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POLICY WATCH

VAT fraud and reverse charge: empirical evidence from VAT return data

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Abstract
In order to stop Value-Added Tax (VAT) fraud, EU member states use the so-called reverse-charge (RC) mechanism, which effectively removes VAT withholding and refunding in business-to-business transactions. Using the German VAT return data, we examine the effects of the introduction of RC and find that requests of input tax refunding decline sharply in the affected industries, supporting the presence of fraud prior to the introduction of RC. Based on our estimates, we quantify the revenue losses from VAT fraud prior to RC implementation in these industries to be around 5% of VAT revenues.

Keywords Value-added tax · Reverse charge · Tax fraud · Missing-trader fraud

JEL Classification H21 · H26

1 Introduction

VAT has become a major source of tax revenue in most countries of the world not least due to certain advantages in tax enforcement. In particular, within the formal sector, the common invoice-credit form of calculating VAT provides a self-enforcing incentive structure (e.g., Pomeranz, 2015). Even in countries that are characterized by a large informal sector, the built-in withholding-tax feature has been shown to facilitate tax enforcement (Waseem, 2022). However, since taxes are refunded on inputs, VAT is susceptible to fraud. This is experienced in particular in the EU, where the so-called missing-trader (MT) fraud exploits the fact that "tax frontiers" have been removed in the EU's common market. As exports are zero-rated and no

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import VAT is levied by the importing country, imports from other EU countries enter the country untaxed (Keen & Smith, 2006). After having sold a product inclusive of VAT, a fraudulent importer may disappear without remitting the VAT. The buyer, however, claims an input tax refund and a loss of VAT revenues occurs as a consequence. This fraud not only reduces available public funds, but it also transfers public resources to organized crime (De La Feria, 2020).

Even though MT fraud has emerged as an issue more than 20 years ago (see Cnossen, 2001), there is still considerable uncertainty about the extent of resulting revenue losses. An often-used estimate of revenue losses due to non-compliance is the VAT gap. Defined as the difference between revenues collected and potential revenues, it is regularly calculated for all EU countries, and the total EU VAT gap in the year 2017 is estimated at about 11.2% of potential revenues (Poniatowski, 2019). However, this figure should not be equated with revenue losses from MT fraud (Yiallourou, 2019).[1] Studies that directly measure VAT fraud come to quite heterogeneous conclusions. Table 1 provides an overview of these estimates. For the EU as a whole, estimates range from annual revenue losses of 0.1% to 9.7% of total VAT revenues. Studies for individual EU countries also differ substantially. While methods vary, estimates are essentially based on trade data or national accounts.

Despite the uncertainty regarding the magnitude of revenue losses, countries have implemented various measures to combat VAT fraud. The key measure used in the EU is to apply the so-called reverse-charge (RC) mechanism on domestic transactions (Keen, 2007). If a good is subject to reverse charge, the tax liability in business-to-business transactions is shifted from the seller to the buyer. Since the seller can no longer charge VAT and disappear without remittance, RC effectively erases the possibility for MT fraud. However, RC removes key features of the common invoice-credit form of the VAT that are important to ensure compliance. In particular, the withholding-tax feature of the VAT is removed and tax collection is effectively shifted to the end of the value chain, which may result in higher tax evasion. As a first step towards an assessment of the costs and benefits of implementing RC, it is important to obtain more reliable estimates of the extent of fraud.

This paper adopts a novel approach to estimate the extent of VAT fraud by analysing the German VAT returns. We argue that the introduction of reverse charge for domestic transactions of certain products has made VAT fraud technically impossible in these areas. The resulting decline in input tax claimed, therefore, reveals the volume of fraudulent trade before RC implementation. Exploiting the German VAT return data at a granular five-digit industry level, we find that VAT reporting, including claims of input VAT, indeed changed significantly after the scope of RC has been widened in the years between 2009 and 2018. We complement our analysis by an analysis of other margins such as total sales and within-EU imports. The estimated effects on these margins are consistent with the view that the effect of RC on VAT returns is driven by MT fraud. Based on our empirical results, we estimate the volume of revenue losses from VAT fraud before introduction of RC at around 5% of total VAT revenues. Assuming that the

[1] The gap reflects tax exemptions, deviations from the standard VAT rate and the registration threshold. There are also measurement issues ranging from temporal allocation to sectoral delimitations and effects of bankruptcies (e.g., Gebauer et al., 2005; Yiallourou, 2019).

extent of fraud is similar in the other EU countries, this figure suggests that about half of the VAT gap in the EU is attributable to MT fraud.

Our key contribution to the literature on VAT fraud is to provide a novel approach to quantify the extent of MT fraud. To this end we exploit an institutional change in the VAT liability and utilize tax return data. A related research strategy has been used by Waseem (2019) to analyse VAT evasion and fraud in Pakistan, where illegitimate input tax credits are generated through "invoice mills". In 2005, a reform reduced the VAT rate to zero for a number of industries, thereby eliminating the tax incentive to misreport. The findings indicate that overclaiming refunds, of which more than a third is found to be due to invoice mills, results in substantial revenue losses. Another contribution of our paper is that we document the scope of RC in German VAT. More specifically, we identify 22 industries affected by RC and quantify the fraction of sales that fall under RC.

We embed the analysis of the effects of the reverse-charge method in a broader discussion of the problem of VAT fraud. In doing so, we explain why RC has been implemented and why it deals effectively with the type of fraud that is so common in Europe. The discussion shows that despite effectiveness of RC in the EU context, there are doubts whether it is really the silver bullet to fight VAT fraud, as it may encourage other forms of non-compliance.

The next section provides a general discussion of VAT fraud and countermeasures, including the reverse-charge mechanism. Section 3 briefly reviews the implementation of reverse charge in Germany. Sections 4 and 5 present the data and discuss the methodology used in the empirical analysis. Section 6 provides the results. Section 7 provides conclusions and suggestions for further research.

2 VAT fraud and countermeasures

The literature on tax evasion has emphasized the great importance of third-party reporting for tax enforcement. The VAT has clear advantages with respect to a retail sales tax in this regard, as taxation of purchases and sales along the value chain creates enforcement spillovers (e.g., Pomeranz, 2015). As firms are entitled to a refund of the taxes paid on their inputs, they have an incentive to request an invoice from their suppliers and report transactions separately from the suppliers to the tax administrator. Hence the common invoice-credit form of the VAT provides a third-party-reported paper trail on taxable transactions. This form of VAT also ensures fractional tax collection along the value chain, and it has an important built-in withholding-tax element: as each supplier withholds VAT paid by the buyer, remittances at upstream stages are protected (Waseem, 2022).

2.1 VAT non-compliance

The third-party reporting and the withholding-tax properties make the VAT particularly attractive as a revenue instrument in weak-enforcement environments. Nevertheless, non-compliance remains a problem for VAT. This is obvious in

Table 1 Estimates of VAT fraud in Europe

Bill. €	% of VAT revenue[3]	Country	Year	References
1.3[1]	0.1	EU	2004–2019	Bussy (2020)
2.5[1]	0.3	EU	2007–2019	Stiller and Heinemann (2019)
64.5	5.7	EU	2018	Braml and Felbermayr (2022)
93.5	9.7	EU	2014	Frunza (2016)
50.0	5.4	EU	2013	European Council (2020)
49.0	5.4	EU	2011	EY (2015)
18.0[1]	2.3	EU	2009	Borselli (2011)
25.0[1]	3.2	EU	2009	Ainsworth (2011)
23.0	2.9	EU	2006	Borselli (2011)
14.8	1.9	EU	2005–2006	OCS SPF Finances Belgique (2007)
0.03	0.1	Belgium	2011	Cour de comptes (2012)
14.0	6.9	Germany	2014	Frunza (2016)
0.6[2]	0.3	UK	2016–2017	HMRC (2018)

[1] Midpoint estimate of a range of estimates.

[2] Upper bound estimate, original figure in £.

[3] Total VAT revenues are taken from OECD (2022). Figures for the EU excludes Bulgaria, Croatia, Cyprus, Malta, and Romania. For the national currencies different from the Euro, we have taken the average exchange rate to Euro between 2004 and 2019 from ECB (2022)

Notes: The following studies use gaps in bilateral trade flows for their estimates: (Bussy, 2020; Stiller & Heinemann, 2019, Braml & Felbermayr, 2022). Frunza (2016) uses bilateral trade flows and VAT gaps. EY (2015) uses survey results. While details are not available, the HMRC methodology is based on national accounts. Bussy (2020)'s estimates are presented as yearly estimates for the indicated period. Braml and Felbermayr (2022) use the average VAT rate for their back-of-the envelope calculation. The HMRC publishes estimates since the early 2000 s; the estimates from previous years are typically above the level of 2016–2017, reaching around 1 billion pounds (HMRC, 2018). Cour de comptes (2012) also provides estimates for the previous years. Frunza (2016) estimates the VAT losses due to MT fraud in all the EU countries separately and both for 2013 and 2014. Other estimates are reported in European Commission (2017), and in International VAT Association (2007) but with unclear sources. Sergiou (2012), Borselli (2011), and Hangá et al. (2018) present further estimates referring to different studies and reports, which are no longer available online or where sources are unclear

a business-to-consumer (B2C) setting, as consumers have no incentive to ask for an invoice and may rather buy products and services without VAT. This opens up the room for evasion by the firm and perhaps collusion between firm and customer. Hence, at the end of the value chain the VAT has a "last-mile" problem (Naritomi, 2019). Enforcement issues arise also in a business-to-business (B2B) setting. In particular, the usual invoice-credit method of revenue collection makes the VAT susceptible to fraud. Since a supplier's invoice constitutes basically "a cheque drawn on the government" (Bird, 1993), there is a strong incentive to seek illegitimate refunds. As Harrison and Krelove (2005) put it, the refunding of credits is the "Achilles heel" of the invoice-credit form of VAT. A swift and easy refunding procedure is important to ensure that the tax does not create any distortions of production, which is regarded as a key advantage compared to gross receipts taxes (e.g., Smart & Bird,

2009). Facing illegitimate claims for VAT refunds, authorities might want to cross-check these claims and the suppliers' tax payments before processing the requests for refunding. As this will slow down the refunding process, compliance costs will rise and B2B trade may become distorted.

Illegitimate refunds can result from actual purchases of goods and services that are falsely claimed as inputs. In industries that are partially exempt from VAT, such as the financial industry, unjustified refunds may arise by misreporting exempted inputs (Buettner & Erbe, 2014). Illegitimate refunds are obtained also for purchases that did not take place at all or where the seller is not remitting the VAT. Fraudulent firms often act collusively to this end. Harrison and Krelove (2005) and Keen and Smith (2006) report that businesses are set up with the main purpose to generate invoices that can be used for a VAT refund. Empirical evidence by Waseem (2019) documents sizable revenue losses due to those "invoice mills" in Pakistan.

Claiming illegitimate refunds is facilitated in the presence of cross-border trade. One reason is the common practice that exporters do not charge VAT on their sales. As VAT is imposed by the importing country, this practice is consistent with the destination principle, which is the dominant international tax principle guiding the taxation of consumption.[2] Due to zero-rating of their sales, however, exporters are typically net VAT claimants. While, usually, net VAT claims serve as a warning sign to tax administration, with zero-rating of exports net VAT claims are much more common, which makes it more difficult to identify fraudulent traders (Waseem, 2019). In addition, imports may enter the country untaxed. In this case, non-complying importers would not risk to lose the refund of any import VAT. This is of particular importance in Europe, after the European Union (EU) established the Single Market, which enables free trade of goods and services and has removed border controls between EU member states.[3] While border controls are important to enforce import VAT and hence to implement taxation according to the destination principle, any "tax frontiers" were considered incompatible with the concept of the Single Market (Martins, 2006).

With the abolition of border controls, import VAT has been replaced in the EU by the "deferred-payment" method (Cnossen & Shoup, 1987). According to this regulation, it is not the exporter but the importer who is liable for VAT. As noted by Cnossen (2001), VAT on imports "is collected on a reverse charge basis: purchasers of out-of-state goods and services declare the imports, [...] apply VAT, and take credit for the same amount, all in the same return".[4] The European Commission originally

[2] As Keen and Hellerstein (2010) note, the destination principle is the norm in international trade, and is sanctioned by World Trade Organization (WTO) rules.

[3] The EU Single Market program involved about 282 specific measures removing non-tariff barriers. In 1996 Member States had put in place on average more than 90% of these measures (Bottasso & Sembenelli, 2001).

[4] In using the reverse-charge method to enforce local taxation in the context of imports, the EU is not alone. Ebrill et al. (2001) cite recommendations of international organizations such as the OECD to tax services delivered over the internet on a reverse-charge basis. Recently, a number of countries have implemented this approach (e.g., Kenya, cf. Ali, 2021, and Chile, cf. Varas, Martínez et al., 2020). But, the reverse-charge method is also used for taxation of imports more generally (e.g., Nigeria, cf. Agbo &

sought a fundamental reform that would have based the EU VAT system on the origin principle and, hence, did away with zero-rating exports altogether. However, what was designed as a "transitional regime" in the early 1990 s (Hart, 1994) is basically still in place today.

Even if the deferred-payment method offers a practical solution to implementing the destination principle in the absence of border controls, the fact that goods and services enter the country untaxed made VAT vulnerable to fraud. In particular, the so-called missing-trader (MT) fraud emerged. In this fraud scheme, the importer charges VAT on a domestic sale, issues an invoice and disappears before remitting any VAT. As the buyer submits the invoice to the authorities, he or she receives an illegitimate refund. As no taxes are paid, this fraud leads to VAT revenue losses.

By exporting and re-importing the goods and in each round not remitting VAT, the fraud can be repeated, which has earned this variant the name "carousel fraud" (e.g., Cnossen, 2001; Keen & Smith, 2006). See Fig. 1 for a schematic illustration. To reduce its traceability, the scheme may also involve "buffer traders," who buy and resell the goods and might not be aware of trading with fraudsters.

2.2 Countermeasures

Apart from proposals to abolish the zero-rating of exports through fundamental VAT reforms (e.g., Keen & Smith, 2000), a number of targeted proposals have been made, and in some cases implemented, that seek to address illegitimate VAT refunding within the current EU VAT system. Usually, VAT is enforced through mandatory VAT reports by registered companies. Based on these reports, firms remit the tax charged on clients (output VAT) net of taxes paid to their suppliers (input VAT). A possible way to limit overclaiming through missing-trader fraud is to supplement the reporting process with the additional requirement to transfer the taxes charged on any transaction into a VAT account (Sinn et al., 2004). Based on individual firms' accounts, the tax authority can then reconcile the reporting with the actual payments before the input tax is refunded. As Keen and Smith (2006) note, due to higher liquidity requirements, regular transfers to VAT accounts may lead to a substantial increase in compliance costs. Even if institutional or technological arrangements may help limiting the compliance cost (e.g., Ainsworth, 2006), the fear of larger compliance cost may explain why EU countries have not adopted this proposal.[5]

To overcome the zero-rating of exports and the associated break in VAT collection across the value chain, Keen and Smith (1996) developed a concept of a "viable integrated" VAT (VIVAT). Accordingly, exporters would charge a uniform VAT rate on all cross-border B2B transactions within the EU's Single Market. Importers

Footnote 4 (continued)

Nwadialor, 2020, and South Africa, cf. Van Zyl, 2014). India has included the reverse-charge mechanism in the Goods and Services Tax in order to deal with B2B transactions where the seller is an unregistered entity (Rao, 2019).

[5] Pashev (2007) discusses the Bulgarian experience with VAT accounts introduced in 2003 and finds that it has facilitated rather than prevented fraud, while compliance costs increased. Bulgaria abandoned VAT accounts in 2007.

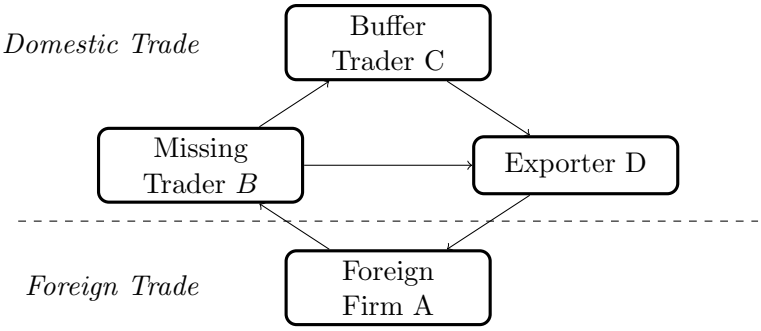
would be entitled to a refund for these input taxes. As the VIVAT would affect the tax revenue distribution among the EU member states, a clearing mechanism could be added, as envisaged in the EU Commission's original proposal for a European VAT system, but which could not be agreed upon.

More recently, Ainsworth (2011) proposed automated VAT withholding by the buyer on all transactions. If implemented in all EU member states and equipped with full information exchange, this would enable cross-checking of transactions that cross borders between EU countries in "real time". Withholding by the buyer, known as *reverse withholding*, has already been implemented as a tool to improve VAT compliance along the value chain in a number of Latin American and African countries (e.g., Keen & Smith, 2006; Ainsworth, 2011; Yesegat & Joseph, 2017). Under this regulation, the buyer is requested to withhold a part of or all taxes from the gross purchase price of a good or service and immediately remit the withheld amount to the tax administrator. If the seller files for VAT, the withheld amount is credited. This policy reduces the gain of a seller from an informal provision of goods and services (Keen, 2008). Hence, it reduces tax evasion and strengthens the third-party-reported paper trail. Although reverse withholding has been primarily used to close gaps in the VAT paper trail resulting from the informal sector, this measure would also address MT fraud. If the exporting firm (Firm D in Fig. 1) is mandated to withhold part or all of the VAT, the withheld amount would reduce or even eliminate profits from the collusion between fraudsters.

An important advantage of reverse withholding is that this instrument can be applied unilaterally and without the need to adjust the international tax system. In fact, some form of withholding by the buyer has already been used to improve VAT compliance in Europe. Germany, for example, had introduced the so-called deduction mechanism in 1980 for construction services provided by a business registered in another EU country. The recipients of the services needed to withhold the VAT and remit it to the tax collector. If the recipients did not withhold the VAT, they were liable for the VAT (Kurz, 2014). Although this procedure was intended to enforce the destination principle, it was considered to be problematic under EU law because it resulted in unequal treatment of domestic and foreign service providers, discriminating the latter.

To combat VAT fraud, EU member states have been pursuing a different approach. By applying the reverse-charge (RC) mechanism to domestic transactions of certain products or services, they provided for a shift in tax liability from the seller to the buyer.[6] The buyer offsets the VAT payments on purchases against the refund of the VAT on the inputs. Hence, for products that fall under the RC mechanism, little or no VAT is collected along the value chain and illegitimate refunding due to MT fraud is impossible. At the same time, a discrimination of foreign suppliers is avoided.

[6] To distinguish reverse charge as an anti-fraud measure from the reverse charging under the deferred-payment method for cross-border transactions, it is sometimes referred to as "domestic" reverse charge, e.g. Potts (2019) and Evans (2020).



Notes: The trade flow starts from company A in the foreign country and follows a clockwise order. The importing firm B acts as Missing Trader and disappears after selling the good either directly to the exporting firm D or through firm C, who acts as Buffer Trader. Adapted from Keen and Smith, 2006.

Fig. 1 Missing-Trader/Carousel Fraud

RC on domestic trades has been included in the EU VAT directive as a formal instrument of tax policy in 2006.[7] It should be noted, however, that the introduction of reverse charge to combat VAT fraud is not confined to the EU. Australia introduced RC in 2017 to protect the Goods and Services Tax against MT fraud associated with valuable metals (Evans, 2020). In 2022, South Africa introduced a similar regulation (Botes, 2022).

Similarly to reverse withholding, RC can be implemented unilaterally, but it has clear advantages. In particular, it is based on self-assessment and does not tie up liquidity. Reverse withholding would imply higher compliance costs, as the proper processing of VAT remittances requires time and resources and withholding is associated with high liquidity requirements (Slemrod, 2008). Proper crediting and refunding is also associated with higher administrative cost (Keen & Smith, 2006; Yesegat & Joseph, 2017).

However, RC can be problematic for VAT compliance in general. While RC basically keeps the third-party-reporting feature of the VAT, it gives up on the withholding-tax feature, since compliant suppliers no longer remit VAT. Therefore, while tax fraud through illegitimate refunding will decrease, informal trading of goods and services might increase. Moreover, if a product is subject to RC, little or no VAT is collected along the value chain and tax collection is concentrated on the B2C stage. Accordingly, tax evasion and thus the last-mile problem could intensify (e.g., Keen, 2007; Cnossen, 2009). Moreover, as long as RC is not comprehensive, the fraud can relocate to other goods or other countries (Stiller & Heinemann, 2019). Hence, the

[7] The application of RC has recently been extended until December 31, 2026 (Official Journal of the European Union, 2022).

advantage that RC prevents illegitimate reimbursement is countered by disadvantages that can be particularly significant in low-enforcement environments.

3 Reverse charge: the case of Germany

As the practice of reverse withholding was considered incompatible with EU law, in 2002, Germany introduced RC, i.e., for certain goods and services VAT liability was shifted to the buyer.[8] Since then, the German VAT Act has been modified several times and the list of goods and services affected by reverse charge has been expanded over time. The main amendments to the VAT Act are reported in Table 2.[9]

Initially, RC was applied mainly to cross-border services in the construction sector. Previously, in this industry, foreign suppliers had to charge VAT, which was refundable as input tax for their domestic business clients. As VAT enforcement of remittances by foreign suppliers proved difficult, reverse withholding was introduced. This regulation required the domestic firm to withhold the VAT invoiced by the foreign supplier. In 2002, withholding was replaced by RC, and the tax liability was shifted to the domestic client (Kurz, 2014). Since the introduction of RC in the construction industry substituted reverse withholding, no effects on VAT fraud are expected for these services. The other two types of transactions subjected to RC in 2002, barter-like and real-estate transactions, were not subjected to the deduction method before. Introducing RC in these areas aimed to secure VAT revenues on those transactions.

Subsequently, the RC mechanism was extended to other products and services, where VAT enforcement proved difficult or fraud connected with cross-border transactions emerged. The first extension in 2004 addressed specific settings of construction work, where subcontractors are involved and was motivated by VAT fraud. The second extension in 2005 involved the supply of energy and gas. This regulation followed an EU directive that defines the place of service delivery for tax purposes for this type of services (Vellen, 2005). Neither the EU directive nor the German law referred to VAT fraud in the legislative explanatory memorandum.

The following extensions of RC on domestic transactions have all been introduced to combat VAT fraud (Pahne, 2011). In 2010, RC has been extended to trade with certificates under the EU emission trading system, after major cases of MT fraud were detected.[10] In January 2011, RC was introduced in the trade of scrap material, gold, and for cleaning services. In July 2011 a new regulation was introduced assigning trades regarding mobile phones and integrated circuits to RC. The 2013 amendment extended the 2005 regulation to energy services. Even though the

[8] This involved the introduction of section 13b in the German VAT Act (*Umsatzsteuergesetz*) (*cf.* European Commission, 2014).

[9] We observe that, for most of the VAT Act's amendments related to reverse charge, only few weeks pass between their publication in the official journal and their entry into force.

[10] In a press release from December 2009 Europol reported revenue losses of more 5 billion Euro associated with the European market for carbon credit, cf. Kim (2017). For a discussion of MT fraud associated with CO_2 emissions, see also Frunza (2016, pp. 21).

earlier regulation was not motivated by VAT fraud, this extension aimed at preventing VAT fraud in electricity and gas markets (Meurer, 2013). In 2014, another extension was implemented to address fraud related to trade in tablets, games consoles, laptops, and metals. Since the empirical analysis below looks at the evolution of VAT between 2009 and 2018, the focus is on the more recent RC expansions, all of which are related to VAT fraud.

4 Data

To analyse the effects of the introduction of reverse charge, we use administrative data from the German VAT returns (*Umsatzsteuer-Voranmeldungen*). The data covers the period between 2009 and 2018 on an annual basis and is derived by aggregation of all VAT returns at industry level.[11] The underlying VAT returns refer to the universe of German and foreign firms that file these tax returns in Germany. These are all firms whose taxable supplies and services have a yearly value greater than 17,500 € (about 3,300,000 firms).[12] Reporting is mandatory and is the main procedure to claim input tax payments.

The data contains information about firms' VAT remittances and claims of input VAT. In the returns, firms report the VAT base (total domestic sales) and the VAT liability on different types of transactions including imports from other EU countries (EU imports) and exports to other EU countries (EU exports).[13] In our analysis, we focus on input VAT, as it is directly related to MT fraud. In addition, we consider effects on total domestic sales as well as on EU imports and EU exports as these transactions are linked to MT fraud either via forward or backward linkages or are used for concealment.

The unit of observation in our analysis is the 5-digit NACE classification (Revision 2, 2008), i.e., the most granular level of industry classification comprising 778 industries. A key advantage of the dataset is that it offers comprehensive information about all firms registered for VAT. Moreover, it directly reflects the reporting items in the underlying VAT returns, which enables us to gain a comprehensive overview of VAT reporting and the effects of reverse charge.[14]

Table 3 shows the descriptive statistics of the variables in constant prices of 2018. The value of domestic sales is about 6.2 billion € per industry-year. EU exports amount to 0.8 billion €. German industries are generally net EU exporters, as EU exports exceed EU imports. We observe on average 4,250 firms per industry.

Notes: Sales subject to RC relative to all domestic sales. Averaged across the respective industry group. Years covered: 2009 to 2018. In prices of 2018. We

[11] Data is available also for the years prior to 2009, but, due to a change in industry classification in 2008, the reconciliation of the earlier periods with the latest ones is impossible.

[12] Note that this threshold does not change over the period under consideration.

[13] Appendix shows the form for VAT filing (Figs. 3 and 4)—with e-filing the reporting form is identical.

[14] The VAT panel provided by the Federal and State Statistical Offices, which provides firm-level data, includes only information for main items and not specifically on sales/purchases subject to RC.

Table 2 Introduction of reverse charge in Germany 2002–2018. *Source*: Bundesministerium der Finanzen (2020), and earlier years

Date of implementation	Product or service
1 January 2002	Contracted work by a company domiciled abroad
	Delivery of goods provided as security
	Taxable real estate transactions
1 April 2004	Contracted work by subcontractors
1 January 2005	Gas and energy by a company domiciled abroad
1 July 2010	Emission allowances for greenhouse gases
1 January 2011	Scrap material, gold, and cleaning services
1 July 2011	Mobile phones and integrated circuits
1 September 2013	Gas and energy by a domestic company
1 October 2014	Tablets, games consoles, laptops, and metals

Note: Dates of implementation of and major amendments to the VAT Act, section 13b, which defines products and services subject to the reverse-charge mechanism

identify 22 individual industries whose main business activity is related to products newly covered by RC in the period studied, i.e., in the years between 2009 and 2018.[15] Panel B shows the descriptive statistics for these 22 industries and Panel C refers to the remaining industries. Interestingly, trade intensity is higher for industries covered by RC as compared to other industries, and EU imports exceed exports.

Figure 2 shows the development of RC sales relative to all domestic sales in the two groups of industries. Note that the fraction of sales subject to reverse charge in the industries affected by RC is sizeable but much below 100%. This reflects the fact that the industries are aggregates capturing sales of a whole range of products, only part of which fall under reverse charge. Moreover, reverse charge does not apply to sales to final consumers. However, the increase in RC sales is clearly concentrated among these industries affected by RC. The strong difference with regard to other industries confirms our identification of industries subject to RC.

5 Methodology

In our empirical analysis, we explore the effects of the implementation of reverse charge (RC) on VAT returns. The database reports the actual VAT returns at the level of individual industries. To remove industry-level effects and common trends, we explore the effect of RC on input VAT using industry-level panel regressions. Denoting observations by industry i and year t, if certain assumptions are met, an estimate of the treatment effect can be obtained by regressing the outcome on the volume of sales subject to RC, as follows.

$$\Delta \log y_{i,t} = \alpha_i + \delta_t + \beta \log RC_{i,t} + \gamma \log y_{i,t-1} + u_{i,t}, \tag{1}$$

[15] The industries are reported in detail in Appendix, see Table 11.

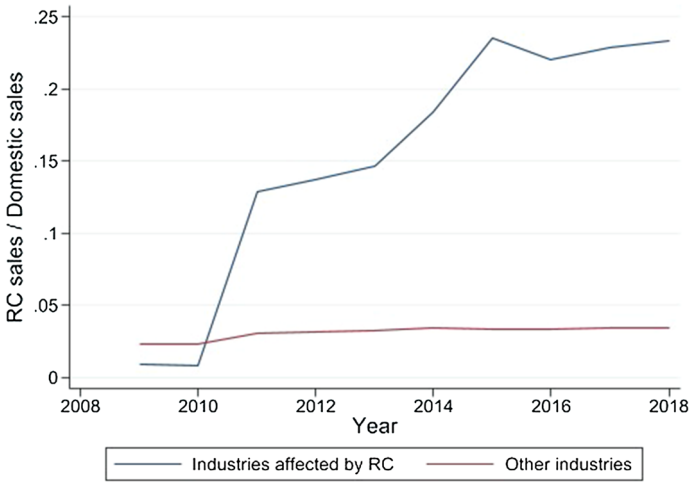
Table 3 Descriptive statistics

	Mean	SD	Min	Max	*n*
Panel A—all industries					
Total domestic sales	6166	14493	.219	195505	7471
of which: RC sales	302	1646	−7	44275	7334
EU exports	841	3579	−.000	93742	7353
Input VAT	1083	2982	.004	50406	7471
EU imports	741	2848	−14.3	73941	7454
Taxable firms[a]	4250	12051	3	242332	7471
RC implemented[b]	.019	.136	0	1	7780
Panel B—industries subject to RC					
Total domestic sales	9837	11926	174	51648	216
of which: RC sales	1624	2518	−.246	10379	216
EU exports	2310	3282	.002	16523	216
Input VAT	2200	2869	14	12095	216
EU imports	2365	4242	.734	18435	216
Taxable firms[a]	2296	4150	47	21661	216
RC implemented[b]	.664	.474	0	1	220
Panel C—other industries					
Total domestic sales	6057	14549	.219	195505	7255
of which: RC sales	262	1596	−7	44275	7118
EU exports	797	3579	−.000	93742	7137
Input VAT	1050	2979	.004	50406	7255
EU imports	693	2782	−14.3	73941	7238
Taxable firms[a]	4309	12203	3	242332	7255
RC implemented[b]	0	0	0	0	7560

Notes: If not noted otherwise, in Mill. € in prices of 2018. [a] : number of firms. [b] : binary variable. Data refers to 778 industries. Annual observations for the years 2009–2018. The negative values in the minima column are due to returns and order cancellations. Such corrections typically take place in the subsequent VAT returns. *Panel A* pools all the industries. *Panel B* shows the variables for the 22 industries subject to reverse charge. *Panel C* shows the variables for all the industries excluding these 22 industries. *RC implemented* is an indicator equal to 1 if industry i is subject by reverse charge in year t and equal to 0 otherwise

where α_i is an industry-level fixed effect, δ captures period-specific effects, and $u_{i,t}$ is an error term. In the basic specification, $\Delta y_{i,t}$ denotes the changes of total input VAT of industry i at time t in logs as a measure of innovations in claims of input VAT. The inclusion of $y_{i,t-1}$ captures the adjustment process. The key explanatory variable is $RC_{i,t}$, the (log) volume of sales subject to RC in the same industry. This variable reflects the extent to which the tax liability is shifted onto the buyer.

β reveals the average treatment effect of RC on the treated industries. If all transactions in an industry are carried out by compliant traders, the level of RC sales in an industry should not affect total input VAT. In this case, β would be zero. If,



Notes: Sales subject to RC relative to all domestic sales. Averaged across the respective industry group. Years covered: 2009 to 2018. In prices of 2018.

Fig. 2 Fraction of Sales Subject to RC: Non-/Affected Industries

however, some of the trading is fraudulent, we expect that the introduction of RC causes a decline in input VAT ($\beta < 0$). In fact, since there is no refunding of input VAT and, hence, no opportunity for fraud, there should be a decrease in input taxes in an amount equal to the previous revenue losses due to VAT fraud. γ can be interpreted as the speed of adjustment to the introduction of reverse charge. If $\gamma = -1$, the effect of reverse charge is fully and instantaneously reflected in the level of the dependent variable. But if $-1 < \gamma < 0$, there is lagged adjustment and β captures only the first-period effect.[16]

The variation in sales subject to RC has different sources. Institutional variation comes from the gradual increase of the number of products and services subject to RC. However, the variation also reflects changes in the volume of trades for other reasons, for instance, changes in the demand for products. Those changes may well be positively correlated with the error term $u_{i,t}$. This raises concerns that the estimate of the treatment effect is biased. To overcome this problem, we employ an instrumental variable (IV) approach based on the extension of the scope of RC in Germany. More precisely, we use a binary indicator that indicates whether the

[16] In this case, the long-run effect on the level of input taxes tends to be larger in absolute terms. If we denote the expected long-run level of input taxes with $\log y_i^*$, and since $\Delta y_i^* = 0$, from Eq. (1), we have

$$0 = \alpha_i + \beta + \gamma \log y_i^*.$$

If we define the expected counterfactual level of input taxes by

$$0 = \alpha_i + \gamma \log y_i^0,$$

the long-run effect of RC is

$$\log y_i^* - \log y_i^0 = -\frac{\beta}{\gamma}.$$

products of the given industry are subject to reverse charge in the given year, or not. Thus, in order to identify the effect of RC implementation, we rely only on the variation of the tax law.

Note that the IV approach is implemented in a panel regression that includes industry fixed effects. Hence, time-invariant differences between industries, which matter for the potential gains and risks of MT fraud, are controlled for. This is important, since RC is implemented in industries that are particularly vulnerable to MT fraud. Including industry-level fixed effects ensures that the estimate of β is not subject to a selection bias.

A requirement for using the RC implementation as an instrumental variable for actual RC sales is that the exclusion restriction holds. This is ensured by the fact that the introduction of RC in an industry affects firms only to the extent that the responsibility for remittances is transferred to the buyer. There is no separate effect of the policy, especially since the basic tax liability remains unchanged. Even if RC leads to a reduction in compliance costs because the liquidity requirement is lower as there are no VAT payments and reimbursements, this reduction in compliance costs depends on the volume of sales that are subject to RC. Another requirement is that the instrumental variable has sufficient predicting power, an issue that requires us to explore the first-stage regressions.

Since MT fraud aims to obtain illegitimate tax refunds for input taxes, we first examine the effects on input taxes using the above regression. To corroborate the presumption of MT fraud and shed more light on the process, we also consider alternative outcome variables.

Effects on domestic sales are expected, since, in order to conceal MT fraud, fraudulent trade is often embedded in other transactions (i.e., buffer transactions).[17] In particular, we expect total domestic sales to decline with the introduction of reverse charge. A decline of reported domestic sales could also be caused by an expansion of tax evasion. As discussed above, a side effect of reverse charge could be that products are sold informally rather than formally at the end of the value chain, without remittance of VAT. This would further contribute to a decline in reported sales. However, it is not clear how much of an impact this has in our study design. While the reverse-charge method is implemented at the level of individual goods, our analysis is based on data for industries. We compare industries where the sale of these goods accounts for a larger share of the business activity with industries where the share is small, and the industries identified as treated in this way are predominantly less active in retailing.

Systematic MT fraud may also affect EU imports. This follows, since missing traders exploit the fact that EU imports are not subject to import VAT. As we noted above, since they do not receive a VAT refund anyway, it is particularly attractive for firms to disappear without remitting the VAT collected on a resale of products imported from another EU country. In other words, the withholding-tax property of VAT (Waseem, 2022) is absent for EU imports. Hence, if MT fraud is significant, the introduction of RC may not only lead to a decrease in input VAT but also of EU

[17] See the explanation in Sect. 2.

imports that are an essential part of MT fraud. Whether this is reflected in the VAT statistics is not clear, however, because if fraudulent traders disappear, the question is whether imports were reported nonetheless.[18]

Similarly, MT fraud can be organized as carousel fraud, where goods are exported into another EU country after achieving a fraudulent input tax rebate. Hence, also EU exports may decline in an industry, where RC has been implemented, effectively stopping carousel fraud.

6 Results

6.1 Basic regression results

Table 4 provides the results for input VAT. The first specification, reported in column (1), shows panel estimates with a full set of industry- and year-fixed effects. The results indicate a positive effect of sales subject to RC (RC sales) on reported input taxes. However, as noted above, the sales may be correlated with the input taxes. Therefore, an instrument-variable (IV) approach is preferable, which employs a binary indicator reflecting the introduction of RC in the treated industries.

Column (2) shows the results of the corresponding IV specification. The first-stage F-statistic reported at the lower panel of the table clearly supports the predictive power of the instrumental variable.[19] With regard to the effect of RC sales on the input VAT, the specification shows a significant negative effect. The point estimate indicates that an increase of the volume of sales subject to RC by 100 log points is associated with a decline in input VAT by 2.9 log points.

Since the dependent variable reflects the development of input VAT at industry level, it is likely that the effect of RC partly captures the general development of industrial activity. Therefore, in column (3) we introduce as control variable the change of the total number of reporting firms. While the effect of the RC indicator is confirmed, we find a strong positive effect of the number of reporting firms indicating that the growth of input taxes is closely related to the growth of the number of firms in the respective industry.[20]

The results of the IV specifications indicate that less input tax is claimed under RC. Before conducting robustness checks and evaluating the empirical magnitudes of MT fraud, we first want to check whether similar effects can be found for other variables in the VAT statistics.

[18] Braml and Felbermayr (2022) argue that the EU's "self-surplus" in trade is driven by fraudulent traders who do not report EU imports. Hungarian authorities, instead, reported that missing traders submitted their VAT returns, even if they never paid the VAT (Europol, 2021).

[19] The effect of the dummy capturing RC introduction in the respective industry (RC implemented) indicates that the introduction of reverse charge resulted in tripling the sales subject to RC starting from very low figures in the pre-2010 level of RC sales. See also Fig. 2

[20] We separately examine the effects on firms below.

Table 5 reports results with the change in (log) domestic sales as outcome variable. Note that even if a firm's products are subject to RC, the sales of the firm would still be taxable. What changes is simply who is liable for the VAT. As compliance costs decrease rather than increase along the value chain, for compliant traders there should be no negative effect from the introduction of RC. But if MT fraud is organized with the involvement of buffer traders, the introduction of RC would lead to a decline of total sales, i.e., due to a reduction in buffer trade.

Similarly to the results for input VAT, the fixed-effect estimates in column (1) suggest that the volume of sales subject to RC has a positive effect on domestic sales. However, the results of the preferred instrumental variable regressions, reported in columns (2) and (3), point to a decline in domestic sales related to the introduction of reverse charge.

A side effect of reverse charge could be that products are sold informally rather than formally at the end of the value chain, without remittance of the VAT. The decline of domestic sales may, therefore, also pick up an increase in VAT evasion. But, even if the decline of domestic sales reflects an increase of VAT evasion, it is not clear whether this affects input VAT.[21] Since no VAT is collected along the value chain under reverse charge, products can be sold "under the desk" without the necessity to underreport inputs.

Table 6 reports results for imports from other EU countries, with the change in (log) EU imports as outcome variable. While column (1) indicates that the volume of sales subject to RC has a positive effect on EU imports, the instrumental variable regressions in columns (2) and (3) point to a decline in imports. Though the effects are estimated imprecisely, the point estimates indicate a similar decline to the one found for input VAT and domestic sales.

The finding that the point estimates for input VAT, domestic sales and EU imports are similar is consistent with a decrease in MT fraud being the primary cause of the decline in input VAT, because, if MT fraud is no longer profitable under RC, the decline of input VAT is reflected in a decline of associated buffer trades and EU imports.

If fraud is in the form of carousel fraud and goods cross the borders several times, there might also be effects on EU exports. Table 7 shows the effects on EU exports. Column (1) reports results of the fixed-effect regression, where the volume of sales subject to RC exerts a small positive effect on EU exports. The instrumental variable regressions in columns (2) and (3) also point to a positive impact of RC on exports. While this result does not support the presence of carousel fraud, it should be noted that a decline will only be found if EU exports associated with VAT fraud were reported before the introduction of RC.

[21] Note that input VAT is still reported under reverse charge, even though remittances might be zero as the buyer is liable for the VAT.

Table 4 RC effect on input VAT

	FE	FE-IV	
	(1)	(2)	(3)
ln(RC sales)	0.014 ***	− 0.029 **	− 0.023 *
	(0.004)	(0.012)	(0.012)
ln(Input VAT_{t-1})	− 0.323 ***	− 0.286 ***	− 0.279 ***
	(0.029)	(0.030)	(0.029)
Δln(Taxable firms)			0.501 ***
			(0.118)
Observations	6585	6583	6583
First stage			
RC implemented		1.953 ***	1.939 ***
		(0.360)	(0.358)
F-stat. first-stage		29.445	29.350
AR *F*-test		4.687	2.795
AR *F*-test *p* value		0.031	0.095

Notes: Dependent variable is the log change of annual input VAT claimed by an industry in the period between 2009 and 2018. All specifications include a full set of industry- and year-fixed effects. Robust standard errors clustered at industry level in parentheses. AR *F*-Test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

Table 5 RC effects domestic sales

	FE	FE-IV	
	(1)	(2)	(3)
ln(RC sales)	0.017 ***	− 0.030 ***	− 0.025 **
	(0.004)	(0.010)	(0.011)
ln(Domestic $sales_{t-1}$)	− 0.285 ***	− 0.245 ***	− 0.239 ***
	(0.022)	(0.025)	(0.025)
Δln(Taxable firms)			0.354 ***
			(0.088)
Observations	6585	6583	6583
First stage			
RC implemented		1.994 ***	1.977***
		(0.371)	(0.369)
F-stat. first-stage		28.898	28.787
AR *F*-test		6.507	4.690
AR *F*-test *p* value		0.011	0.031

Notes: Dependent variable is the log change of annual domestic sales by an industry in the period between 2009 and 2018. All specifications include a full set of industry- and year-fixed effects. Robust standard errors clustered at industry level in parentheses. AR *F*-Test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

Table 6 RC effect on EU imports

	FE	FE-IV	
	(1)	(2)	(3)
ln(RC sales)	0.039 ***	− 0.028	− 0.024
	(0.012)	(0.035)	(0.036)
ln(EU Imports$_{t-1}$)	− 0.522 ***	− 0.505 ***	− 0.503 ***
	(0.049)	(0.052)	(0.052)
Δln(Taxable firms)			0.310
			(0.200)
Observations	6577	6575	6575
First stage			
RC implemented		2.051 ***	2.033 ***
		(0.412)	(0.408)
F-stat. first-stage		24.798	24.808
AR *F*-test		0.769	0.534
AR *F*-test *p* value		0.381	0.465

Notes: Dependent variable is the log change of annual EU imports of an industry in the period between 2009 and 2018. All specifications include a full set of industry- and year-fixed effects. Robust standard errors clustered at industry level in parentheses. AR *F*-Test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

Table 7 RC effect on EU exports

	FE	FE-IV	
	(1)	(2)	(3)
ln(RC sales)	0.027	0.067	0.074
	(0.019)	(0.078)	(0.078)
ln(EU exports$_{t-1}$)	−0.570 ***	−0.575 ***	−0.574 ***
	(0.038)	(0.037)	(0.037)
Δln(Taxable firms)			0.514 *
			(0.289)
Observations	6508	6502	6502
First stage			
RC implemented		2.062 ***	2.037 ***
		(0.418)	(0.412)
F-stat. first-stage		24.344	24.456
AR *F*-test		0.586	0.710
AR *F*-test *p* value		0.444	0.400

Notes: Dependent variable is the log change of annual EU exports reported by an industry in the period between 2009 and 2018. All specifications include a full set of industry- and year-fixed effects. Robust standard errors clustered at industry level in parentheses. AR *F*-Test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

Table 8 Robustness: industry-year effects

	Input VAT (1)	Domestic sales (2)	EU imports (3)	EU exports (4)
ln(RC sales)	−0.023 *	−0.018	−0.009	0.083
	(0.013)	(0.012)	(0.042)	(0.088)
ln(Input VAT$_{t-1}$)	−0.292 ***			
	(0.030)			
ln(Domestic sales$_{t-1}$)		−0.261 ***		
		(0.025)		
ln(EU imports$_{t-1}$)			−0.515 ***	
			(0.054)	
ln(EU exports$_{t-1}$)				−0.568 ***
				(0.035)
Observations	6583	6583	6575	6502
Industry-year FE	Yes	Yes	Yes	Yes
First stage				
RC implemented	1.830 ***	1.858 ***	1.917 ***	1.922 ***
	(0.278)	(0.282)	(0.309)	(0.311)
F-stat. first-stage	43.426	43.246	38.365	38.117
AR *F*-test	2.747	1.968	0.049	0.772
AR *F*-test *p* value	0.098	0.161	0.825	0.380

Notes: The dependent variables are reported at the top of each column and are in log changes. Robust standard errors clustered at industry level in parentheses. AR *F*-test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

6.2 Robustness checks and alternative specifications

As a robustness check against different time trends across groups of industries, we report results from a set of regressions in which we include (one-digit) industry-year fixed effects. This specification is also useful to rule out the effects of general, non-specific measures to combat VAT non-compliance, if those affect industry groups differently.[22]

Table 8 reports results for our preferred specification, i.e., a fixed-effects instrumental variable estimation. For the four outcome variables, the results are qualitatively identical to the finding from the basic specifications. This suggests that trends for groups of industries do not affect our basic results, although the effects of RC are not precisely estimated.

To address the concern that non-affected industries might not be sufficiently comparable to industries subject to RC, we conduct regressions where we include only those industries in the control group that may have a similar exposure to MT fraud.

[22] Lamensch and Ceci (2018) provide a useful overview of the EU regulatory framework to combat VAT fraud, on top of RC. These measures do not affect specific goods or industries but typically involve platforms to facilitate the exchange of information among member states (including Germany), such as Eurofisc and the VAT Expert Group.

To this end, we focus on industries with similar trade intensity (i.e., exports relative to domestic sales, in 2018). In this robustness check, trade intensity serves as a proxy for how easily an industry's output can be shipped across borders, and, hence, how easy it might be to engage in MT or carousel fraud. Table 9 shows the results with the so-defined set of non-affected industries. While the set of treated industries is the same, the estimation sample includes 273 instead of 756 industries in the control group. The empirical results for input taxes and domestic sales are similar to the basic specifications, suggesting that the validity of the above findings is not limited by a lack of comparability between treated and control groups. Interestingly, the results get stronger rather than weaker, and even the expected negative effects on EU trade prove significant.

If the measured effects are driven by a decline in VAT fraud, as we suspect, we will also expect a decline in the number of firms in the VAT statistics. To examine whether RC introduction is associated with firm exit, we regress the change in the number of taxable firms on sales subject to RC. The results are shown in Table 10. The instrumental-variable results in column (2) show that an increase in RC sales is in fact related to a decline in the number of taxable firms. This finding supports the view that registered firms participating in MT fraud have disappeared. This could explain why the treatment effect in the basic specification is slightly smaller when controlling for the number of firms. Accordingly, it seems reasonable to use the results of the basic specification without controlling for the change in the number of firms for the calculation of the total VAT revenue effects of RC.

6.3 Magnitude of MT fraud

In order to provide a rough estimate of the magnitude of MT fraud and the associated revenue loss, we finally evaluate the basic findings of the effect of RC on input taxes. The preferred estimate of the slope parameter in column (2) of Table 4 shows that, when RC sales increase by one log point, the input tax declines by 0.029 log points. Since the above results indicate that there is lagged adjustment, the long-run effect is bigger in absolute terms pointing to a decline by 0.101 log points.[23] From the first-stage regression, we know that after introduction of RC, sales subject to RC have increased substantially in treated industries. The point estimate indicates an increase by 195 log points.[24] Based on this figure, input taxes should have declined by 19.8 log points. The average value of input tax payments in the industries affected by RC is 2.2 bill. euros. Using this figure to evaluate the treatment effect, the decline in input taxes is estimated with 395 mill. euros per industry. For all treated industries, the effect amounts to 8.682 bill. euros. As the decline results primarily from the fact that MT fraud is no longer possible under RC, this figure indicates the damage to VAT revenues caused by this fraud. If this value is put in relation to total tax revenues, the revenue loss due to MT fraud in Germany amounts to around 5.4% of German VAT revenues.[25] As the VAT gap in Germany is

[23] The long-run effect results after dividing by the absolute value of the coefficient associated with the lagged level of input taxes, see also footnote 16.

[24] See the "First stage" panel of Table 4.

[25] VAT revenues are calculated by taking the average VAT revenues between 2009 and 2018, in 2018 prices.

Table 9 Robustness: industries with similar trade intensity

	Input VAT (1)	Domestic sales (2)	EU imports (3)	EU exports (4)
ln(RC sales)	−0.032 *	−0.039 **	−0.061 ***	−0.037 *
	(0.018)	(0.019)	(0.023)	(0.021)
ln(Input VAT$_{t-1}$)	−0.236 ***			
	(0.035)			
ln(Domestic sales$_{t-1}$)		−0.220 ***		
		(0.026)		
ln(EU imports$_{t-1}$)			−0.368 ***	
			(0.045)	
ln(EU exports$_{t-1}$)				−0.299 ***
				(0.037)
Observations	2621	2621	2621	2621
Industry-year FE	Yes	Yes	Yes	Yes
First stage				
RC implemented	1.733 ***	1.748 ***	1.755 ***	1.734 ***
	(0.396)	(0.391)	(0.424)	(0.422)
F-stat. first-stage	19.186	19.972	17.154	16.844
AR *F*-test	2.479	3.074	6.523	3.139
AR *F*-test *p* value	0.116	0.081	0.011	0.077

Notes: The dependent variables are reported at the top of each column and are in log changes. The sample includes the 22 industries subject to RC as well other industries if their trade intensity, defined by the export-to-domestic-sales ratio, lies within a specific interval. The midpoint is defined by the average trade intensity of industries subject to RC. The width of the interval is determined by the standard deviation of the intensity. Robust standard errors clustered at industry level in parentheses. AR *F*-test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

estimated at about 10% in 2009 (Barbone et al., 2013), i.e., in the first year of our period of investigation, this suggests that about half of the VAT gap is attributable to MT fraud.

7 Summary and concluding remarks

This paper sheds light on VAT fraud through illegitimate input tax credits, that has plagued the countries of the European Union, in particular after the creation of the common market and the removal of border controls. As the quantification of the magnitude of VAT fraud has proved difficult, this paper adopts a new method to estimate the extent of this fraud by exploring German VAT data.

The introduction of the reverse-charge method for domestic transactions of certain products has made VAT fraud technically impossible for these products. The resulting decline in input taxes claimed, therefore, reveals the volume of fraudulent trade before

Table 10 RC effect on the (log) number of registered firms

	FE	FE-IV
	(1)	(2)
ln(RC sales)	0.001	−0.013 ***
	(0.001)	(0.003)
ln(Taxable firms$_{t-1}$)	−0.183 ***	−0.167 ***
	(0.020)	(0.022)
Observations	6585	6583
First stage		
RC implemented		2.080 ***
		(0.434)
F-stat. first-stage		22.939
AR *F*-test		18.704
AR *F*-test *p* value		0.000

Notes: Dependent variable is the log change of taxable firms in an industry in the period between 2009 and 2018. All specifications include a full set of industry- and year-fixed effects. Robust standard errors clustered at industry level in parentheses. AR *F*-test refers to the Anderson-Rubin (AR) *F*-test (Baum et al., 2007). One (*), two (**), or three stars (***) indicate statistical significance at 10%, 5%, and 1% levels

the policy implementation. Exploiting the German VAT return data at industry level, we find that VAT reporting changed indeed and that claims of input VAT declined substantially after the scope of RC has been widened in the years between 2009 and 2018. We complement our analysis by examining other margins such as total sales and within-EU imports. The estimated effects on these margins are consistent with the view that the effect of RC on VAT returns is driven by what is referred to as MT fraud.

Based on our finding of a significant decline of input VAT, we estimate that the volume of MT fraud stopped by RC in the years between 2009 and 2018 amounts to about 5% of VAT revenues. This confirms concerns of considerable revenue losses due to fraud: for Germany, our estimate adds up to losses of around 8-9 billion euros per year. Compared with the range of previous studies, which largely use indirect methods and exploit other data sources, such as trade statistics or national accounts, this estimated value is around the midpoint of the range of estimates. While our estimate is lower than the existing estimate of the revenue loss in Germany, it should be noted that our estimate only relates to industries where the government has put a stop to MT fraud by introducing reverse charge. It cannot be ruled out that there are other industries in which MT fraud continues to be practiced.

To what extent the findings from Germany can be generalized to other countries is not clear, however. It is conceivable that decentralized tax collection at subnational level increases Germany's exposure to VAT fraud and that the problem of VAT fraud is less pronounced in other countries with more centralized tax administration.

Even though our study shows significant revenue losses due to VAT fraud, the question remains as to whether RC is the best instrument to address this issue. While

a comprehensive evaluation of the reverse-charge method is clearly beyond the scope of this paper, our analysis provides guidance on how to examine the impact of the introduction of the RC method based on VAT statistics.

Our discussion has shown that the protection of tax revenues is only one element of a proper cost-benefit assessment. Another issue is the effect on compliance cost. Leaving aside the one-time costs of adjustment to RC, while firms still have to file VAT returns under RC, a decline in compliance cost may occur because the liquidity requirement is lower as there are no VAT remittances in business-to-business (B2B) trade. However, the consequences of reverse charge for VAT compliance need to be discussed more broadly. Since VAT is no longer collected along the value chain, the tax collection is effectively shifted to the end of the value chain. The VAT is known to have a last-mile problem that is likely to be exacerbated if the reverse-charge method is applied to domestic trade. Accordingly, tax evasion in business-to-consumer (B2C) transactions could increase. In addition to this argument, due to the lack of VAT withholding, also the informal sector may increase.

It should also be noted that once reverse charge is implemented in one area, fraud might spread to other areas. This could lead to a process in which more and more areas need to be subjected to reverse charge. In fact, as our discussion shows, the European problem of VAT fraud has become so virulent not least because Europe switched to the deferred-payment method in the first place, which involves a reverse-charge system for intra-European cross-border trade. Through this arrangement, the withholding-tax feature of the VAT is not effective for imports and the goods and services basically enter the respective member country untaxed. This fuels the potential profits of MT fraud, where VAT is charged by the importer but not remitted.

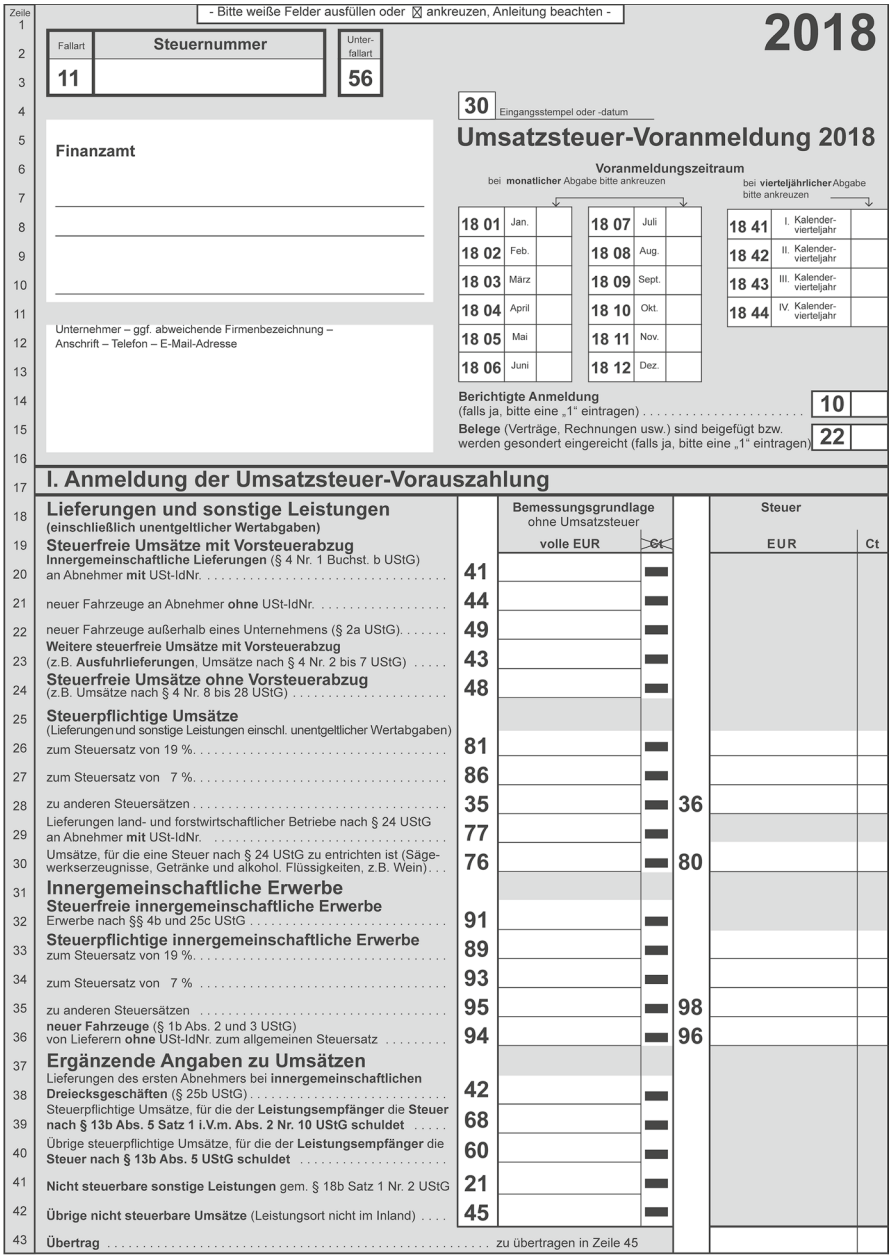
To some extent, the potential proliferation of the reverse-charge mechanism is also reflected in the policy debate. While the current EU directive restricts member states to subject only specific products to RC, proposals for a broader application are under discussion. One proposal is to allow EU countries to switch entirely for all domestic B2B trade to the RC method. However, if RC were applied generally, VAT is effectively transformed into a retail sales tax (De La Feria, 2019). The fractional tax collection along the value chain and the withholding-tax property of VAT would completely disappear. Though compliant firms would still report taxable sales, the quality of the reporting can be questioned, as no taxes are collected on B2B transactions.

Appendix

A: Data sources and definitions

The database is the VAT statistics (*Umsatzsteuerstatistik-Voranmeldungen*) which is reported annually in series 14 8.1 of the German federal statistical office (*Statistisches Bundesamt (DESTATIS)*).

The variables provided in the VAT statistics correspond to the actual VAT return forms (see Figs. 3 and 4).



Zeile

- Bitte weiße Felder ausfüllen oder ☒ ankreuzen, Anleitung beachten -

2018

Fallart	Steuernummer	Unterfallart
11		56

30 Eingangsstempel oder -datum

Finanzamt

Unternehmer – ggf. abweichende Firmenbezeichnung –
Anschrift – Telefon – E-Mail-Adresse

Umsatzsteuer-Voranmeldung 2018

Voranmeldungszeitraum

bei **monatlicher** Abgabe bitte ankreuzen

18 01	Jan.		18 07	Juli	
18 02	Feb.		18 08	Aug.	
18 03	März		18 09	Sept.	
18 04	April		18 10	Okt.	
18 05	Mai		18 11	Nov.	
18 06	Juni		18 12	Dez.	

bei **vierteljährlicher** Abgabe bitte ankreuzen

18 41	I. Kalendervierteljahr	
18 42	II. Kalendervierteljahr	
18 43	III. Kalendervierteljahr	
18 44	IV. Kalendervierteljahr	

Berichtigte Anmeldung (falls ja, bitte eine „1" eintragen) 10

Belege (Verträge, Rechnungen usw.) sind beigefügt bzw. werden gesondert eingereicht (falls ja, bitte eine „1" eintragen) 22

I. Anmeldung der Umsatzsteuer-Vorauszahlung

	Bemessungsgrundlage ohne Umsatzsteuer volle EUR	Ct		Steuer EUR	Ct
Lieferungen und sonstige Leistungen (einschließlich unentgeltlicher Wertabgaben)					
Steuerfreie Umsätze mit Vorsteuerabzug					
Innergemeinschaftliche Lieferungen (§ 4 Nr. 1 Buchst. b UStG) an Abnehmer **mit** USt-IdNr. 41					
neuer Fahrzeuge an Abnehmer **ohne** USt-IdNr. 44					
neuer Fahrzeuge außerhalb eines Unternehmens (§ 2a UStG) 49					
Weitere steuerfreie Umsätze mit Vorsteuerabzug (z.B. **Ausfuhrlieferungen**, Umsätze nach § 4 Nr. 2 bis 7 UStG) 43					
Steuerfreie Umsätze ohne Vorsteuerabzug (z.B. Umsätze nach § 4 Nr. 8 bis 28 UStG) 48					
Steuerpflichtige Umsätze (Lieferungen und sonstige Leistungen einschl. unentgeltlicher Wertabgaben)					
zum Steuersatz von 19 %. 81					
zum Steuersatz von 7 %. 86					
zu anderen Steuersätzen 35			36		
Lieferungen land- und forstwirtschaftlicher Betriebe nach § 24 UStG an Abnehmer **mit** USt-IdNr. 77					
Umsätze, für die eine Steuer nach § 24 UStG zu entrichten ist (Sägewerkserzeugnisse, Getränke und alkohol. Flüssigkeiten, z.B. Wein) 76			80		
Innergemeinschaftliche Erwerbe					
Steuerfreie innergemeinschaftliche Erwerbe Erwerbe nach §§ 4b und 25c UStG 91					
Steuerpflichtige innergemeinschaftliche Erwerbe zum Steuersatz von 19 %. 89					
zum Steuersatz von 7 % 93					
zu anderen Steuersätzen 95			98		
neuer Fahrzeuge (§ 1b Abs. 2 und 3 UStG) von Lieferern **ohne** USt-IdNr. zum allgemeinen Steuersatz 94			96		
Ergänzende Angaben zu Umsätzen					
Lieferungen des ersten Abnehmers bei **innergemeinschaftlichen Dreiecksgeschäften** (§ 25b UStG) 42					
Steuerpflichtige Umsätze, für die der **Leistungsempfänger** die **Steuer nach § 13b Abs. 5 Satz 1 i.V.m. Abs. 2 Nr. 10 UStG schuldet** 68					
Übrige steuerpflichtige Umsätze, für die der **Leistungsempfänger** die **Steuer nach § 13b Abs. 5 UStG schuldet** 60					
Nicht steuerbare sonstige Leistungen gem. § 18b Satz 1 Nr. 2 UStG 21					
Übrige nicht steuerbare Umsätze (Leistungsort nicht im Inland) 45					
Übertrag zu übertragen in Zeile 45					

USt 1 A – Umsatzsteuer-Voranmeldung 2018 – (09.17)

Fig. 3 VAT return form—page 1

					Steuer EUR	Ct
44	**Steuernummer:**					
45	**Übertrag**					
46	**Leistungsempfänger als Steuerschuldner (§ 13b UStG)**	Bemessungsgrundlage ohne Umsatzsteuer volle EUR	Ct			
47						
48	Steuerpflichtige sonstige Leistungen eines im übrigen Gemeinschaftsgebiet ansässigen Unternehmers (§ 13b Abs. 1 UStG)	46		47		
49	Andere Leistungen eines im Ausland ansässigen Unternehmers (§ 13b Abs. 2 Nr. 1 und 5 Buchst. a UStG)	52		53		
50	Lieferungen sicherungsübereigneter Gegenstände und Umsätze, die unter das GrEStG fallen (§ 13b Abs. 2 Nr. 2 und 3 UStG)	73		74		
51	Lieferungen von Mobilfunkgeräten, Tablet-Computern, Spielekonsolen und integrierten Schaltkreisen (§ 13b Abs. 2 Nr. 10 UStG)	78		79		
52	Andere Leistungen (§ 13b Abs. 2 Nr. 4, 5 Buchst. b, Nr. 6 bis 9 und 11 UStG)	84		85		
53	**Umsatzsteuer**					
54	**Abziehbare Vorsteuerbeträge**					
55	Vorsteuerbeträge aus Rechnungen von anderen Unternehmern (§ 15 Abs. 1 Satz 1 Nr. 1 UStG), aus Leistungen im Sinne des § 13a Abs. 1 Nr. 6 UStG (§ 15 Abs. 1 Satz 1 Nr. 5 UStG) und aus innergemeinschaftlichen Dreiecksgeschäften (§ 25b Abs. 5 UStG)			66		
56	Vorsteuerbeträge aus dem innergemeinschaftlichen Erwerb von Gegenständen (§ 15 Abs. 1 Satz 1 Nr. 3 UStG)			61		
57	Entstandene Einfuhrumsatzsteuer (§ 15 Abs. 1 Satz 1 Nr. 2 UStG)			62		
58	Vorsteuerbeträge aus Leistungen im Sinne des § 13b UStG (§ 15 Abs. 1 Satz 1 Nr. 4 UStG)			67		
59	Vorsteuerbeträge, die nach allgemeinen Durchschnittssätzen berechnet sind (§§ 23 und 23a UStG)			63		
60	Berichtigung des Vorsteuerabzugs (§ 15a UStG)			64		
61	Vorsteuerabzug für innergemeinschaftliche Lieferungen neuer Fahrzeuge außerhalb eines Unternehmens (§ 2a UStG) sowie von Kleinunternehmern im Sinne des § 19 Abs. 1 UStG (§ 15 Abs. 4a UStG)			59		
62	Verbleibender Betrag					
63	**Andere Steuerbeträge**					
64	Steuer infolge Wechsels der Besteuerungsform sowie Nachsteuer auf versteuerte Anzahlungen u. ä. wegen Steuersatzänderung			65		
65	In Rechnungen unrichtig oder unberechtigt ausgewiesene Steuerbeträge (§ 14c UStG) sowie Steuerbeträge, die nach § 6a Abs. 4 Satz 2, § 17 Abs. 1 Satz 6, § 25b Abs. 2 UStG oder von einem Auslagerer oder Lagerhalter nach § 13a Abs. 1 Nr. 6 UStG geschuldet werden			69		
66	**Umsatzsteuer-Vorauszahlung/Überschuss**					
67	**Abzug** der festgesetzten **Sondervorauszahlung** für Dauerfristverlängerung (in der Regel nur in der letzten Voranmeldung des Besteuerungszeitraums auszufüllen)			39		
68	**Verbleibende Umsatzsteuer-Vorauszahlung** **(bitte in jedem Fall ausfüllen)**			83		
	Verbleibender Überschuss - bitte dem Betrag ein Minuszeichen voranstellen -					

II. Sonstige Angaben und Unterschrift

Ein Erstattungsbetrag wird auf das dem Finanzamt benannte Konto überwiesen, soweit der Betrag nicht mit Steuerschulden verrechnet wird.
Verrechnung des Erstattungsbetrags erwünscht / Erstattungsbetrag ist abgetreten (falls ja, bitte eine „1" eintragen) 29
Geben Sie bitte die Verrechnungswünsche auf einem gesonderten Blatt an oder auf dem beim Finanzamt erhältlichen Vordruck „Verrechnungsantrag".

Das **SEPA-Lastschriftmandat** wird ausnahmsweise (z.B. wegen Verrechnungswünschen) für diesen Voranmeldungszeitraum **widerrufen** (falls ja, bitte eine „1" eintragen) 26
Ein ggf. verbleibender Restbetrag ist gesondert zu entrichten.

Über die Angaben in der Steueranmeldung hinaus sind weitere oder abweichende Angaben oder Sachverhalte zu berücksichtigen (falls ja, bitte eine „1" eintragen) 23
Geben Sie bitte diese auf einem gesonderten Blatt an, welches mit der Überschrift **„Ergänzende Angaben zur Steueranmeldung"** zu kennzeichnen ist.

Datenschutz-Hinweis:
Die mit der Steueranmeldung angeforderten Daten werden auf Grund der §§ 149, 150 AO und der §§ 18, 18b UStG erhoben. Die Angabe der Telefonnummern und der E-Mail-Adressen ist freiwillig.

Bei der Anfertigung dieser Steueranmeldung hat mitgewirkt:
(Name, Anschrift, Telefon, E-Mail-Adresse)

Datum, Unterschrift

- nur vom Finanzamt auszufüllen -

11 19

12

Bearbeitungshinweis
1. Die aufgeführten Daten sind mit Hilfe des geprüften und genehmigten Programms sowie ggf. unter Berücksichtigung der gespeicherten Daten maschinell zu verarbeiten.
2. Die weitere Bearbeitung richtet sich nach den Ergebnissen der maschinellen Verarbeitung.

Datum, Namenszeichen

Kontrollzahl und/oder Datenerfassungsvermerk

Fig. 4 VAT return form—page 2

As dependent variables, we use the following indicators:

- "Input VAT" is the broadest measure for input VAT and is reported by the statistical office. This variable includes input VAT (third-party reported) and input VAT under reverse charge as well as input VAT from imports, correction of the input tax deduction, and input VAT under general average rates.[26] While the first component declines mechanically under reverse charge due to a re-classification of the transaction, the sum of all the components should convey the total reporting on input VAT. Input VAT refers to the following positions from the VAT return form: 66, 61, 62, 67, 63, and 64.
- "Domestic sales" is the sum of four components: taxable sales at the standard rate (19%), taxable sales at the reduced rate (7%), taxable sales at other rates, and taxable sales under reverse charge (related to mobile phones, integrated circuits, etc.). Domestic sales refers to the following positions from the VAT return form: 81, 86, 35, 60, and 68.
- "EU imports" sums taxable (at different tax rates) and exempted imports to Germany from other EU countries. EU imports refers to the following positions from the VAT return form: 91, 89, 93, 95, and 94.
- "EU exports" is the value of the zero-rated export sales to other EU countries. EU exports refers to position 41 from the VAT return form.

[26] The latter category applies to groups of companies.

B: Additional tables

Table 11 Industries affected by the expansion of RC, 2009–2018

NACE code	Industry	Year effective
38110	Collection of non-hazardous waste	2011
38320	Recovery of sorted materials	2011
46770	Wholesale of waste and scrap	2011
81210	General cleaning of buildings	2011
81221	Other building and industrial cleaning activities (chimney sweeping)	2011
81229	Other building and industrial cleaning activities (special cleaning of building and machinery)	2011
81292	Other cleaning activities (means of transportation)	2011
81299	Other cleaning activities (disinfection and pest control)	2011
24410	Precious metals production	2011
46433	Wholesale of electrical household appliances	2011
46510	Wholesale of computers, computer peripheral equipment and software	2011
46520	Wholesale of electronic and telecommunications equipment and parts	2011
35120	Transmission of electricity	2013
24420	Aluminium production	2014
24430	Lead, zinc and tin production	2014
24440	Copper production	2014
24510	Casting services of iron	2014
24520	Casting services of steel	2014
24530	Casting services of light metals	2014
24540	Casting services of other non-ferrous metals	2014
24450	Other non-ferrous metal	2014
46720	Wholesale of metals and metal ores	2014

Note: The table reports industries that are affected by the expansion of RC in German in the years between 2009 and 2018 as well as their respective NACE code

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References

Agbo, E. I., & Nwadialor, E. O. (2020). The genesis and development of value added tax administration: Case study of Nigeria. *International Journal of Academic Research in Accounting, Finance and Management Sciences, 10*(2), 15–30.

Ainsworth, R. T. (2006). Carousel fraud in the EU: A digital VAT solution. *Tax Notes International, 42*, 5.

Ainsworth, R. T. (2011). VAT fraud as a policy stimulus—Is the US watching? VAT withholding, RTvat, and the mittler model. *Tax Notes International, 62*, 397.

Ali, A. (2021). Value added tax on cross-border digital supplies: The Kenyan approach under the finance act 2019. *Journal of Intellectual Property and Information Technology Law, 1*, 37–62.

Barbone, L., et al., (2013). Study to quantify and analyse the VAT Gap in the EU-27 Member States. 116.

Baum, C. F., Schaffer, M. E., & Stillman, S. (2007). Enhanced routines for instrumental variables/generalized method of moments estimation and testing. *The Stata Journal, 7*(4), 465–506.

Bird, R. M. (1993). Discussion of principles and practices of value added tax: Lessons for developing countries by M. C. Purohit. *Canadian Tax Journal, 41*(6), 1222–1225.

Borselli, F. (2011). Organised VAT fraud: Features, magnitude, policy perspectives. Policy Perspectives (October 12, 2011). Bank of Italy Occasional Paper 106.

Botes, M. (2022). South Africa—value added tax. IBFD-Tax Research Platform.

Bottasso, A., & Sembenelli, A. (2001). Market power, productivity and the EU single market program: Evidence from a panel of Italian firms. *European Economic Review, 45*(1), 167–186.

Braml, M. T., & Felbermayr, G. J. (2022). The EU self-surplus puzzle: An indication of VAT fraud? *International Tax and Public Finance, 29*(5), 1075–1097.

Buettner, T., & Erbe, K. (2014). Revenue and welfare effects of financial sector VAT exemption. *International Tax and Public Finance, 21*(6), 1028–1050.

Bundesministerium der Finanzen, (Federal Ministry of Finance) (2020). Amtliche Umsatzsteuer-Handausgabe.

Bussy, A. (2020). Cross-border value added tax fraud in the European Union. Working paper available at SSRN 3569914.

Cnossen, S. (2001). Tax policy in the European Union: A review of issues and options. *FinanzArchiv/Public Finance Analysis, 58*(4), 466–558.

Cnossen, S. (2009). German and Austrian VAT proposals to combat carousel fraud. *EC Tax Review, 18*, 4.

Cnossen, S., & Shoup, C. S. (1987). Coordination of value-added taxes. In S. Cnossen (Ed.), *Tax coordination in the European community* (pp. 59–84). Springer.

Cour de comptes (2012). Fraude intracommunautaire à la TVA. Technical report.

De La Feria, R. (2019). The new VAT general reverse-charge mechanism. *EC Tax Review, 28*(4), 172–175.

De La Feria, R. (2020). Tax fraud and selective law enforcement. *Journal of Law and Society, 47*(2), 240–270.

Ebrill, L. P, Keen, M., & Perry, V. P. (2001). *The modern VAT*. International Monetary Fund.

ECB (2022). Euro foreign exchange reference rates. https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/index.en.html

European Commission (2014). *Assessment of the application and impact of the optional Reverse Charge Mechanism*. Brussels: Final Report.

European Commission (2017). Towards a single EU VAT area—time to act. Amended proposal for a COUNCIL REGULATION amending Regulation (EU) No 904/2010 as regards measures to strengthen administrative cooperation in the field of value added tax. COM(2017) 706 final. https://data.consilium.europa.eu/doc/document/ST-14893-2017-INIT/en/pdf

European Council (2020). VAT reverse charge mechanism: preventing VAT fraud. https://www.consilium.europa.eu/en/policies/vat-reverse-charge/

Europol (2021). e14.2 million seized from cross-border VAT fraudsters in Hungary. https://www.europol.europa.eu/media-press/newsroom/news/%E2%82%AC142-million-seizedcross-border-vat-fraudsters-in-hungary

Evans, M. B. (2020). GST: where to next? *eJournal of Tax Research, 18*(1), 45–98.

EY (2015). Implementing the destination principle to intra-EU B2Bsupplies of goods. https://taxation-customs.ec.europa.eu/system/files/2016-09/ey_study_destination_principle.pdf

Frunza, M. (2016). Cost of the MTIC VAT fraud for European Union members. Working Paper available at SSRN 2758566.

Gebauer, A., Chang, W. N., & Parsche, R. (2005). VAT evasion and its consequence for macroeconomic clearing in the EU. *FinanzArchiv/Public Finance Analysis,* 462–487.

Hangá cová, N., & Strémy, T. (2018). Value added tax and carousel fraud schemes in the European Union and the Slovak Republic. *European Journal of Crime, Criminal Law and Criminal Justice, 26*(2), 132–159.

Harrison, G., & Krelove, R. (2005). VAT refunds: A review of country experience. 218.

Hart, C. A. (1994). The European community's value-added tax system: Analysis of the new transitional regime and prospects for further harmonization. *INT'L Tax and Business Law, 12*, 1–62.

HMRC (2018). Measuring tax gaps 2019 edition—Tax gap estimates for 2016–17.

International VAT Association (2007). Combating VAT fraud in the EU—The way forward.

Keen, M. (2007). VAT attacks! *International Tax and Public Finance, 14*(4), 365–381.

Keen, M. (2008). VAT, tariffs, and withholding: Border taxes and informality in developing countries. *Journal of Public Economics, 92*(10–11), 1892–1906.

Keen, M., & Hellerstein, W. (2010). Interjurisdictional issues in the design of a VAT. *Tax Law Review, 63*(2), 359–408.

Keen, M., & Smith, S. (1996). The future of value added tax in the European Union. *Economic Policy, 11*(23), 373–420.

Keen, M., & Smith, S. (2000). Viva VIVAT! *International Tax and Public Finance, 6*(2), 741–751.

Keen, M., & Smith, S. (2006). VAT fraud and evasion: What do we know and what can be done? *National Tax Journal*, 861–887.

Kim, S. Y. (2017). An analytical approach to detect MTIC/MTEC VAT fraud involving energy trading. *IOTA Papers, 12*, 1–7.

Kurz, D. (2014). Umkehr der Steuerschuldnerschaft hinsichtlich der Umsatzsteuer bei der Erbringung von Bauleistungen. *Die Unternehmensbesteuerung, 7*(6), 372–379.

Lamensch, M. & Ceci, E. (2018). *VAT fraud: Economic impact, challenges and policy issues*.

Martins, A. (2006). Sources of complexity in the value added tax: A European perspective. In *Proceedings annual conference on taxation and minutes of the annual meeting of the national tax association* (Vol. 99, pp. 92–101).

Meurer, T. (2013). AmtshilfeRLUmsG: Auswirkungen auf das Umsatzsteuergesetz. *Steuerberater Woche, 2013*, 797–806.

Naritomi, J. (2019). Consumers as tax auditors. *American Economic Review, 109*(9), 3031–3072.

OCS SPF Finances Belgique (2007). Extracts from Attempt to measure cross border VAT fraud. https://publications.parliament.uk/pa/ld200607/ldselect/ldeucom/101/101we11.htm#n7

OECD (2022). Global Revenue Statistics Database. https://stats.oecd.org/Index.aspx?DataSetCode=RS_GBL

Official Journal of the European Union (2022). Council Directive (EU) 2022/890 of 3 June 2022 amending Directive 2006/112/EC as regards the extension of the application period of the optional reverse charge mechanism in relation to supplies of certain goods and services susceptible to fraud and of the Quick Reaction Mechanism against VAT fraud. https://eurlex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2022:155:FULL &from=EN

Pahne, J. (2011). Dem Umsatzsteuerbetrug hinterherlaufen! *Umsatzsteuer-Rundschau, 60*(7), 247–254.

Pashev, K. V. (2007). Countering cross-border VAT fraud: The Bulgarian experience. *Journal of Financial Crime*.

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

Poniatowski, G., et al. (2019). *Study and reports on the VAT gap in the EU-28 Member States: 2019 final report*.

Potts, J. (2019). Reversing the charges. *Construction Journal*, 18–19.

Rao, R. K. (2019). Goods and service tax: Performance and progress. In Kavita Rao, R., Mukherjee, S., & Bagchi, A. *Goods and services tax in India* (pp. 166–181). Cambridge University Press.

Sergiou, L. (2012). Value added tax (VAT) carousel fraud in the European Union. *The Journal of Accounting and Management, 2*, 2.

Sinn, H.-W., Gebauer, A., & Parsche, R. (2004). The IFO institute's model for reducing VAT fraud: Payment first, refund later *5*(2), 30–34.

Slemrod, J. (2008). Does it matter who writes the check to the government? The economics of tax remittance. *National Tax Journal, 61*(2), 251–275.

Smart, M., & Bird, R. M. (2009). The impact on investment of replacing a retail sales tax with a value-added tax: Evidence from Canadian experience. *National Tax Journal, 62*(4), 591–611.

Stiller, W., & Heinemann, M. (2019). Do more harm than good? The optional reverse charge mechanism against VAT fraud. https://www.researchgate.net/profile/Wojciech-Stiller/publication/351904988_Do_More_Harm_than_Good_The_Optional_Reverse_Charge_Mechanism_against_VAT_Fraud/links/60af7870a6fdcc647edf7ba7/Do-More-Harm-than-Good-The-Optional-Reverse-Charge-Mechanism-against-VAT-Fraud.pdf

Van Zyl, S. P. (2014). The collection of value added tax on cross-border digital trade-part 1: registration of foreign vendors. *Comparative and International Law Journal of Southern Africa, 47*(2), 154–186.

Varas, G., Martínez, G., et al. (2020). Chilean IRS interprets the new VAT rules on digital services. *International Tax Review*.

Vellen, M. (2005). Umsatzbesteuerung der Lieferungen von Gas und Elektrizitä t. *Umsatzsteuer-Rundschau, 54*(3), 133–142.

Waseem, M. (2019). Overclaimed refunds, undeclared sales, and invoice mills. In *Proceedings annual conference on taxation and minutes of the annual meeting of the national tax association* (Vol. 112, pp. 1–56).

Waseem, M. (2022). The role of withholding in the self-enforcement of a value-added tax: Evidence from Pakistan. *Review of Economics and Statistics, 104*(2), 336–354.

Yesegat, W. A., & Joseph, S.-A. (2017). VAT withholding in Ethiopia: Implications for revenue collection and refunds. *Australian Tax Forum, 32*(2), 399–428.

Yiallourou, K. (2019). The limitations of the VAT gap measurement. *EC Tax Review, 28*, 4.