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Effects of the Reverse Charge Mechanism on VAT Gaps*

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Abstract

The purpose of this paper is to evaluate the effect of reverse-charge mechanism (RCM) implementation on VAT compliance using an overall, country-level measure of VAT compliance, the VAT gap. The VAT gap is defined as the overall difference between expected and realized VAT revenues and is a broader measure than outcomes employed in previous research, incorporating all types of VAT evasion. Exploiting the staggered adoption of RCM across Europe and the size of industries targeted by RCM, we compare changes in the VAT gap before and after RCM implementation. Evidence from difference-in-differences, event study, and heterogeneous treatment effects estimators indicates that the adoption of the RCM does not lead to significant EU-wide changes on the aggregate VAT gap. Moreover, our results illustrate the mixed impacts of RCM on different goods and industries, with measurable decreases in VAT losses in the construction and industrial crops industries. This study's findings do not provide strong support for policy changes that cast the net of the RCM wider on all industries and EU member states, although bilateral coordination in RCM adoption with top trading partners may assist in curbing VAT fraud relocation.

JEL Classification: H26; K42

Keywords: Tax evasion, VAT, VAT gap, reverse-charge mechanism, carousel fraud

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1 Introduction

The Value-Added Tax (VAT) enjoys widespread adoption in more than 130 countries and generates on average 20% of total government revenue (Keen and Lockwood, 2010). Despite its relevance and popularity, VAT suffers from significant non-compliance, with foregone VAT estimated to be about 9.1% of its expected revenues in the European Union (EU) in 2020 (European Commission, 2022). Some of the most prominent cases of VAT losses are caused by carousel fraud or Missing Trader Intra-Community (MTIC) fraud schemes, which exploit cross-border transactions and VAT refund rules. In a single instance, these types of schemes are estimated to cost as much as €2.2 billion in foregone VAT revenues in the EU (EPPO, 2022). Similar fraud schemes have been documented in Australia (Evans, 2020) and Canada (CBC, 2024).

The remedy of choice to close the loopholes exploited by such fraud schemes is the introduction of the Reverse Charge Mechanism (RCM), which shifts the liability for VAT remittance from the supplier to the buyer in business-to-business transactions. Recent papers have shown that RCM adoption reduces the prevalence of MTIC and related fraud schemes (Buettner and Tassi, 2023; Stiller and Heinemann, 2024; Bussy and Tassi, 2025; Heinemann, 2025). However, RCM may "break the VAT chain" by undermining the standard self-enforcing mechanisms of VAT (Pomeranz, 2015; Morrow et al., 2022). With full adoption of RCM, the VAT becomes a pure sales tax, with strongly inferior compliance qualities (De La Feria, 2019; Tassi and Bussy, 2025). Moreover, introducing RCM can shift fraudulent activities to other sectors or countries (Stiller and Heinemann, 2024).

This paper evaluates the effect of RCM on overall VAT compliance, taking into account not only the direct effect of RCM on fraud schemes, but also its unintended consequences in terms of compliance incentives and potential fraud relocation. We employ EU-wide data on aggregate country-level VAT gaps, which measure the difference between potential and realized VAT revenues. The key benefit of this data source lies in its comparability across countries and over time, and the fact that it includes all forms of VAT non-compliance and can thereby measure the bottom-line effect of RCM on compliance.

Our identification exploits variation in the timing and the intensity of RCM adoption across EU member states. We employ a broad range of methods, ranging from classical general difference-in-differences (DiD) two-way fixed effects (TWFE) designs including event studies, to several novel DiD estimation strategies accounting for heterogeneous treatment effects (Callaway and Sant'Anna, 2021; De Chaisemartin and d'Haultfoeuille, 2020). Our analysis begins by evaluating how the measured country-wide VAT gap responds to the first instance of RCM adoption in a given country. In more refined analyses, we additionally exploit differences in the intensity of RCM adoption across countries, since governments individually define the set of products or services subject to RCM. Our intensity measure consists of the pre-reform share of GDP subject to RCM.

Our overall results do not provide evidence for a significant effect of RCM adoption on VAT compliance measured by the observed country-wide VAT gap. This non-significance is consistent across classical TWFE estimates as well as newer methods accounting for heterogeneous treatment effects, both in DiD and event study setups. However, although insignificant, most point estimates are negative and exhibit a meaningful economic magnitude. Considering that our aggregate country-level estimation design is subject to limited statistical power, we cannot wholly exclude potential reductions in the VAT gap. Importantly, we do not find any evidence for RCM increasing VAT gaps, suggesting that at the least RCM does not seem to harm aggregate VAT collection.

Moreover, it should be emphasized that these aggregate estimates mask substantial heterogeneity across different industries. When decomposing RCM's impact by industry, we find VAT gap reductions when implementing RCM on industrial crops' trade and in some estimations on the construction industry. In an extension, we observe that the adoption of RCM by top trading partners is associated with a marginally positive but statistically insignificant increase in VAT gaps, indicating potential VAT fraud relocation to other countries.

This paper makes several contributions to the literature on VAT compliance and the effectiveness of RCM. The primary contribution lies in providing an integrative framework to measure the overall effectiveness of RCM on VAT compliance. While previous approaches have focused on specific margins of non-compliance (e.g. trade) or specific sectors or countries, our paper assesses the generalized impact of RCM on overall VAT compliance. Even though the aggregate nature of our data does not allow us to specifically identify certain mechanisms, the paper speaks to the bottom-line effect in a way that has not been possible with previous micro-level approaches.

The first strand of literature our paper contributes towards are studies with micro-level evidence from specific sectors or countries. Using quarterly information of VAT revenues in the Czech Republic from 1999 to 2016, Arltová et al. (2020) find an increase of 14.5% of total annual VAT revenues following the implementation of RCM for scrap and emission allowances and other anti-fraud measures. Using administrative data from German VAT returns, Buettner and Tassi (2023) estimate VAT fraud prior to the introduction of RCM to be around 5% of German VAT revenues. More recent studies using firm-level data offer some evidence consistent with MTIC fraud removal (Heinemann, 2025), or show increased VAT compliance in the construction sector (Cipullo et al., 2024; Junttila et al., 2024), after RC implementations. We contribute towards this literature by estimating the overall effect of RCM across all sectors and in various jurisdictions.

The second strand of literature deals with the role trade plays in the application of fraud schemes. Bussy and Tassi (2025) evaluate RCM's impact on VAT fraud by comparing reporting gaps in trade statistics of goods affected by RCM to unaffected ones (following the approach of Fisman and Wei, 2004). Using 54 episodes of RCM's implementation by member states in 2004-2019 and a battery of quasi-experimental techniques, this study finds low VAT fraud reductions amounting to 0.07-0.21% of VAT revenues or 0.7-0.9% of the VAT gap, following RCM implementation in various member states. Furthermore, Braml and Felbermayr (2022) posit that MTIC fraud may be a potential explanation for the strikingly large unaccounted trade surpluses between member states. However, there is no empirical backing of this conjecture to this day. Our measure of VAT non-compliance, the observed VAT gap, includes both domestic and cross-border transactions and therefore includes any trade-related fraud activities.

A last strand of literature deals with a range of unintended consequences of RCM. The first issue lies in the potential relocation of fraud to sectors or countries with more lenient institutions. Stiller and Heinemann (2024) use trade gaps to estimate the deterrent effect of the RCM on MTIC fraud from 2007 to 2019. They find that RCM eliminates MTIC fraud in the member state where it was implemented but also shifts VAT fraud to countries that do not apply RCM. A similar negative spillover effect in the form of MTIC fraud relocation is reported following an increase of tax enforcement in a member state. The second unintended consequence is the potential of RCM to erode the self-enforcing mechanisms of VAT. Tassi and Bussy (2025) directly test this hypothesis and find no evidence that RCM breaks the VAT chain, as the study documents no increase in VAT evasion at the the business-to-consumer stage in Germany. We contribute to the literature on these unintended effects by including them and any further mechanisms into our summary measure of VAT compliance. Our main null result could be interpreted as showing that these unintended consequences may somewhat mitigate the direct, positive effects of RCM introduction.

These results have important policy implications for VAT design by providing weak support for the expansion of RCM's implementation to selected industries. We do not find strong support for a general expansion of the RCM, which is currently possible under specific circumstances (De La Feria, 2019). From an aggregate perspective, it appears that implementations of RCM are if anything closing the VAT gap on average.

The rest of the paper is organized as follows. Section 2 provides a conceptual framework of VAT fraud and the institutional background surrounding RCM implementations. Section 3 describes the data and section 4 discusses the methods employed. Section 5 presents and interprets the results, and includes details on further extensions such as cross-border fraud and robustness checks. Section 6 highlights study limitations and concludes.

2 The Expected Impact of RCM on VAT Compliance and Institutional Background

In order to understand the effectiveness of the RCM in stopping VAT fraud, we first describe how the fraud scheme works. The fraud scheme is also represented in Figure 1. Assume that an Italian company A sells some goods to a trading partner B, which imports the goods into Greece, another EU country. Since the sale (from the Italian perspective) takes place within the common market, A does not charge VAT on the transaction. In other words the export is zero-rated. Once the Greek importer B sells the goods to a buffer trader, C, the domestic transaction within Greece is subject to VAT collection, so that B charges and collects VAT on the sale.

Information asymmetries between tax collection agencies in cross-border trade, however, create a gainful opportunity for fraudsters. In fact, B has not paid any input VAT to A.

Moreover, while B collects VAT from C, it could also "disappear" without remitting the VAT to the tax authorities, which explains why this scheme is called "missing-trader" or MTIC fraud. Irrespective of whether C further sells the goods domestically or abroad, the Greek tax authorities lose the portion of the VAT revenues kept by B, when C claims its VAT input payments.[1] It is important to note that carousel fraud is not restricted to the EU but relevant to any setting where firms sell zero-rated goods but can still claim input tax credit from the government (e.g., the GST/HST in Canada).

Another variant of the fraud, also depicted in Figure 1, requires at least two more participants in the scheme, an exporter D and a foreign company A. Continuing the previously described chain of trade, company D buys the goods from C and exports them outside of Greece, by selling the goods to A. The goods would then be re-imported by B, even multiple times, to multiply the gains from the fraud, i.e., by not remitting the VAT in every round. This fraud variant is known as "carousel fraud," since the goods cross borders several times.

The RCM has been introduced by EU member states to stop the MTIC or the carousel fraud schemes described above. The principle of the RCM is simple: for all goods and services affected by RCM, the buyer becomes liable for VAT remittance. This contrasts with the standard VAT collection, where the seller charges and collects the VAT, and remits it to the tax authorities.

The advantage of the RCM in this setting is clear. To illustrate this with the help of the previous example, if RCM applies to the goods sold by B, B will no longer collect VAT from C in Greece, therefore any gains from the MTIC or the carousel fraud schemes are removed.[2]

The change in VAT liability brought about by the RCM, though, might cause weaknesses in the VAT collection downstream. For example, Keen and Smith (2006) and De La Feria (2019) criticize the RCM as it transforms the VAT into a de facto retail sales tax, where tax collection takes place at the last stage of the value chain, which is the most vulnerable to tax evasion (e.g., Pomeranz (2015)).

Even though, under the RCM, the buyers are liable for VAT remittance, they can deduct their input costs from their VAT liability, which are expected to net out (Buettner and Tassi, 2023). This explains why there will be no VAT collection nor remittance for business-to-business (B2B) sales. Tax authorities, however, typically mandate firms to report the sales and liabilities arisen under the RCM in their tax returns (e.g., Tassi and Bussy (2025)).

Since the shift in liability from seller to buyer does not apply to business-to-consumer (B2C) sales, VAT collection is concentrated at this stage of the value chain. Retailers and B2C service providers are therefore liable for the full VAT remittance on their sales and not only for their value added. The concern expressed in the literature relates exactly to the concentration of VAT collection at the "last stage," where third-party reporting stops and tax evasion is thus easier to conceal (see Tassi and Bussy (2025) for an empirical analysis of

[1]The buffer trader C could be involved in the scheme or be completely unaware of the fraud (Keen and Smith, 2006).

[2]Note that RCM does not solve MTIC fraud involving B2C sales, as the missing trader would still be collecting VAT.

this evasion margin). Other possible unintended consequences of the RCM are the shifting of fraud to other countries or other goods on which the RCM does not yet apply (see, e.g., European Commission (2018) and Stiller and Heinemann (2024)).

Taking together the previous considerations, the impact of RCM on VAT revenues and on the VAT gap is ex ante ambiguous. First, the RCM effectively stops MTIC or carousel fraud. This should be reflected in a decline in the VAT gap that is proportional to the size of the MTIC fraud, since VAT revenues should tend to their expected value. Second, the RCM might lead to a reduction in VAT revenues due to increased VAT evasion at the B2C stage or at the domestic B2B stage from weakened paper trail of domestic B2B transactions, thus expanding the VAT gap. Third, the RCM might lead to more fraud in other sectors not yet covered by the policy, which would also increase the VAT gap.

If stopping missing-trader fraud is met by the counterbalancing consequences of the RCM on VAT evasion or increase fraud in other sectors, the net effect on the VAT gap will be zero. Otherwise, depending on which of the two counteracting mechanisms prevails, RCM might increase or reduce VAT compliance as measured by the VAT gap. It is important to note that our conclusions should hold without making strong assumptions on whether missing traders report to the tax authorities or not.[3] Since missing traders are never remitting VAT to the tax authorities, their reporting status should not affect the estimated volume of the VAT gap.

The introduction of RCM in the European Union is regulated by the VAT Directive (Council of the European Union, 2006). In particular, articles 199 and 199a list the supply of goods or services to which the RCM may apply.[4] To date, all member states apply the RCM on one or more goods or services.[5] However, countries adopted RCM in different years and on distinct types of products, giving rise to a natural experiment. Appendix Table C3 summarizes the RCM instances analysed in this paper, providing information on country and year of implementation. We focus on 8 RCM instances applied in more than one country: mobile phones, laptops, integrated circuits, industrial crops, logging, construction, waste, and raw metals.

[3] See Braml and Felbermayr (2022) and Europol (2021) for different views on the issue.

[4] Article 199a has been introduced in 2010 with the Council Directive 2010/23/EU. Two related articles are 199b, regulating the so-called "quick reaction mechanism" which has been introduced in 2013 with the Council Directive 2013/42/EU, and article 199c related to the application of the generalized reverse charge mechanism introduced by the Council Directive (EU) 2018/2057.

[5] A few countries apply RCM to CO2 emission permits or other special cases (Bussy and Tassi, 2025), which are not considered in this analysis due to data limitations, for example in relation to the difficulty in measuring the value of the affected industries. Moreover, some countries like France set the VAT rate to 0% in response to fraud in the CO2 emission permits market and only applied RCM at a later point in time, such that RCM implementation would not per se capture the effects of removing fraud on the VAT gap.

3 Data

To assess the effects of RCM on VAT compliance, we use data from 2000 to 2020 on the 27 EU members.[6] Data on VAT compliance, specifically on the VAT gap, come from reports by the Center for Social and Economic Research (CASE) (see Poniatowski et al. (2020) and earlier versions).[7] The VAT gap is defined as the difference between expected VAT revenues and VAT revenues collected. The expected VAT revenues are also known as the VAT Total Tax Liability (VTTL), which reflect projections based on VAT legislation and ancillary regulations. The VTTL and, by construction, the VAT gap are calculated using a top-down consumption-side approach (Poniatowski et al., 2020). The VAT gap not only includes VAT lost to fraud and evasion, but also to tax avoidance, bankruptcies, financial insolvencies as well as tax administration miscalculations (Poniatowski et al., 2020). A great advantage of these estimates is that they provide a standardized measure of overall VAT non-compliance across countries, taking into account the timely alignment of estimated liabilities and actual revenues. To the best of our knowledge, the computation of the VTTL has not been modified to take into account RCM implementations. On the contrary, the 2023 CASE report presents descriptive evidence of VAT gap trends changing around RCM implementations (Poniatowski et al., 2023).

For our main analysis we scale the VAT gap by the VTTL. It should be noted that, whereas the 2000-2019 observations of the VAT gap are representing the true amount of foregone VAT revenues, the 2020 VAT gaps are merely forecasts.

The expected heterogeneous impact of RCM is motivated by the overall economic value of transactions affected by the reform.[8] We therefore collect information on the economic importance (production value and input costs) of the industries affected by the RCM from Eurostat's "Annual detailed enterprise statistics for services." The production value of these industries is based on sales including changes in stocks and the resale of goods and services. The total purchases of goods and services (input costs) include the value of all goods and services purchased during the accounting period for resale or the production process, excluding capital goods. Further information on the agricultural statistics of industrial crops is retrieved from Eurostat's "Economic accounts for agriculture," which are measured in millions of euros. Logging data is retrieved from Eurostat's "Gross value added of the forestry industry" measured as the value of outputs minus the value of intermediate consumption.

We collect other variables on potential confounders or determinants of the VAT gap. Information on cash withdrawals and debit and credit card transactions comes from the European Central Bank. Data on socio-economic characteristics like inflation or percentage of the labor force with basic education come from Eurostat and the World Bank, while the public sector corruption index comes from the Quality of Government Institute. We

[6] Our analysis excludes the UK.

[7] These reports are commissioned by the EU Directorate-General of the Taxation and Customs Union (DG-TAXUD) with the aim of providing policy-makers with accurate information about the extent of the VAT gap that could be used to evaluate policies aiming to reduce foregone indirect tax revenue such as the RCM.

[8] Appendix Table C2 shows the industries related to each RCM instance, providing their NACE codes.

also account for the introduction of VAT listings, that is regular reports required from VAT payers (Holá et al., 2022). In an extension of the main analysis, we obtain information on top export and import trading partners over time for member states from the World Integrated Trade Solution (WITS) database by the World Bank.

Table 1 reports the descriptive statistics separately for countries that do and do not apply RCM in Panels A and B, respectively. Interestingly, the average VAT gap is about the same in both groups and it is around 15-16% of expected VAT revenues. We can also notice that countries applying the RCM are the majority. These countries also display on average a greater share of rural population and greater corruption. The two groups are otherwise similar in other aspects including the values of debit and credit card transactions (e-payments) to GDP, inflation, and broadband subscriptions.

4 Empirical Analysis

4.1 Difference-in-Differences

The most straightforward evaluation of the effects of the RCM considers only the first RCM implementation in each country. We estimate the effects of RCM on the VAT gap based on the following difference-in-differences (DiD) model.

$$VAT\ gap_{ct} = \alpha_c + \delta_t + \beta RCM_c \times Post_t + \gamma X_{ct} + u_{ct}, \tag{1}$$

where we regress the VAT gap (as a percentage of the VAT Total Tax Liability) of country c in period t on country (α_c) and year (δ_t) fixed effects. The main regressor is $RCM_c \times Post_t$, an indicator for the implementation of RCM interacted with an indicator for the periods after the reform. X_{ct} includes the following time-varying state-level control variables: cash withdrawals (% GDP), card transactions (% GDP), broadband subscriptions (% per 100 people), consumer price inflation (annual, in %), share of the labor force with basic education, share of the rural population, public sector corruption index, and an indicator for VAT listings. u_{ct} is the error term.

Additionally, we examine whether RCM is effective in reducing large-to-extreme cases of VAT gaps. For this purpose, we estimate Regression equation 1 using different moments of the distribution of the outcome. Specifically, we redefine the outcome variable to an indicator, equal to 1 in years when the VAT gap is greater than or equal to the 75th percentile of the VAT gap distribution (as a percentage of the VAT Total Tax Liability).

To evaluate the validity of the DiD design, we test for the presence of divergent trends in VAT gaps prior to RCM implementation in an event-study setting, as expressed in the following equation

$$VAT\ gap_{ct} \quad = \quad \alpha_c + \delta_t + \sum_{\tau=-14}^{-2} \beta_\tau RCM^{\tau}_{j,t} + \sum_{\tau=0}^{18} \beta_\tau RCM^{\tau}_{j,t} + \gamma X_{ct} + u_{ct}. \tag{2}$$

Specifications (1) and (2) are also estimated with the method proposed by Callaway and Sant'Anna (2021), to take into account the staggered adoption of RCM across countries.

4.2 Exposure to RCM

An important shortcoming of the previous estimators in our study setting is that they do not consider subsequent expansions of RCM. These approaches also do not take into account the country's exposure to RCM, i.e., the value of domestic RCM transactions.

To address these limitations, we first include a measure for the intensity of the reform based on the share of the economy affected by the RCM. In particular, we estimate

$$\begin{aligned} VAT\ gap_{ct} &= \alpha_c + \delta_t + \beta_1 RCM_c \times Post_t \times Value\ RCM\ industries_{c,t_0} + \\ &+ \beta_2 RCM_c \times Post_t + \gamma X_{ct} + u_{ct}, \end{aligned} \tag{3}$$

a model which contains a triple interaction $\beta RCM_c \times Post_t \times Value\ RCM\ industries_{c,t_0}$, where $Value\ RCM\ industries_{c,t_0}$ is a variable capturing the value of production (or costs) related to all the instances of RCM implemented in a given country, relative to the country's GDP. In order to circumvent potential endogeneity issues, we calculate this share in the last pre-reform period with available data. $Value\ RCM\ industries_{c,t_0}$ is therefore time-invariant and t_0 refers to the period prior the introduction of the RCM.

In an alternative approach exploiting the same underlying difference in reform intensity, we estimate the following regression, which uses the previously described measure of reform intensity directly. The main regressor $RCM\ intensity_c$ is defined as the (normalized) share of the pre-treatment production value of all industries eventually affected by RCM.

$$VAT\ gap_{ct} = \alpha_c + \delta_t + \beta RCM\ intensity_c \times Post_t + \gamma X_{ct} + u_{ct}. \tag{4}$$

The same regression is estimated using the De Chaisemartin and d'Haultfoeuille (2020) estimator, which allows for non-binary treatment exposure and estimates an average treatment effect.

4.3 Product-specific RCM Implementations

The third approach exploits the fact that the RCM was introduced for different product categories in different countries. In this empirical design we estimate the effect of multiple treatment types, differentiating between the distinct instances i of RCM introduction in different countries and times. We estimate the equation

$$VAT\ gap_{ct} = \alpha_c + \delta_t + \sum_{i=1}^{8} \beta^i RCM_c^i \times Post_t + \gamma X_{ct} + u_{ct}, \tag{5}$$

where $i = 1, ..., 8$ indicates one of the 8 categories of RCM introductions: mobile phones, laptops, integrated circuits, industrial crops, logging, construction, waste, and raw metals. Regression equation (5) is also estimated using the method proposed by de Chaisemartin and D'Haultfœuille (2023), which isolates treatment effects in cases when multiple treatments are implemented and are expected to affect the same outcome. Intuitively, this approach estimates treatment effects separately for each treatment and only keeps control observations where other treatments remained constant and equal to the treated unit.

5 Results

This section presents and discusses the results of our paper. Employing a battery of quasi-experimental techniques, we provide evidence for a general negative but not statistically significant effect of the RCM on the observed VAT gap. However, we find some heterogeneous responses depending on the type of service subject to RCM and along important country characteristics such as industry exposure to RCM.

5.1 Difference-in-Differences

The baseline results from Regression equation (1) using a general difference-in-differences two-way-fixed effects (TWFE) setup and the Callaway and Sant'Anna estimator are reported in Table 2. Across all model specifications (columns 1-4), RCM implementation is associated with a negative but statistically insignificant effect on the VAT gap. While we cannot rule out small effects due to limited power, the consistently negative signs across specifications hint at economically relevant, albeit imprecisely estimated, reductions in VAT losses.

Next, we address the issue that the benefits of RCM (reduced MTIC or carousel fraud) might only outweigh its costs (increased VAT evasion at domestic B2B and the B2C stage, shift of fraudulent activities) in cases of sufficiently large VAT gaps. Discretizing the outcome to take on the value of 1 if the VAT gap is greater than or equal to the 75th percentile of its distribution, we find that this percentile value corresponds to a 22% VAT gap. Estimating specification (1) with the discretized VAT outcome in Table 2 columns 5 and 6, we find that the RCM does not seem to have a significant effect on relatively large VAT gaps above the 75th percentile, although the coefficients become more negative.

Event study plots in Figure 2 confirm that the previous result of a null RCM effect holds dynamically. Additionally, we recover a U-shaped effect which suggests that VAT gap reductions, if any, are short-lived potentially because VAT fraudsters shift MTIC fraud to different goods or different member states. Apart from very early periods suffering from small sample size, we do not find any evidence for significant pre-trends between treatment and control group.

Figures 3 and 4 replicate the previous TWFE approach based on the Callaway and Sant'Anna (2021) method, which addresses the well-known issues around the identification of TWFE models in settings with different timings of treatment. While Figure 3 employs a more general definition of the control group, Figure 4 uses only not-yet-treated countries in its control group. Both approaches confirm the previous results, also over time.

5.2 Exposure to RCM

The next set of results additionally exploits the varying intensity of RCM exposure across different EU countries. Our measure of intensity is given by the relative size of the economy exposed to RCM in the pre-reform period, which is considerably heterogeneous across our observed sample (see Table 1). In a first approach, we estimate the triple-difference regression equation (3) with the pre-implementation production value of industries exposed to RCM as an additional interaction. The results in Table 3 show that both, the estimate of RCM implementation, and the triple-difference interaction with value of RCM industries remain non-significant, and in the case of the triple-difference estimator even changes signs. This offers weak evidence that VAT gaps widened following RCM implementation in proportion to the country's pre-implementation production value of industries affected by RCM. This may be understood as corroborating evidence that RCM adoption simply relates to a shift in fraudulent activity to other goods not yet subject to RCM as opposed to eliminating fraud, a phenomenon more widespread among countries with relatively higher exposure to the RCM. The lack of statistical significance implies we cannot reject the null hypothesis of no effect at conventional levels; however, the direction and consistency of the estimates remain informative.

In an alternative approach exploiting the varying intensity of RCM implementation, Table 3 (columns 3 to 6) provides evidence from a difference-in-differences setup without a binary treatment indicator for RCM adoption, but instead a continuous measure based on the 'intensity' of the reform, measured through the pre-reform share of the economy exposed to RCM. Table 3 provides evidence for this difference-in-differences estimator with a continuous treatment. Columns (3) and (4), reporting regression equation (4), show that in the standard TWFE framework, the intensity is positively associated with the VAT gap as in the earlier estimates, but the estimate is small and not statistically significant. In columns (5) and (6), we implement the same analysis using the De Chaisemartin and d'Haultfoeuille (2020) estimator (dC&DH) that overcomes the usual caveat applying TWFE in settings with differential timing in treatment and, additionally, permits for a continuous treatment variable, unlike the previously employed Callaway and Sant'Anna (2021) estimator.

As an alternative to the production value of industries subject to RCM, we use input costs to measure the bite of the policy in the economy. The results from Appendix Table C1 replicate the results from Table 3, but using measures of inputs instead of output values. Despite the different measurement, which might matter especially if mostly intermediate products are affected by RCM, the results from the two tables are quantitatively and qualitatively similar.

5.3 Product-specific RCM Implementations

In the next exercise we consider several treatments represented by the different products or services to which RCM applies. Table 4 presents the results for Regression equation (5). Here, we can notice that most of the RCM implementations did not have a significant effect on the VAT gap. Applying RCM on construction and on industrial crops, however, is associated with a significant reduction of the VAT gap and these results are robust to the inclusion of controls. Columns (3) and (4) of Table 4 use the de Chaisemartin and D'Haultfœuille (2023) approach for the estimation of several treatment effects. These results show non-significant effects of the waste and construction treatments. A limitation of this approach, however, is represented by the large number of treatments we consider, which leads us to drop observations with no control group. Therefore, we are not able to estimate all the treatment effects.[9]

5.4 VAT Gap Cross-border Shifting

In this subsection, we expand our baseline analysis with supplementary results concerning potential VAT fraud relocation across national borders, building upon the foundations established by Bussy and Tassi (2025) and Stiller and Heinemann (2024). Our approach builds on their intuition but is limited to country-year observations as compared to bilateral trade data. We consider the potential of VAT fraud relocation from member states introducing RCM to top trading partner member states without RCM. Specifically, we investigate if the introduction of RCM by a top import m or top export x partner of country c (i.e., country of import or export) has effects on the VAT gap of country c itself. Trading partner information is obtained from the "TradeStats" section of the World Integrated Trade Solution dataset of the World Bank.

We adopt two strategies to detect these potential relocation effects and present the results in Table 5. First, we restrict the sample to pre-RCM country-year observations of member states that ever adopted RCM and all country-year observations of member states that never adopted RCM. Using this sub-sample, we test if RCM imposed on any product in year t by a top import or top export partner has any effects on country c that has yet to implement RCM; an exercise akin to a placebo test (Panel A). Given the imprecise estimates with the full sample, we do not anticipate to detect large and statistically significant reductions in VAT gap in this relatively underpowered analysis. However, a positive estimated coefficient may still have practical significance as weak evidence of VAT fraud displacement from an RCM adopter and relocation to a top trading partner. Conversely, for our second strategy we use the full dataset, in conformity with our baseline analysis. Here, we estimate the impact of RCM adoption both in a top import m or top export x partner of country c and country c itself (Panel B). The simultaneous presence of RCM in both ends of the trade chain implies that fewer trading partners can now be targeted for VAT fraud displacement,

[9] For example, while some countries implemented RCM on phones, laptops, and integrated circuits at the same time, some others did not and therefore it is impossible to estimate the treatments effect of these instances separately or even jointly.

potentially bolstering the impact of RCM on VAT gap reductions in country c.

The results in Table 5 illustrated in Panel A present a marginally positive, though insignificant, coefficient for the implementation of RCM by the top importer/exporter. This positive coefficient is consistent with potential fraud relocation as the VAT gap intensifies when leading trading partners enforce RCM. Although these effects are not statistically significant, they are not true zeros and have economic implications. These non-negligible increases in VAT gaps are suggestive of VAT fraud relocation. The results presented in Panel B indicate that VAT fraud relocation to trading partners after RCM adoption is less pervasive, if any, when a top import or export partner has simultaneously adopted RCM. These findings may be viewed as evidence that RCM adoption may be a best response following RCM introduction in a top trading partner.

6 Conclusion

This paper evaluates the overall impact of the RCM on the VAT gaps of EU member states over two decades. The main contribution of this study is the integral evaluation of RCM implementations by accounting all response margins—MTIC fraud and all other forms of VAT non-compliance. Using aggregate-level data and policy variation across countries and over time, we show that the adoption of the RCM does not lead to EU-wide changes in the VAT gap. This finding is consistent across different designs including TWFE, event study and heterogeneous treatment effects estimators. We find no evidence that RCM adoption harms VAT compliance: point estimates are negative or near zero, with upper bounds suggesting any possible adverse impact is economically minimal. In practice, this implies RCM reforms are fiscally neutral on average, neither exacerbating nor markedly reducing VAT revenue shortfalls. These findings are also in line with Bussy and Tassi (2025) who offer descriptive evidence of no detectable changes on the VAT gap and Madzharova (2020) who controls for the adoption of RCM by EU countries when estimating the effects of cashless payments on VAT performance (a measure somewhat close to VAT gap) and also finds no significant effects.

There is only limited evidence that following RCM implementation VAT gaps increase proportionally to a country's production value of RCM-targeted industries. Further, we provide evidence of varying effectiveness of RCM adoption across different goods with its implementation in crops- and construction-related economic activities yielding statistically significant reductions in the VAT gap. On the contrary, introducing RCM for transactions involving waste, mobile phones & electronics has null effects which are, arguably, reflecting true zeros.

Concerns about potential unintended consequences, such as shifting fraud to untreated sectors or countries, or undermining the VAT's self-enforcing chain, find mild support in our aggregate data. After a member state adopts RCM, VAT gaps in its top trading partners vary in a manner that is suggestive of VAT fraud relocation, although these changes are not statistically significant, contrary to Stiller and Heinemann (2024). However, the simultaneous adoption of RCM by a member state and a top trading partner appears to reinforce the deterrent effect of RCM on VAT fraud relocation.

The empirical investigation is subject to a number of limitations. First, adoption of RCM for a specific industry in a given year is likely driven by suspicions of extensive evasion. However, we are limited in our ability to estimate the propensity of RCM adoption to match comparable adoption and non-adoption countries in our empirical investigation as all countries eventually adopt the RCM on some types of B2B transactions. Future work should account for the non-random nature of RCM implementation by individual EU member states over time. Second, our proxy of evasion is aggregated to the country-level and cannot capture regional effects or sectoral compliance changes. Lastly, our results should be interpreted with caution given the small size of our sample, and the aggregate level nature of the analysis.

In sum, our findings suggest that the redesign of the VAT system to integrate the RCM neither reduces VAT gaps nor breaks the VAT chain to facilitate more domestic B2B VAT fraud or evasion. However, industry-specific RCM adoption may generate sizable reductions in VAT gaps as evidence from the introduction of the RCM for crops and construction suggests. The policy implications of these findings are twofold; they cast doubt on the effectiveness of RCM adoption for an increasingly larger array of goods or even universal application of the RCM (see De La Feria (2019)). While our results show that targeted RCM implementation in a subset of industries may be effective in reducing VAT gaps, fraud relocation may still be a concern. Considerations of an EU-wide adoption of the RCM should proceed with caution in the absence of evidence of improvements in overall VAT compliance using aggregate, country-level data. Policymakers can consider that expanding RCM coverage does not appear to worsen VAT gaps, though neither should RCM be viewed as a strong, standalone solution for VAT fraud. Instead, focusing on sector- or product-specific RCM implementation, supported by robust enforcement and monitoring to mitigate potential fraud displacement. Additional research, ideally with administrative, firm-level data and larger sample sizes, could further clarify sector- or context-specific impacts (Buettner and Tassi, 2023; Cipullo et al., 2024). Given the sectoral applicability of many RCM components, industry-specific future VAT gap estimates by CASE would also enable a number of VAT gap abatement strategy investigations.

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A Tables

Table 1: Descriptive Statistics, by group.

	Mean	St. Dev.	Min	Max	N
Panel A – countries applying RCM, all years					
VAT gap	0.15	0.10	0.00	0.49	460
RCM baseline value	0.11	0.08	0.01	0.32	483
E-payments (% of GDP)	0.11	0.08	0.00	0.42	462
Broadband subscriptions	21.02	12.79	0.03	47.50	458
Cash (% of GDP)	0.13	0.06	0.01	0.30	419
Inflation	2.55	3.45	-4.48	45.67	483
Labor force with basic education	36.58	12.56	14.08	69.00	480
Rural population	28.88	12.65	-0.31	49.25	483
Public sector corruption index	0.15	0.21	0.00	1.90	472
Unemployment rate	8.73	4.50	1.72	27.47	483
VAT listings	0.19	0.39	0.00	1.00	483
Panel B – countries not applying RCM, all years					
VAT gap	0.16	0.10	0.02	0.67	84
RCM baseline value	0.00	0.00	0.00	0.00	105
E-payments (% of GDP)	0.12	0.06	0.00	0.24	105
Cash (% of GDP)	0.11	0.06	0.02	0.23	94
Broadband subscriptions	22.70	13.07	0.01	41.41	103
Inflation	2.15	2.15	-2.10	15.40	105
Labor force with basic education	39.18	5.62	27.02	51.11	105
Rural population	16.91	12.94	1.92	33.20	105
Public sector corruption index	0.07	0.06	0.02	0.18	84
Unemployment rate	7.36	3.25	1.81	19.48	84
VAT listings	0.49	0.50	0.00	1.00	105

Notes: VAT gap as % of VTTL, broadband subscriptions (% per 100 people), consumer price inflation (annual %), labor force with basic education and rural population in %, public sector corruption index, and an indicator for VAT listings. Sources: Eurostat, World Bank, ECB, Quality of Government Institute, and Holá et al. (2022).

Table 2: RCM effects on VAT Gap and top quartile VAT gap.

	VAT Gap				$\mathbb{1}\{VATgap \geq 75th\ percentile\}$	
	TWFE		CS estimator		TWFE	
	(1)	(2)	(3)	(4)	(5)	(6)
$RCM \times Post$	-0.021	-0.020	-0.047	-0.047	-0.148	-0.093
	(0.020)	(0.019)	(0.046)	(0.045)	(0.090)	(0.080)
Controls	No	Yes	No	No	No	Yes
Observations	544	461	544	544	544	461

Notes: All specifications include country and year FE. Standard errors clustered at the country level in parentheses. Column (2) uses never treated control group and column (3) the not-yet treated. Controls are omitted for brevity but coefficient estimates in columns (2) and (6) are adjusted by cash to GDP, e-money to GDP, broadband subscriptions (% per 100 people), consumer price inflation (annual %), % labor force with basic education, % rural population, public sector corruption index, and an indicator for VAT listings. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 3: Intensity of RCM effects on VAT Gap.

	TWFE estimator				dC&DH (2020)	
	(1)	(2)	(3)	(4)	(5)	(6)
$RCM \times Post$	-0.033	-0.026				
	(0.024)	(0.027)				
$RCM \times Post \times Value\ RCM\ ind.$	0.118	0.057				
	(0.107)	(0.100)				
$RCM\ intensity \times Post$			0.008	0.002	0.134**	-0.047
			(0.009)	(0.007)	(0.058)	(0.286)
Controls	No	Yes	No	Yes	No	Yes
Observations	544	461	544	461	148	98

Notes: All specifications include country and year FE. Standard errors clustered at the country level in parentheses. Controls are omitted for brevity but coefficient estimates in columns (2), (4), and (6) are adjusted by cash to GDP, e-money to GDP, broadband subscriptions (% per 100 people), consumer price inflation (annual %), % labor force with basic education, % rural population, public sector corruption index, and an indicator for VAT listings. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table 4: RCM-by-product type effects on VAT Gap.

	TWFE		dC&DH (2023) estimator	
	(1)	(2)	(3)	(4)
$RCM_{waste} \times Post$	-0.007	0.001	-0.026	0.063
	(0.018)	(0.019)	(0.019)	(0.141)
$RCM_{phones} \times Post$	-0.001	0.007		
	(0.025)	(0.025)		
$RCM_{IC} \times Post$	-0.002	0.006		
	(0.022)	(0.025)		
$RCM_{laptops} \times Post$	0.015	-0.004		
	(0.014)	(0.016)		
$RCM_{crops} \times Post$	-0.055***	-0.056***		
	(0.012)	(0.016)		
$RCM_{metals} \times Post$	-0.026	-0.019		
	(0.017)	(0.013)		
$RCM_{logging} \times Post$	-0.040	-0.015		
	(0.031)	(0.028)		
$RCM_{construction} \times Post$	-0.017	-0.034**	0.038	-0.106
	(0.015)	(0.013)	(0.034)	(1.651)
Controls	No	Yes	No	Yes
Observations	544	461	See table notes	

Notes: All specifications include country and year FE. Standard errors clustered at the country level in parentheses. Controls are omitted for brevity but coefficient estimates in columns (2) and (4) are adjusted by cash to GDP, e-money to GDP, broadband subscriptions (% per 100 people), consumer price inflation (annual %), % labor force with basic education, % rural population, public sector corruption index, and an indicator for VAT listings. The coefficients from columns (3) and (4) are estimated in 4 separate regressions, following the de Chaisemartin and D'Haultfœuille (2023) approach. The number of observations for each regression varies; RCM_{Waste} (without controls) is estimated with 100 observations. RCM_{Waste} (with controls) is estimated with 76 observations. $RCM_{construction}$ (without controls) is estimated with 34 observations. $RCM_{construction}$ (with controls) is estimated with 28 observations. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

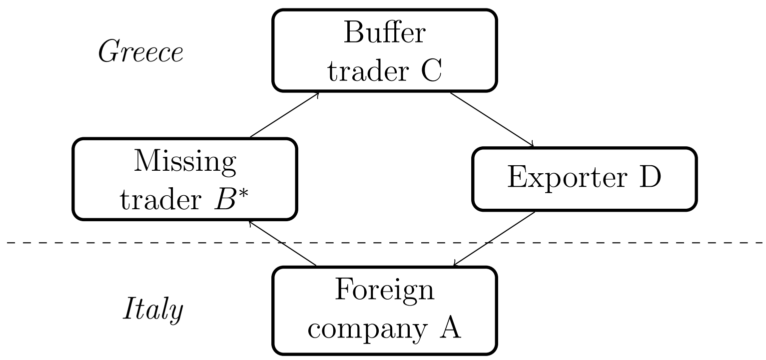
Table 5: RCM relocation effects.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A – observations before own RCM implementation						
$RCM_{importer}$	0.035	0.035*	0.002			
	(0.022)	(0.018)	(0.016)			
$RCM_{exporter}$				0.020	0.020	0.009
				(0.026)	(0.013)	(0.011)
Observations	233	174	174	233	174	174
Panel B – full panel						
RCM_{own}	-0.021	-0.019	-0.010	-0.021	-0.019	-0.014
	(0.020)	(0.018)	(0.017)	(0.020)	(0.018)	(0.022)
$RCM_{importer}$	0.007	0.016	0.008			
	(0.020)	(0.016)	(0.021)			
$RCM_{exporter}$				0.003	0.010	0.022
				(0.021)	(0.019)	(0.022)
Observations	524	461	460	524	461	460

Notes: The dependent variable is VAT gap as % of VTTL. Columns (1) and (4) only include country and year FEs. Columns (2) and (5) also include controls, and columns (3) and (6) include controls and importer/exporter FEs. Standard errors clustered at the country level in parentheses. Controls are omitted for brevity but coefficient estimates in columns (2), (3), (5), and (6) are adjusted by cash to GDP, e-money to GDP, broadband subscriptions (% per 100 people), consumer price inflation (annual %), % labor force with basic education, % rural population, public sector corruption index, and an indicator for VAT listings. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

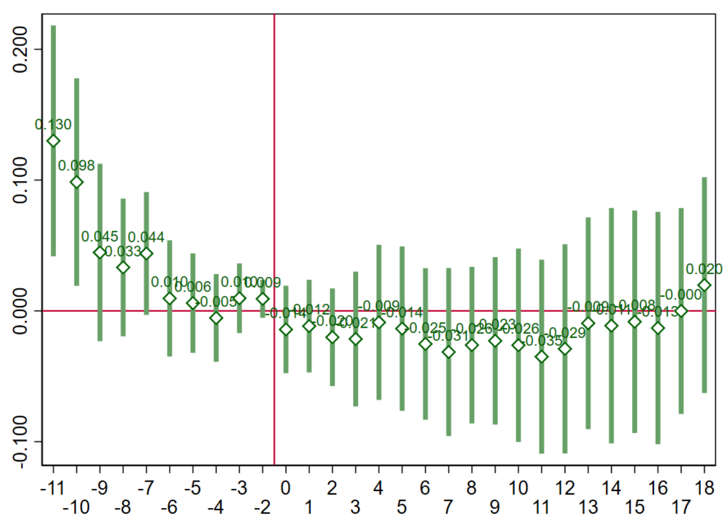
B Figures

Figure 1: MTIC and Carousel Fraud



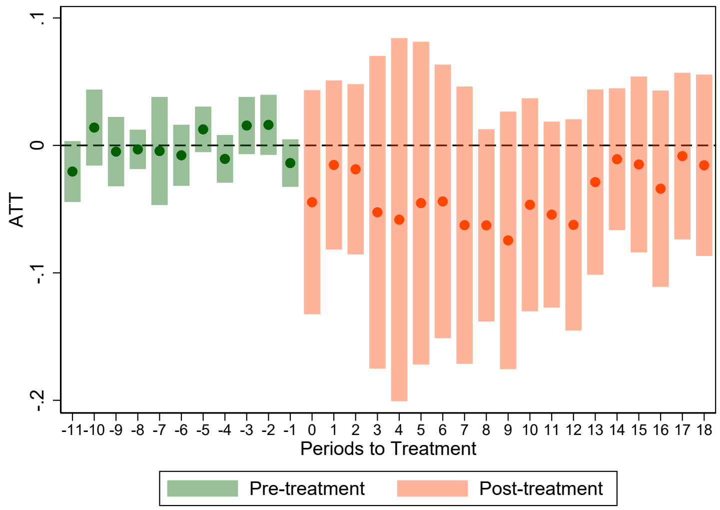
Notes: The trade flow starts from company A in the foreign country, Italy, and follows a clockwise order. The importing firm B acts as Missing Trader and disappears after selling the good to firm C, who acts as Buffer Trader. Adapted from Keen and Smith (2006) and Buettner and Tassi (2023).

Figure 2: TWFE event study results: yearly DID point estimates, with controls



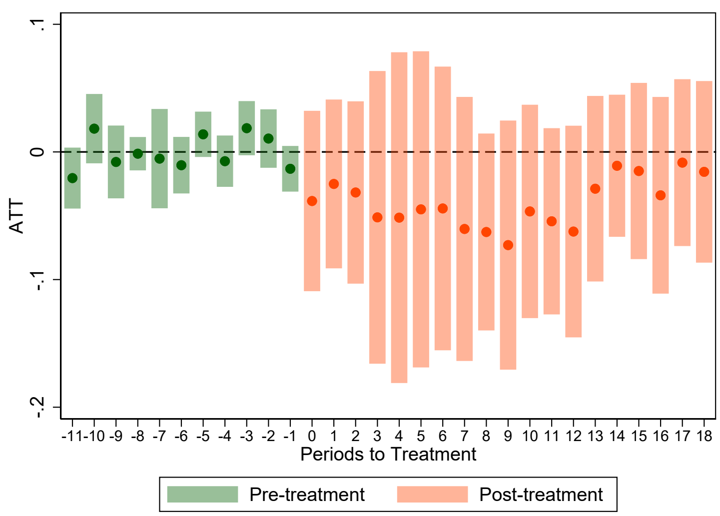
Notes: The vertical bars show the 95% confidence intervals from robust standard errors clustered at the country level. The excluded period is −1.

Figure 3: Event study estimates: Callaway and Sant'Anna (2021) estimator



Notes: The vertical bars show the 95% confidence intervals from robust standard errors clustered at the country level. The excluded period is -1. The control group is represented by the never treated.

Figure 4: Event study estimates: Callaway and Sant'Anna (2021) estimator (not-yet treated)



Notes: The vertical bars show the 95% confidence intervals from robust standard errors clustered at the country level. The excluded period is -1. The control group is represented by the not-yet treated.

C Supplementary Appendix

Table C1: Intensity of RCM effects on VAT Gap, using input costs.

	TWFE				dC&DH (2020)	
	(1)	(2)	(3)	(4)	(5)	(6)
RCM × *Post*	-0.030	-0.025				
	(0.028)	(0.029)				
RCM × *Post* × *Inputs RCM ind.*	0.086	0.048				
	(0.174)	(0.179)				
RCM intensity × *Post*			0.005	0.001	0.134**	-0.047
			(0.014)	(0.014)	(0.058)	(0.286)
Controls	No	Yes	No	Yes	No	Yes
Observations	544	461	544	461	148	98

Notes: All specifications include country and year FE. Standard errors clustered at the country level in parentheses. Controls are omitted for brevity but coefficient estimates in columns (2), (4), and (6) are adjusted by cash to GDP, e-money to GDP, broadband subscriptions (% per 100 people), consumer price inflation (annual %), % labor force with basic education, % rural population, public sector corruption index, and an indicator for VAT listings. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

Table C2: Reverse Charge instances and corresponding NACE codes

RC Instance	**Code and Description**
Cereals and Industrial Crops [199a(i)]	1.11 - Growing of cereals (except rice), leguminous crops and oil seeds 1.15 - Growing of tobacco 1.16 - Growing of fibre crops 1.28 - Growing of spices, aromatic, drug and pharmaceutical crops 10.61 - Manufacture of grain mill products 12.00 - Manufacture of tobacco products
Supplies of Raw and Semi-Finished Metals [199a(j)]	7.10 - Mining of iron ores 7.29 - Mining of other non-ferrous metal ores 24.10 - Manufacture of basic iron and steel and of ferro-alloys 24.31 - Cold drawing of bars 24.32 - Cold rolling of narrow strip 24.33 - Cold forming or folding 24.34 - Cold drawing of wire 24.41 - Precious metals production 24.43 - Lead, zinc, and tin production 24.44 - Copper production 24.45 - Other non-ferrous metal production 24.51 - Casting of iron 24.52 - Casting of steel 24.52 - Casting of light metals 24.54 - Casting of other non-ferrous metals 25.50 - Forgings, pressing, stamping and roll-forming of metal; powder metallurgy 46.12 - Agents involved in the sale of fuel, ores, metals, and industrial chemicals 46.72 - Wholesale of metals and metal ores
Integrated Circuit Devices [199a(d)]	26.11 - Manufacture of electronic components 26.12 - Manufacture of loaded electronic boards
Laptops and Game Consoles [199a(h)]	26.20 - Manufacture of computers and peripheral equipment 26.40 - Manufacture of consumer electronics 46.51 - Wholesale of computers, computer peripheral equipment and software 47.41 - Retail sale of computers, peripheral units and software in specialised stores
Mobile Phones [199a(c)]	26.30 - Manufacture of communication equipment 46.52 - Wholesale of electronics and telecommunications equipment and parts 47.42 - Retail sale of telecommunications equipment in specialised stores
Waste and Scraps [199.1(d)]	38.32 - Recovery of sorted materials 46.77 Wholesale of waste and scrap

Table C3: Reverse Charge instances and corresponding country-year applications

RC Instance	Year	Country
Cereals and Industrial Crops [199a(i)]	2011	Romania
	2012	Hungary
	2014	Bulgaria, Slovakia
	2015	Czech Republic
	2016	Latvia
Supplies of Raw and Semi-Finished Metals [199a(j)]	2009	Slovakia
	2011	Germany
	2012	Estonia
	2014	Austria
	2015	Czech Republic, Hungary, Poland, Spain
	2018	Latvia
	2019	Croatia
Laptops and Game Consoles [199a(h)]	2013	Netherlands
	2014	Austria, Germany, Denmark
	2015	Czech Republic, Poland, Spain
	2016	Italy, Latvia, Romania
	2017	Greece
	2019	Lithuania
Integrated Circuits Devices [199a(d)]	2007	Great Britain
	2011	Germany, Italy
	2012	Austria
	2013	Netherlands
	2014	Denmark, Slovakia
	2015	Czech Republic
	2016	Latvia, Romania
	2017	Poland
Mobile Phones [199a(c)]	2007	Great Britain
	2011	Germany, Italy
	2012	Austria
	2013	Netherlands
	2014	Denmark, Slovakia
	2015	Czech Republic, Poland, Spain
	2016	Romania, Latvia
	2017	Greece
	2019	Lithuania
Waste and Scraps [199.1(d)]	2004	Spain
	2006	Portugal
	2007	Austria, Greece, Netherlands, Bulgaria
	2008	France, Hungary, Lithuania

Continued on next page

Table C3 – continued from previous page

RC Instance	Year	Country
Waste and Scraps [199.1(d)]	2009	Slovakia
	2010	Slovenia
	2011	Czech Republic, Estonia, Germany, Ireland, Latvia, Poland
	2012	Denmark
	2013	Sweden
	2015	Finland
Logging	2000	Latvia
	2008	Italy, Lithuania
Construction [199.1(a)]	2002	Austria
	2004	Germany
	2007	Portugal, Sweden
	2008	Hungary, Ireland, Italy
	2011	Finland, Slovenia
	2012	Czech Republic, Spain, Latvia
	2013	Croatia
	2014	France
	2016	Slovakia

Sources: Bussy and Tassi (2025), OECD, and national legislations.