but the policy bundle improves compliance for payroll taxes.

The wide coverage of the policy in the industry demonstrates that firms are unable or unwilling to switch over to consumer-facing positions to avoid the policy, which also makes the reform effective.

Our paper offers practical insights for tax design. We show that tax systems should account for who remits the taxes even when all of the firms operate in a formal sector monitored by various authorities. Our findings suggest that VAT reverse charge is a simple and effective policy tool to combat VAT evasion in a sector where downstream firms are large formal companies and upstream firms are non-compliant. In our setting, changing remittance rules is superior to broadening third-party information reporting.

References

Allingham, M. G., & Sandmo, A. (1972). Income tax evasion: A theoretical analysis. *Journal of Public Economics*, *1*(3), 323–338.

Almunia, M., & Lopez-Rodriguez, D. (2018). Under the radar: The effects of monitoring firms on tax compliance. *American Economic Journal: Economic Policy*, *10*(1), 1–38. https://doi.org/10.1257/pol.20160229

Bibler, A. J., Teltser, K. F., & Tremblay, M. J. (2021). Inferring Tax Compliance from Pass-Through: Evidence from Airbnb Tax Enforcement Agreements. *The Review of Economics and Statistics*, *103*(4), 636–651. https://doi.org/10.1162/rest_a_00910

Buettner, T., & Tassi, A. (2023). VAT fraud and reverse charge: Empirical evidence from VAT return data. *International Tax and Public Finance*, *30*(3), 849–878. https://doi.org/10.1007/s10797-023-09776-y

Carrillo, P., Donaldson, D., Pomeranz, D., & Singhal, M. (2023). Ghosting the Tax Authority: Fake Firms and Tax Fraud in Ecuador. *American Economic Review: Insights*, *5*(4), 427–444. https://doi.org/10.1257/aeri.20220321

Carrillo, P., Pomeranz, D., & Singhal, M. (2017). Dodging the taxman: Firm misreporting and limits to tax enforcement. *American Economic Journal: Applied Economics*, *9*(2), 144–164. https://doi.org/10.1257/app.20140495

Cipullo, D., Gamannossi Degl'Innocenti, D., Le Moglie, M., & Passerini, F. (2024). Inverting the chain? VAT collection regimes and tax compliance [Available at SSRN: https://ssrn.com/abstract=4880152 or http://dx.doi.org/10.2139/ssrn.4880152].

EY. (2024, June 24). Worldwide VAT, GST and Sales Tax Guide. Retrieved June 24, 2024, from https://www.ey.com/en_gl/tax-guides/worldwide-vat-gst-and-sales-tax-guide

Garriga, P., & Tortarolo, D. (2024). Firms as tax collectors. *Journal of Public Economics*, *233*, 105092. https://doi.org/10.1016/j.jpubeco.2024.105092

Heinemann, M., & Stiller, W. (2023). Digitalization and cross-border tax fraud: Evidence from e-invoicing in italy. *International Tax and Public Finance*. https://doi.org/https://doi.org/10.1007/s10797-023-09820-x

Iacus, S. M., King, G., & Porro, G. (2012). Causal Inference without Balance Checking: Coarsened Exact Matching. *Political Analysis*, *20*(1), 1–24. https://doi.org/10.1093/pan/mpr013

Kaçamak, Y., Velayudhan, T., & Wilking, E. (2023). Retailer Remittance Matters: Evidence from Voluntary Collection Agreements. *National Tax Journal*, *76*(2), 239–265. https://doi.org/10.1086/724590

Karvonen, T., & Muinonen, P. (2014, February). *Rakennusalan verovalvontahanke RAKSA 2008 – 2012 loppuraportti* (tech. rep.). Finnish Tax Authority.

Keen, M. (2008). Vat, tariffs, and withholding: Border taxes and informality in developing countries. *Journal of Public Economics*, *92*(10), 1892–1906. https://doi.org/https://doi.org/10.1016/j.jpubeco.2008.05.006

Kleven, H. J., Knudsen, M. B., Kreiner, C., Pedersen, S., & Saez, E. (2011). Unwilling or unable to cheat? evidence from a tax audit experiment in denmark. *Econometrica*, *79*(3), 651–692.

Kleven, H. J., Kreiner, C. T., & Saez, E. (2016). Why can modern governments tax so much? an agency model of firms as fiscal intermediaries. *Economica*, *83*(330), 219–246. https://doi.org/10.1111/ecca.12182

Konda, L., Patel, E., & Seegert, N. (2022). Tax enforcement and the intended and unintended consequences of information disclosure. *Journal of Public Economics*, *212*, 104690. https://doi.org/10.1016/j.jpubeco.2022.104690

Naritomi, J. (2019). Consumers as tax auditors. *American Economic Review*, *109*(9), 3031–3072. https://doi.org/10.1257/aer.20160658

OECD. (2023). *Revenue statistics 2023*. https://doi.org/https://doi.org/https://doi.org/10.1787/9d0453d5-en

OECD. (2024). Tax revenue. Retrieved September 1, 2024, from https://www.oecd.org/en/data/indicators/tax-revenue.html

Pomeranz, D. (2015). No taxation without information: Deterrence and self-enforcement in the value added tax. *American Economic Review*, *105*(8), 2539–2569. https://doi.org/10.1257/aer.20130393

Poniatowski, G., Bonch-Osmolovskiy, M., Durán-Cabré, J. M., Esteller-Moré, A., & Śmietanka, A. (Eds.). (2019). *Study and reports on the VAT gap in the EU-28 member states: 2019 final report*. CASE - Centre for Social; Economic Research.

Rambachan, A., & Roth, J. (2023). A More Credible Approach to Parallel Trends. *Review of Economic Studies*, *90*(5), 2555–2591. https://doi.org/10.1093/restud/rdad018

Slemrod, J. (2007). Cheating ourselves: The economics of tax evasion. *The Journal of Economic Perspectives*, *21*(1), 25–48. Retrieved March 11, 2024, from http://www.jstor.org/stable/30033700

Transparency International, o. (2023, January). 2023 Corruption Perceptions Index: Explore the results. Retrieved September 1, 2024, from https://www.transparency.org/en/cpi/2023

Waseem, M. (2022). The Role of Withholding in the Self-Enforcement of a Value-Added Tax: Evidence from Pakistan. *The Review of Economics and Statistics*, *104*(2), 336–354. https://doi.org/10.1162/rest_a_00959

Waseem, M. (2023). Overclaimed refunds, undeclared sales, and invoice mills: Nature and extent of noncompliance in a value-added tax. *Journal of Public Economics*, *218*, 104783. https://doi.org/https://doi.org/10.1016/j.jpubeco.2022.104783

A Appendix

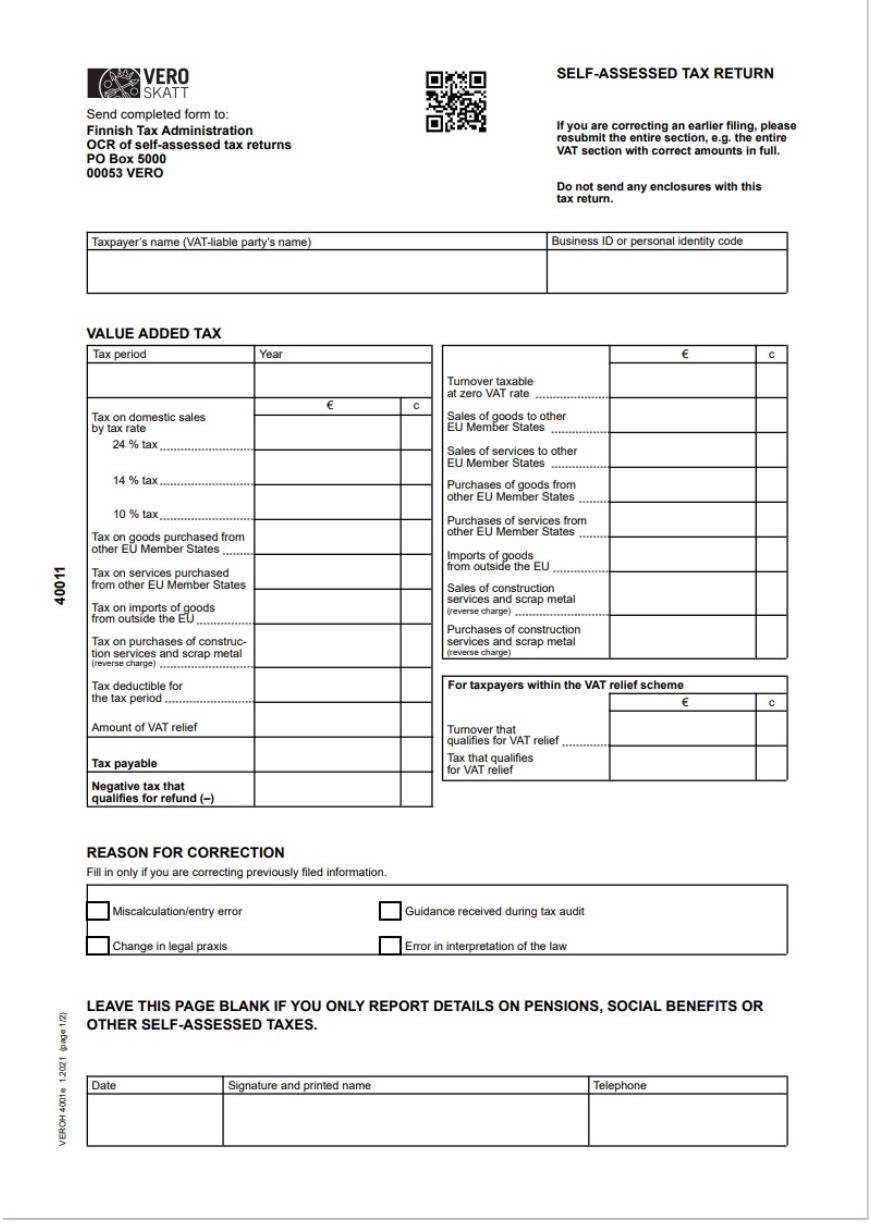
A.1 Countries With Domestic RC

Table A1: Countries With Domestic RC

Country	Construction	Precious metals	Scrap	Electronics	Certificates	Cereal	Telecom services	Other
Australia		X						
Austria	X	X	X	X	X			
Belgium	X	X			X			
Bulgaria		X	X		X	X		
Chile								X
China			X					
Croatia	X		X		X			X
Cyprus	X	X	X	X				
Czech Republ ic	X	X	X	X	X	X	X	
Denmark		X	X	X	X		X	X
Estonia		X	X					X
Ethiopia								X
Finland	X	X	X		X			
France	X	X	X		X		X	X
Georgia								X
Germany	X	X	X	X	X		X	X
Greece	X	X	X	X	X			
Guatemala								X
Honduras								X
Hungary	X		X	X	X	X	X	X
India								X
Ireland	X		X		X			
Israel	X							
Italy	X	X	X	X	X			X
Rebublic of Korea								X
Kosovo	X							
Latvia	X	X	X	X	X	X		
Lithuania	X		X	X				X
Luxembourg				X				X
Malta	X							
Moldova								X
Montenegro								X
Nepal	X							
Netherlands	X	X	X	X	X		X	
North Macedonia	X		X					
Norway		X			X			
Poland	X	X			X			X
Portugal	X		X		X			
Romania		X	X	X	X	X		X
São Tomé and Príncipe	X							X
Serbia	X							
Singapore				X				
Slovak Rebublic	X	X	X	X	X			X
Slovenia	X		X		X			
South Africa		X						
Spain	X	X	X	X	X			X
Sweden	X	X	X	X	X			
Swizerland								X
United Arab Emirates		X		X				X
United Kindom	X			X	X		X	X
Uruguay								X
Zambia								X
Zimbabwe								X

Notes: Columns refer to most common goods and services subject to RC found by screening (EY, 2024).

A.2 Sample VAT Form



VERO SKATT

Send completed form to:
Finnish Tax Administration
OCR of self-assessed tax returns
PO Box 5000
00053 VERO

SELF-ASSESSED TAX RETURN

If you are correcting an earlier filing, please resubmit the entire section, e.g. the entire VAT section with correct amounts in full.

Do not send any enclosures with this tax return.

Taxpayer's name (VAT-liable party's name)	Business ID or personal identity code

VALUE ADDED TAX

Tax period	Year

	€	c
Tax on domestic sales by tax rate		
24 % tax		
14 % tax		
10 % tax		
Tax on goods purchased from other EU Member States		
Tax on services purchased from other EU Member States		
Tax on imports of goods from outside the EU		
Tax on purchases of construction services and scrap metal (reverse charge)		
Tax deductible for the tax period		
Amount of VAT relief		
Tax payable		
Negative tax that qualifies for refund (–)		

	€	c
Turnover taxable at zero VAT rate		
Sales of goods to other EU Member States		
Sales of services to other EU Member States		
Purchases of goods from other EU Member States		
Purchases of services from other EU Member States		
Imports of goods from outside the EU		
Sales of construction services and scrap metal (reverse charge)		
Purchases of construction services and scrap metal (reverse charge)		

For taxpayers within the VAT relief scheme

	€	c
Turnover that qualifies for VAT relief		
Tax that qualifies for VAT relief		

40011

REASON FOR CORRECTION

Fill in only if you are correcting previously filed information.

☐ Miscalculation/entry error
☐ Guidance received during tax audit
☐ Change in legal praxis
☐ Error in interpretation of the law

LEAVE THIS PAGE BLANK IF YOU ONLY REPORT DETAILS ON PENSIONS, SOCIAL BENEFITS OR OTHER SELF-ASSESSED TAXES.

Date	Signature and printed name	Telephone

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Figure A.1: The VAT form. Sales and purchases of construction services are itemized in the right column, while reverse charge and other tax remittances are recorded on the left side. Taxes and deductions are aggregated by rates and there are no attachments required.

A.3 Data Description

Table A2: Data Descriptions for Selected Variables

Variable	Description
Difference-in-Differences Analysis	
Gross VAT	Total reported VAT for the year. This is the sum of value added taxes for each rate and VAT from purchases made from other EU countries. Taxes from sales of construction services are added by multiplying tax free sales by the common rate. Reverse charge is excluded.
Deductibles	Total reported VAT deductions for the year. This is the sum of VAT included in input costs.
Net VAT	Gross VAT - Deductibles - VAT Relief = Net VAT. VAT liabilities for the year.
Sales	Total sales for the year without VAT included. This also includes sales made under zero rate.
Employer's remittance	Payroll taxes remitted by the employer. Includes payroll tax and taxes withheld from employees' wages.
Sector Industry Code (SIC)	Five-digit code determined by the industry where a firm produces most value added.
Coarsened Exact Matching	
Indicator for Zero Revenue	Takes value of one, if sales is equal to zero that year.
Number of employees	Average number of employees, divided into 11 categories. (NA, 0, 1-4, 5–9, 10–19, 20–49, 50–99, 100–249, 250–499, 500–999 and 1 000+)
Mean wages	Annual wages divided by the number of employees. Winsorized at 0.1% to deal with extreme outliers. Coarsened according to the Sturge's rule.

Notes: All variables are at firm level. Firm's sector industrial classification is determined as the activity where it created the most value added. Business registered to one industry may conduct several types of production in other industries too. Classifications are internationally standardized and the classifications considered in this paper are entirely comparable with the European Classification of Economic Activities (NACE) and the International Standard Industrial Classification (ISIC).

A.4 Matching

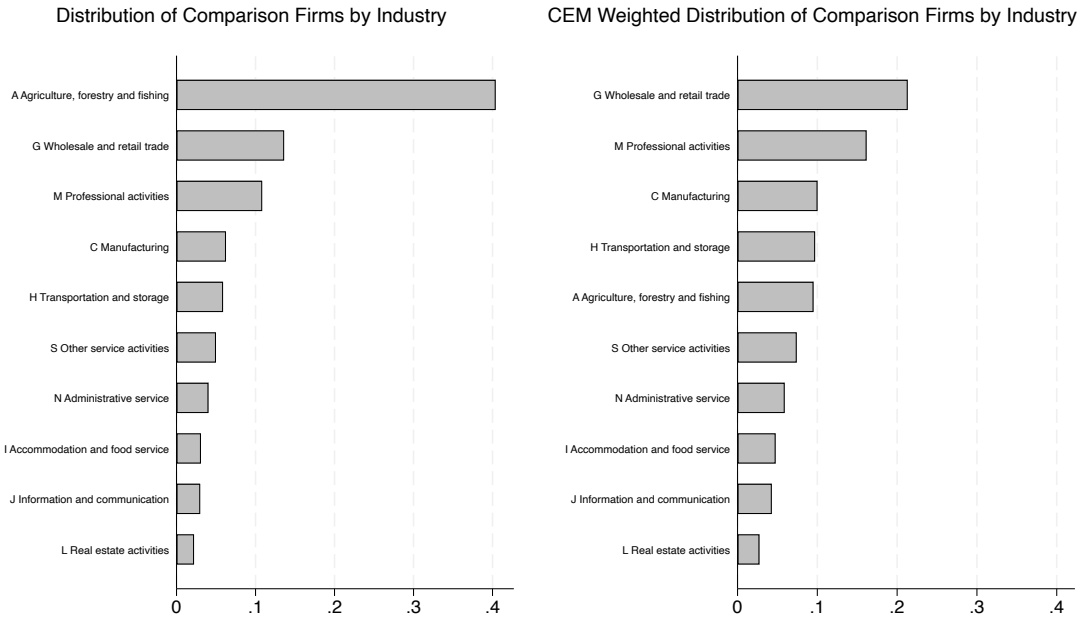

Figure A.2: The panels depict industry shares measured by the number of firms in the VAT register. In the left panel, each firm is counted once (equal weights). On the right, shares are calculated according to each sector's sum of CEM weights.

Our preferred weighting scheme reduces the influence of primary producers on the estimates. The CEM algorithm redistributes the weight from these firms mainly to retail, professional services and manufacturing. The large share of firms in sector A is due to widespread forestland ownership. The sale of timber and maintenance of forest assets is part of the VAT base.

A.5 Robustness Checks

A.5.1 Full Sample

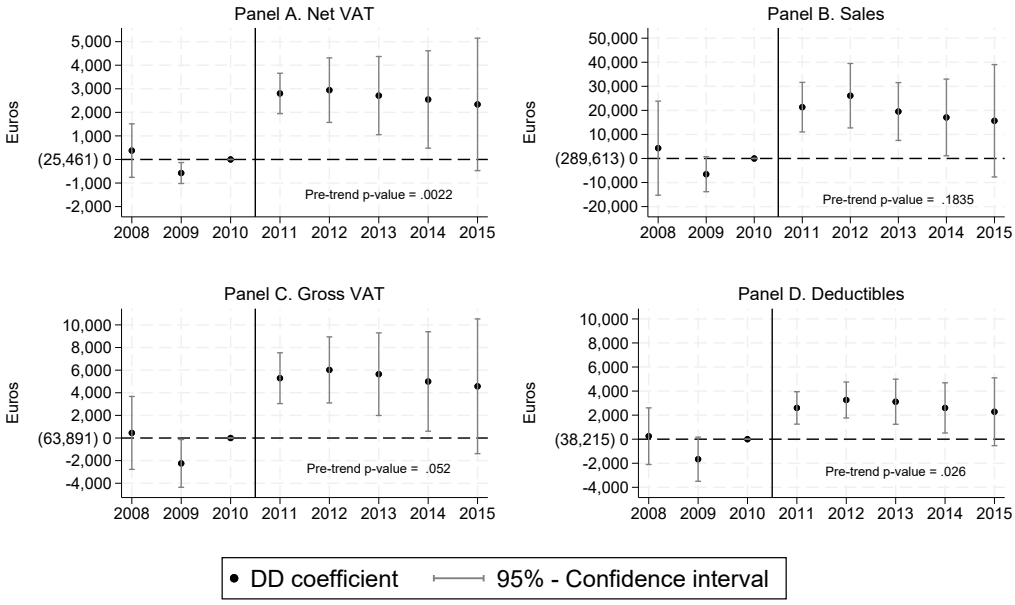

Figure A.3: Dynamic DD with a full sample of firms that entered the register before 2011. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. Standard errors are clustered by one-digit industry codes and dependent variables are winsorized at 1% at both tails.

Pre-trends between the construction industry and the rest of the firms indicate that construction is more cyclical. Construction firms' reports are relatively more sensitive to business cycles prior to the policy, which signals that they are likely to affect differences in VAT reports in the post-treatment period as well. It is very likely that with this specification the DD coefficients are biased since exact parallel trends do not appear plausible.

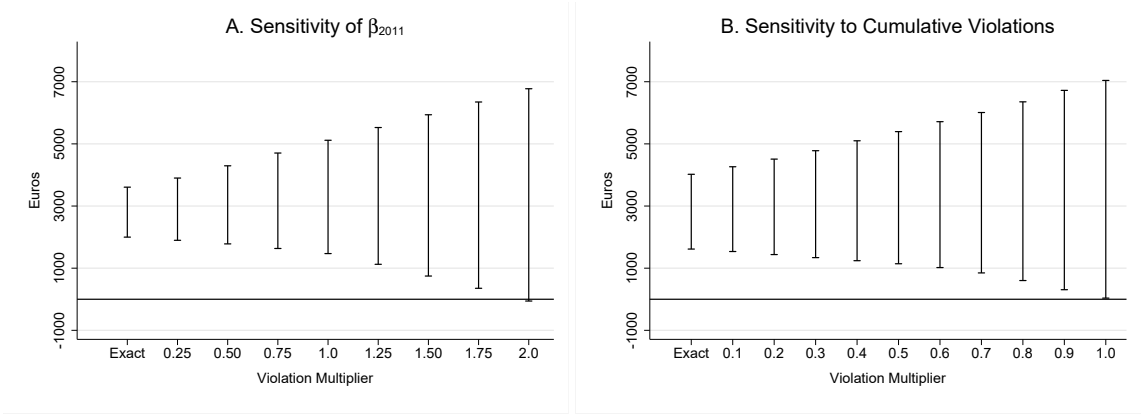

Figure A.4: Full sample sensitivity tests for dynamic DD parameters with Net VAT as the outcome. The x-axis shows violation multipliers for the maximum pre-trend violations. Panel A shows the sensitivity ofβ_{2011} and Panel B shows the sensitivity of our mean causal effect under consecutive shocks. The confidence sets include the true parameter 95% of the time when the parallel trends violation is bounded within a given magnitude. The standard errors are clustered at the one-digit industry level. "Exact" shows the 95% CI with exact parallel trends.

Sensitivity analysis of the unweighted estimates demonstrates that rejecting a null effect of the policy requires very large deviations from the parallel trends. The right panel shows that additive shocks to construction firms would have to be as large as with the 2009 recession *each year* before we would not be able to reject the null. Correspondingly, unless a trend violation in 2011 were to be twice as large as after the financial crisis, we conclude that the RC reform increased net VAT. As discussed in Appendix A.4, we prefer the more conservative CEM-weighted estimates since the matched groups are more comparable.

Table A3: Unweighted Difference-in-Differences Estimates

	(1) Net VAT	(2) Gross VAT	(3) Sales	(4) Deductibles
Construction × *Post*	2,673.9***	5,582.5**	20,408.8.8**	3,057.0**
	(678.8)	(1,709.6)	(6,645.9)	(922.2)
Observations	2,521,382	2,521,382	2,521,382	2,521,382
R^2	0.90	0.94	0.94	0.94
Construction average (2010)	35,152.2	100,415.8	448,044.8	65,238.1
Scaled estimate	0.0761	0.0556	0.0456	0.0469

Notes: Dependent variables are winsorized at 1% at both tails. Standard errors clustered by one-digit sector industry codes in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5.2 Quarterly Dynamic DD Estimates

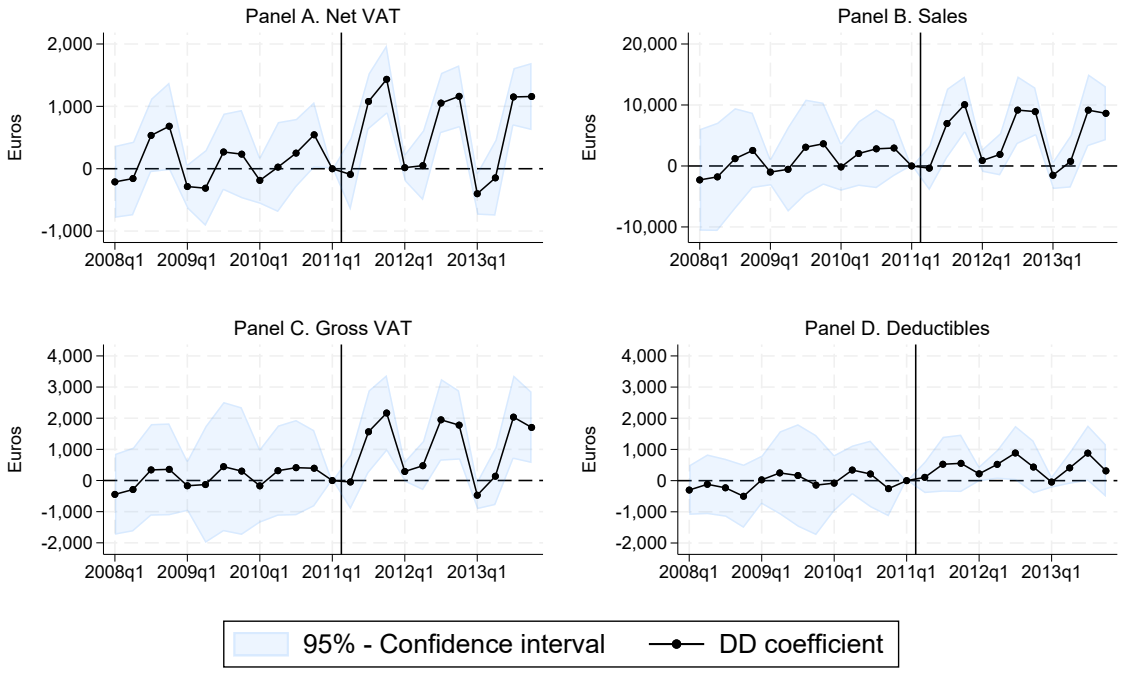

Figure A.5: Dynamic DD with weighted sample of firms that file VAT returns quarterly or monthly (N = 271,209). The baseline difference is normalized to zero and it is the last quarter before the reverse charge mechanism was implemented. The specification includes fixed effects for *firm*, *quarter* $\times$ *year* and *quarter* $\times$ *industry*, to deal with seasonal trends. The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails.

A.5.3 Dynamic DD Estimates Conditional on Surviving

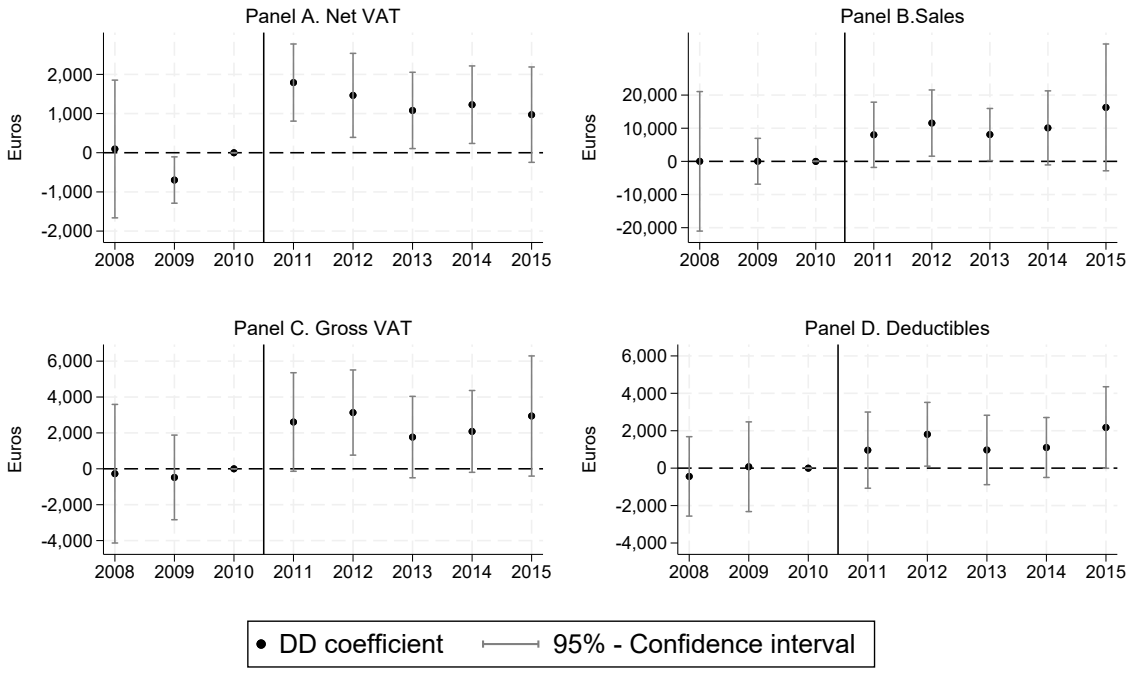

Figure A.6: Dynamic DD with a weighted sample where firms remain in the register between 2008-2015. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails.

Dynamic DD estimates for a sample restricted to firms that remain in the register from 2008 to 2015.

A.5.4 Imputed Sample

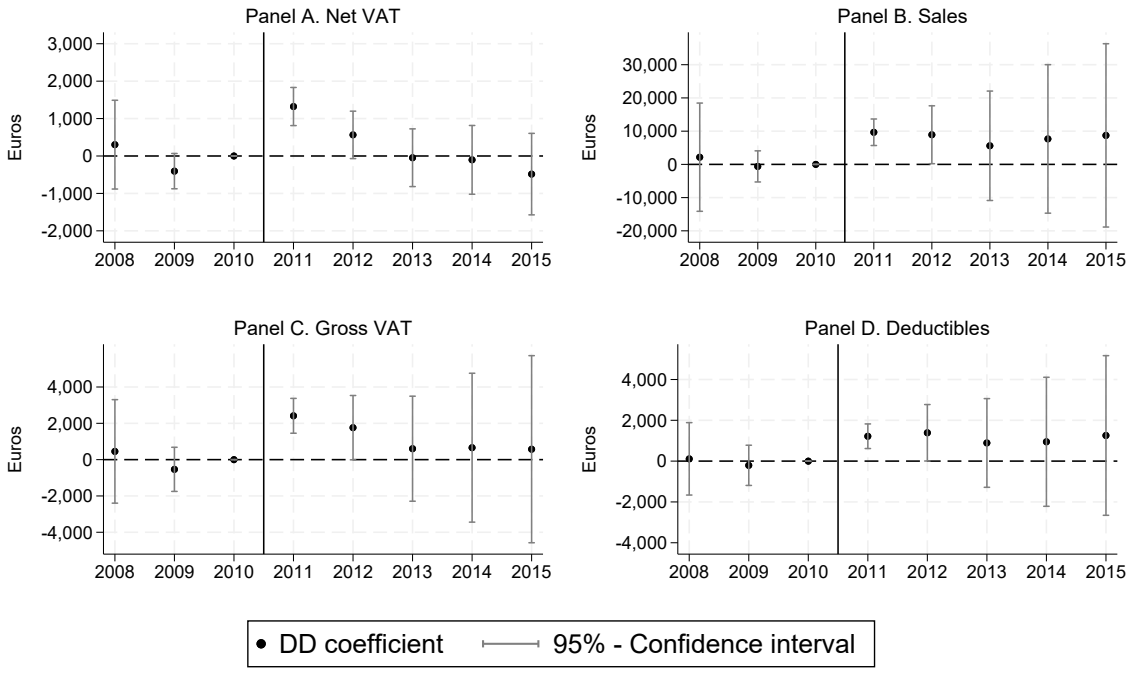

Figure A.7: Dynamic DD with the weighted sample where firms that exit the register are kept in the sample by imputing zero returns. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails.

Here we use the weighted sample, where we also impute zero returns for firms after they have left the register. Since relatively more construction firms leave each year, the differences decrease mechanically with time.

A.5.5 Stratum-level Dynamic DD Estimates

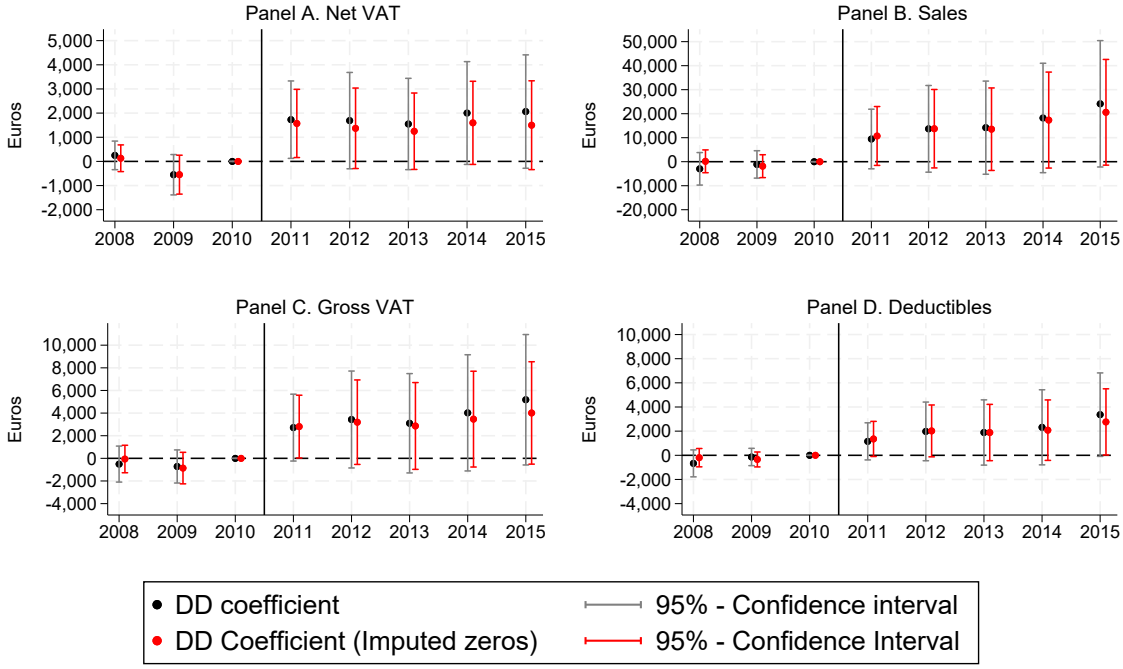

Figure A.8: Dynamic DD on stratum-level average outcomes. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for group-stratum and year-fixed effects. Imputed zeros refers to a sample where firms are assigned zero returns after they exit the register. The standard errors are clustered by stratum and the dependent variables are winsorized at 1% at both tails before aggregation.

We study the permanence of the ITT effect by constructing a repeated cross-section of CEM strata. This allows for firm exits and entries. We use the coarsened bins that were generated with the preferred CEM specification. First we assign each firm to a stratum according to its annual returns. Then we split each stratum into a construction-stratum group and a comparison-stratum group. After each firm has been assigned its respective group, we aggregate the groups and calculate the averages for outcomes of interest. Finally, we weight the groups to make the treatment and comparison cells comparable. A treated stratum receives a weight equal to the number of units in the stratum in 2010. Weights for the control stratum are calculated in two steps. First, we divide the number of treatment units in the corresponding stratum by the number of control units in 2010. Secondly, we normalize the weight so that the control group's weights sum up to the number of comparison firms in 2010. This process is analogous to CEM matching with in-

dividual firms, but we now can observe how the ITT effect evolves as new firms enter and old ones exit the market.

A.5.6 Falsification Study

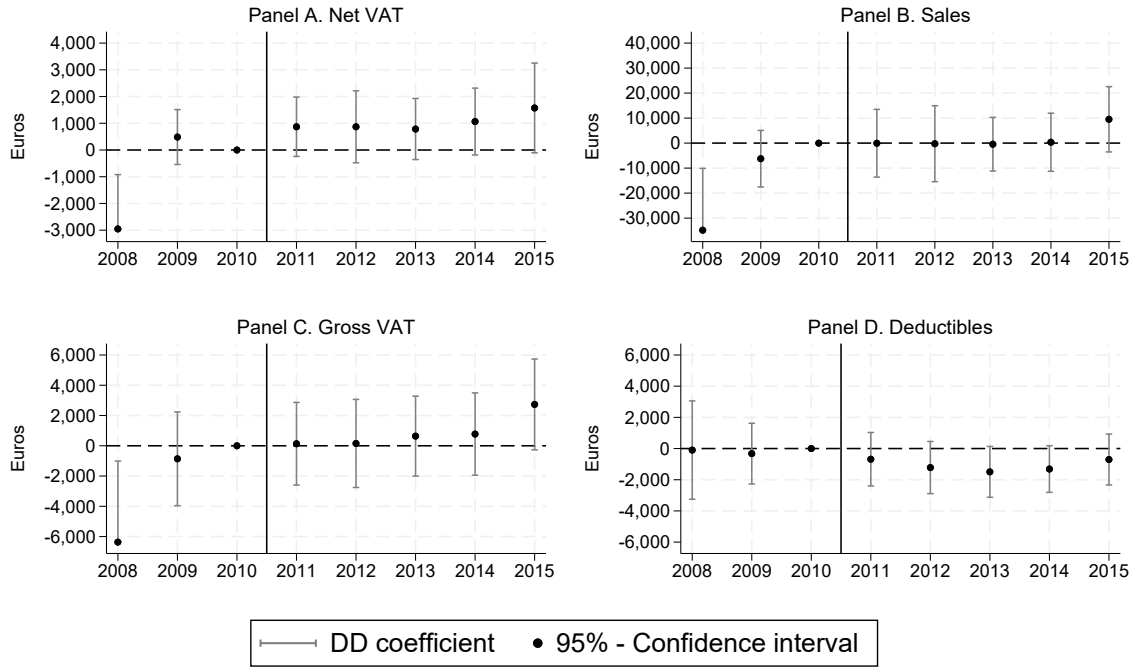

Figure A.9: Dynamic DD with the placebo group. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails. The lower bound of the 2008 confidence interval in panels A, B and C is truncated for readability of the figures.

We check that the results in the construction industry are not driven by a demand shock by examining an adjacent industry, real estate activities[18], where the remittance rule remained the same. The industry classification covers buying, selling and operating real estate as well as real estate activities on a fee or contract basis. If the reported increase in construction services is driven by real economic factors, we expect to see similar increases for real estate agencies and managers. The falsification study repeats the steps in the main analysis with two changes. First, we remove construction firms from the full sample. Second, we use firms registered in real estate activities as a placebo treatment group (N = 9,184). The dynamic difference-in-differences estimates are plotted in Figure A.9.

We do not observe similar dynamics between the designated placebo group and firms that were affected by the actual reform. After a significant drop in 2008, sales

[18](NACE 2008 Classification: L)

and gross VAT in the placebo group remain stable compared to the their baseline difference, while deductions decrease. A reduction in deductibles drives increases in net VAT.

A.5.7 Results Using Alternative Matching Variable

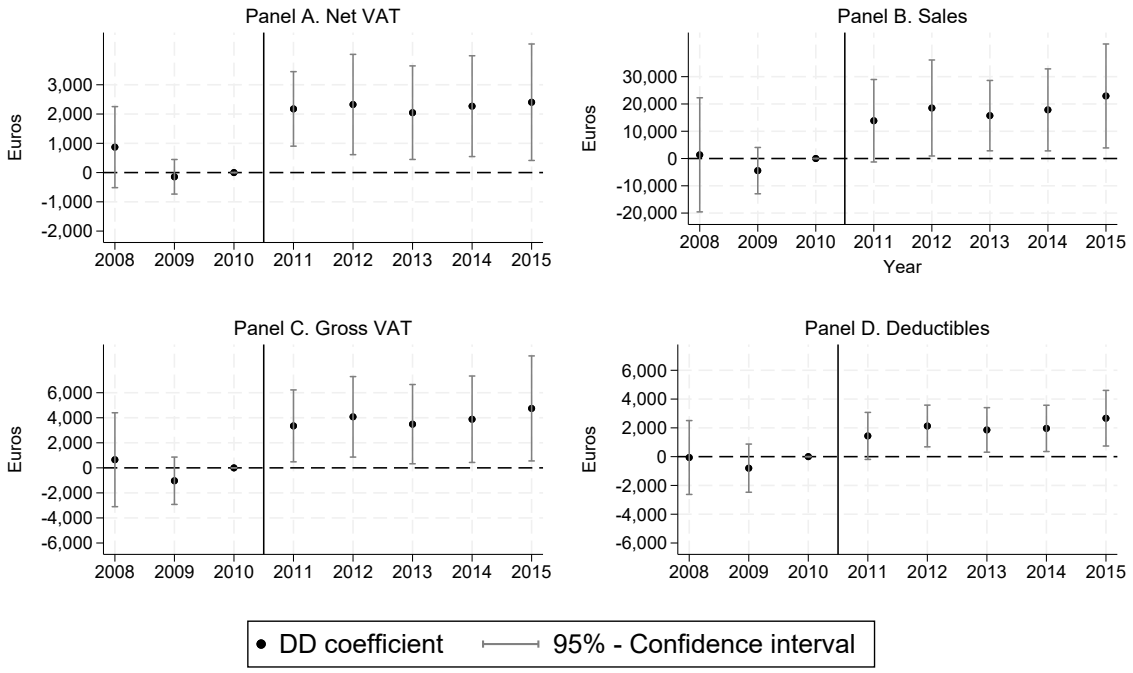

Figure A.10: Dynamic DD with a weighted sample, where employee count and average salary are replaced by sales as a matching variable. Coarsening (in thousands): 0 - 39 , 40 - 99 , 100 - 399 , 400 - 1 999 , 2 000 - 9 999 , 10 000 - 39 999 , 40 000 - 199 999 and 200 000+. "DD coefficient" shows the mean difference to the 2010 baseline, after controlling for company and year fixed effects. The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails.

A.5.8 Results Using Alternative Matching Year

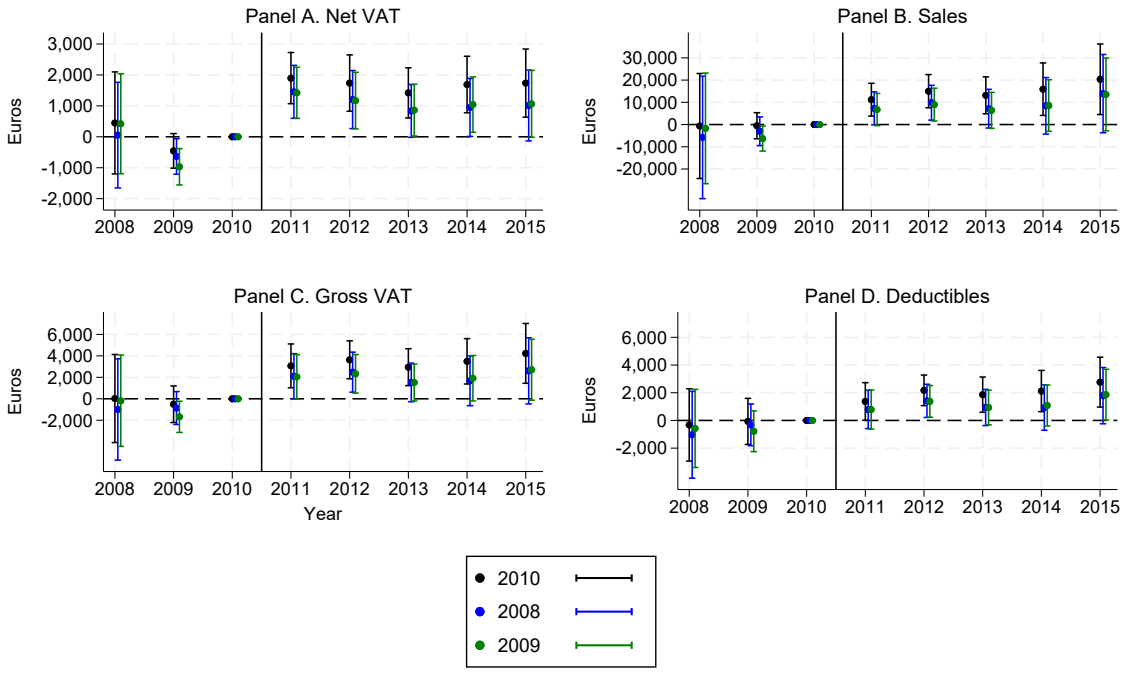

Figure A.11: Dynamic DD with weighted samples. We conduct CEM, with the same matching criteria as with the preferred specification, for firms' VAT returns in 2008 (blue) and 2009 (green). Results for the main specification (black). The standard errors are clustered by one-digit industry codes and the dependent variables are winsorized at 1% at both tails.

Table A4: Difference-in-Differences Estimates for Alternative Spesifications

	(1) Alt. Coarsening	(2) Alt. Size Var	(3) Cond. survival	(4) Matching 2008	(5) Matching 2009
Net VAT	1,787.4***	2,030.1*	1,636.4**	1,385.5**	1,396.8**
	(457.4)	(749.5)	(493.9)	(477.9)	(444.7)
R^2	0.89	0.89	0.90	0.90	0.89
Mean (2010)	35,155.8	35,152.2	46,251.1	39,502.8	37,595.0
Gross VAT	3,476.0***	3,869.6*	2,698.1*	2,692.3**	2,660.7**
	(874.6)	(1,550.6)	(1,229.3)	(934.1)	(838.2)
R^2	0.94	0.93	0.95	0.94	0.94
Mean (2010)	100,417.6	100,415.8	133,036.9	112,889.7	107,094.0
Sales	13,758.2**	17,370.1*	8,880.6*	11,071.0	10,248.7*
	(4,360.8)	(7,925.4)	(3,724.3)	(5,600.9)	(4,566.5)
R^2	0.94	0.93	0.95	0.94	0.94
Mean (2010)	448,053.9	448,044.8	594,265.6	504,856.1	478,353.4
Deductibles	1,945.6**	2,118.4*	1,344.0	1,501.7*	1,496.5*
	(588.4)	(752.4)	(1,055.7)	(593.6)	(548.2)
R^2	0.93	0.92	0.94	0.93	0.93
Mean (2010)	65,236.3	65,238.1	86,762.4	73,361.3	69,473.4
Observations	2,517,077	2,521,382	1,811,952	2,397,280	2,527,934

Notes: Difference-in-differences estimates for alternative CEM criterion and sample restrictions. The dependent variables are winsorized at 1% at both tails. Mean refers to the average outcome for construction firms in 2010. The standard errors are clustered by one-digit sector industry codes in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

1. Alternative coarsening: alternative choice of coarsening for employee bins: missing value, sole entrepreneur, micro (1-9 employees), small (10-49), medium (50-249) and large (250+).

2. Alternative Size Variable: CEM specification with only sales and zero sales dummy in 2010 as matching variable.

3. Balanced panel: firms that remain in the sample from 2008 until 2015.

4. Matching "year": preferred matching specification conducted using data from other years.

Table A5: Difference-in-Differences Estimates for Alternative Winsorizing levels

	(1) 1%	(2) 0.1%	(3) 3%
Net VAT	1,781.9*** (449.2)	1,930.5* (701.2)	1,231.5** (336.5)
R^2	0.89	0.89	0.88
Construction average (2010)	35,152.2	35,152.2	35,152.2
Gross VAT	3,494.4*** (866.9)	4,620.5* (2,102.3)	2,592.4** (697.7)
R^2	0.94	0.95	0.93
Construction average (2010)	100,415.8	100,415.8	100,415.8
Sales	13,828.5** (4,280.1)	20,997.6** (5,626.6)	10,738.3* (3,914.2)
R^2	0.94	0.94	0.93
Construction average (2010)	448,044.8	448,044.8	448,044.8
Deductibles	1,961.7** (583.4)	2,796.1 (1,699.4)	1,562.8** (483.3)
R^2	0.93	0.94	0.92
Construction average (2010)	65,238.1	65,238.1	65,238.1
Observations	2,516,771	2,516,771	2,516,771

Notes: Difference-in-differences estimates of the preferred specification in column 1 and with alternative levels of winsorizing at both tails in columns 2 and 3. Standard errors clustered by one-digit sector industry codes in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$