# The impact of cash and card transactions on VAT collection efficiency *

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## Abstract

Using EU country-level data, this paper investigates the connection between transactions' payment method and tax compliance in the context of the Value-added tax. Intuitively, the visibility of card payments by third-party institutions can serve as a deterrent to sales under-reporting and other evasion strategies. Countries like the U.S. and Turkey have already implemented policies directly utilising electronic payments as a tax control instrument. Estimates based on the European data do not find a statistically significant effect of cards on VAT performance, but do show that cash usage has a negative impact, a result that remains robust to a wide range of controls and specifications. It is further demonstrated that the relationship between cards, cash and the VAT revenue ratio is best modelled via a second-order Taylor approximation. The role of standard and reduced VAT rates, turnover thresholds and exposure to trade is also explored.

**Keywords**: Value added tax, VAT revenue ratio, card payments, cash, tax evasion, EU
**JEL Classification**: H21; H25; H26; K34

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# 1 Introduction

Due to technological progress and the introduction of new methods of payment, tax administrations face new possibilities of improving tax enforcement, while firms devise creative opportunities for tax evasion. Nowhere is this trend more pronounced than in the case of the value-added tax (VAT). Ainsworth (2011) points out that the supply of goods and services, the movement of the supply and funding in the context of carousel VAT fraud are already entirely digitised. Given the enormous estimated losses of VAT revenue, radical proposals for fraud prevention are not infrequent. Examples range from VAT withholding, which would split the VAT amount from the taxable amount in real time, thus eliminating both firms' access to VAT and voluntary compliance, to data mirroring of companies' hard disks for tax control purposes as advanced in a bill by the Danish Ministry of Taxation (PriceWaterhouseCoopers, 2010; Skatteministeriet J. 2010-711-0044, 2010).

A common factor among these proposals and recent developments in tax enforcement policies in general, is the move to discourage business/customer cash transactions in favour of electronic payments that are more easily monitored, and hence constitute a strong incentive for compliance. The deterrent effect of card transactions on tax evasion, however, is yet to be established in the economic literature. Recently, Hasan et al. (2012) provided some preliminary evidence that retail electronic transactions, and especially retail card payments are positively correlated with GDP per capita growth, consumption, and trade. Whether a similar effect exists between electronic payments and tax compliance, remains a largely unexplored question.

The empirical literature on VAT thus far has primarily studied the effect of standard and reduced rates (Bogetić and Hassan (1993), Agha and Haughton (1996), Engel et al. (2001)), and the quality of tax administrations (de Mello (2008)) on VAT's performance, predominantly using a large cross-section of countries. A more recent panel data analysis performed by Aizenman and Jinjarak (2008) focuses on levels of urbanisation, trade openness and some political variables as determinants of VAT's collection efficiency.

While controlling for most of the variables used in the above studies, this paper further investigates if there is any association between method of payment and VAT's revenue outcomes. Using country-level panel data for 26 EU countries in the period 2000-2010, I find that the relationship between both cash and cards and the chosen VAT performance ratio is non-linear, even after controlling for the number of ATMs and point of sale terminals (POS) per million of inhabitants, the VAT rate, and other explanatory variables. In particular, this relationship is convex in the case of cash, measured as the share of ATM cash withdrawals in GDP, vis-à-vis VAT revenue as a proportion of net consumption, and concave for card transactions (share of total card transactions in GDP).

The empirical analysis does not demonstrate a statistically significant relationship between VAT revenue and card usage, but shows the consistently negative impact of cash, whose effect can turn positive in countries with high preference for cash transactions. While it is possible that there is simply no connection between cards and VAT performance, this lack of correlation can also be attributed to the fact that electronic payments are not an explicit tax control instrument

in the EU, as is the case in the U.S. and Turkey, for example. Despite the insignificant results for cards, POS terminals are shown to affect the VAT-to-consumption ratio positively in almost all regressions.

These findings are robust for both low- and high-income member states, and hold for alternative dependent variables. They are also unaffected by the inclusion of additional control variables. Although a different specification strategy, in which the VAT rate is considered endogenous and is hence, instrumented for, yields higher coefficients in absolute value, the results remain qualitatively the same. Nevertheless, since the study is limited to 26 EU members, its findings are likely specific.

The paper is organised as follows. The next section discusses the specific role electronic payments play in tax policies targeting compliance. Section 3 describes the data, the estimation strategy, and examines the results. Concluding comments are presented in Section 4.

## 2 Role of Electronic Payments in Tax Policy and Enforcement

The retail sales of a firm can generally be split into two categories based on the method of payment chosen by the consumer: electronic payments via credit/debit cards or mobile devices (m-payments), and cash payments. The former have an almost 100% probability of detection if an audit is instigated, since a record of the transaction exists and can be cross-checked through third-party reporting, while the latter are easily manipulated and evaded. In fact, for resourceful retailers the probability that the tax authorities would uncover cash sales evasion has decreased substantially with the invention of Zappers – add-on programs in electronic cash registers (ECR) or point of sales systems, which skim sales and simultaneously re-number and re-calculate the records of the remaining invoices, thus creating consistent financial statements (Ainsworth, 2010). Even if a retailer is unaware of the evasion opportunities arising from Zappers, Ainsworth, (2012) notes that an operation conducted by the US Department of Taxation and Finances, in which false restaurants were opened with the goal of soliciting tenders for ECR, showed that 70% to 80% of the sales representatives actively marketed sales deletion software.

With regard to electronic payments, the firm's knowledge that transactions are recorded by banks, credit card companies, mobile operators or others can serve as a major deterrent to evasion and as a tool to diminish the tax gap.[1] This was the objective of adding Section 6050W to Title 26 of the US Code in 2008 (in force from January 2011), which requires banks, third-party settlement organisations, and other organisations with contractual obligations in the settlement of payment cards to send annual reports to the IRS containing information on payments made to merchants via debit/credit cards or certain electronic means. The IRS can use this data to match merchants' sales with the ones reported on their tax returns (Treasury Inspector General for Tax Administration, 2011).

[1] In a randomised enforcement experiment studying evasion responses of individuals, Kleven at al. (2011) show that in Denmark evasion is modest for personal income subject to third-party reporting, and considerable for self-reported income. The advantages of third-party collection – withholding employees' PIT and collecting it from employers – versus self-declaration are, for example, explored in Dusek (2003).

A similar policy is in place in Turkey. According to Dogan (2011), since 2008, Turkish businesses can check their monthly credit card sales online when preparing their VAT returns. If there is a discrepancy between the company's records and the online statement, the firm can ignore the discrepancy provided it can furnish an explanation; otherwise it will be subject to an audit. Before the implementation of the system, 140,000 taxpayers did not report any credit card sales in their VAT returns and 60,000 had deviations in more than 20% of their transactions. One year later fewer than 20,000 had a discrepancy rate of over 20% (Dogan, 2011). It is unclear, however, how issues of data protection and privacy, as well as compliance costs incurred by merchants are to be addressed by the US and Turkish policies.

Effective taxation hinges crucially on the availability and processing of information. The rise in cashless retail sales means that complete information exists for the fraction of firms' retail transactions executed electronically. Thus, while businesses act as collectors of VAT for the tax authorities, at the retail stage of VAT collection, customers increasingly become the enforcers. Clearly, the substantial wedge between the probabilities of detection of suppressed cash and electronic transactions can induce firms to hide more of their cash receipts to compensate for their inability to cheat elsewhere. In a laboratory experiment conducted by Johnson et al. (2009), for example, tax revenues declined by 15% when participants were told that part of their income would be perfectly monitored by the tax administration but that they had the opportunity to transfer income from the monitored to the unmonitored source at a cost. Even if transfers were not allowed, reporting rates remained similar to the baseline case without perfect monitoring, suggesting that taxpayers would find a way to adjust to tax policy changes in order to maintain their preferred level of tax compliance (Johnson et al., 2009).

In general, a firm cannot switch easily between monitored and unmonitored sales as it faces exogenously given demand for the methods of payment, which is determined by consumers' preferences for anonymity and convenience, the amount of transaction fees, and other factors. Nevertheless, if the firm is a monopolist it can use cash discounts as a means of price discrimination, a possibility explored by Gordon (1990). Alternatively, provided that the customer initiates bargaining for a price reduction, as modelled by Fedeli (2003), then the chosen method of payment will depend on the customer's intention to evade VAT.

To prevent collusion between retailers and customers, tax administrations resort to various policies. In Italy, for example, upon leaving a restaurant, hotel, or a bar, a consumer may be required by the police to produce a fiscal receipt showing the VAT paid. Failure to do so, results in a fine (Tait, 1988). Gordon (1990), however, demonstrates that shifting part of the liability for unpaid taxes onto consumers can increase tax evasion, since the firm has to cut its cash price to maintain cash sales demand constant.

A superior strategy is to align the incentives of the final consumer and the tax authorities, especially in areas that are notoriously hard to tax – the businesses of plumbers, builders, electricians, etc. Instead of establishing a reduced VAT rate for renovation and restoration of private dwellings, Denmark allows 15,000 DKK ($\approx$ €2000) per person per year, which is spent on renovation, to be deducted from the personal income tax (PIT). In order to qualify for the

deduction, a household must have paid for the services via a card or a bank (cash or check payments are not eligible) and present a detailed documentation about the supplier and the services performed.[2]

Although the scope of this policy is relatively limited, in a nutshell it contains several essential elements, which can be useful for broader tax purposes: 1) It demonstrates that the effect of reduced VAT rates can be successfully achieved through the interaction of tax bases, in this case through deductions in the PIT, while avoiding further complexity in VAT; 2) Despite the loss of tax revenue as a result of the deductions, the tax administration can obtain a very clear picture on the amount of VAT and income evasion in this predominantly cash-based sector. It can do so by comparing revenue before and after the introduction of the policy, taking into account the possibility that the tax policy itself could have increased the demand for home renovations; 3) Last, and possibly most importantly, the policy, even if of temporary nature, roots out the use of cash in an industry, where cash payments are practically entrenched. It is worth pointing out that while such measures can be effective in countries with high PIT rates relative to VAT, which makes deductions worthwhile for the consumer, most Central and Eastern European (CEE) countries, for instance, have flat PIT schemes below the standard VAT rate, so that VAT evasion remains the more profitable option.

Overall, the final consumer's choice of a payment instrument can be a powerful enforcement measure if card payments on retail level become the norm, as they already are in several EU countries. While a large part of the public will continue to adopt convenient, secure, and innovative cashless payment methods as they become more and more widespread, tax policy clearly has the means to considerably reinforce this trend through monetary or other incentives.

## 3 Data

To check if the method of payment matters for tax compliance, I use a small unbalanced panel dataset for 26 EU countries, namely Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the UK for the period 2000-2010.

The main dependent variable is the VAT Revenue Ratio ($VRR$), which is a measure of the performance of countries' VAT regimes. The $VRR$ is the ratio of actual collected VAT revenue to net consumption, divided by the standard VAT rate ($SVAT$). Net consumption is item P3 in the National Accounts minus VAT revenue. In the literature, VAT performance ratios differ given the economic base they assume for VAT. The Efficiency ratio, used for example by Engel et al. (2001) and Bogetić and Hassan (1993), scales the consumption-type VAT revenue by GDP, which would have been the tax base if VAT were a gross-product based tax, under which firms cannot deduct expenditure on capital goods from sales when computing their value-added (Department of the Treasury, 1984).

[2]Details on the conditions, requirements, and services covered are available on the website of the Danish Tax Authorities (in Danish): http://www.skat.dk/SKAT.aspx?oId=1947018&vId=0#os

If the goal is to estimate the extent to which exemptions, reduced and zero rates, and avoidance/evasion activities erode VAT revenue collection, a more appropriate indicator would be the C-efficiency ratio, $\frac{\text{VAT Revenue}}{\text{Final consumption*SVAT}}$, whose denominator captures the potential tax base given a single VAT rate, no exemptions and full compliance. This was the chosen performance variable in Ebrill et al. (2001), Aizenman and Jinjarak (2008), and de Mello (2008). The C-efficiency ratio, however, understates VAT's collection capacity since the National Accounts compute consumption inclusive of VAT, at market prices. Therefore, VAT revenue should be subtracted from final consumption in the ratio's denominator, resulting in an improved measure, $VRR$. Chapter 4 of the 2010 edition of OECD (Various Years) discusses the $VRR$ in detail and proposes steps towards its further refinement.

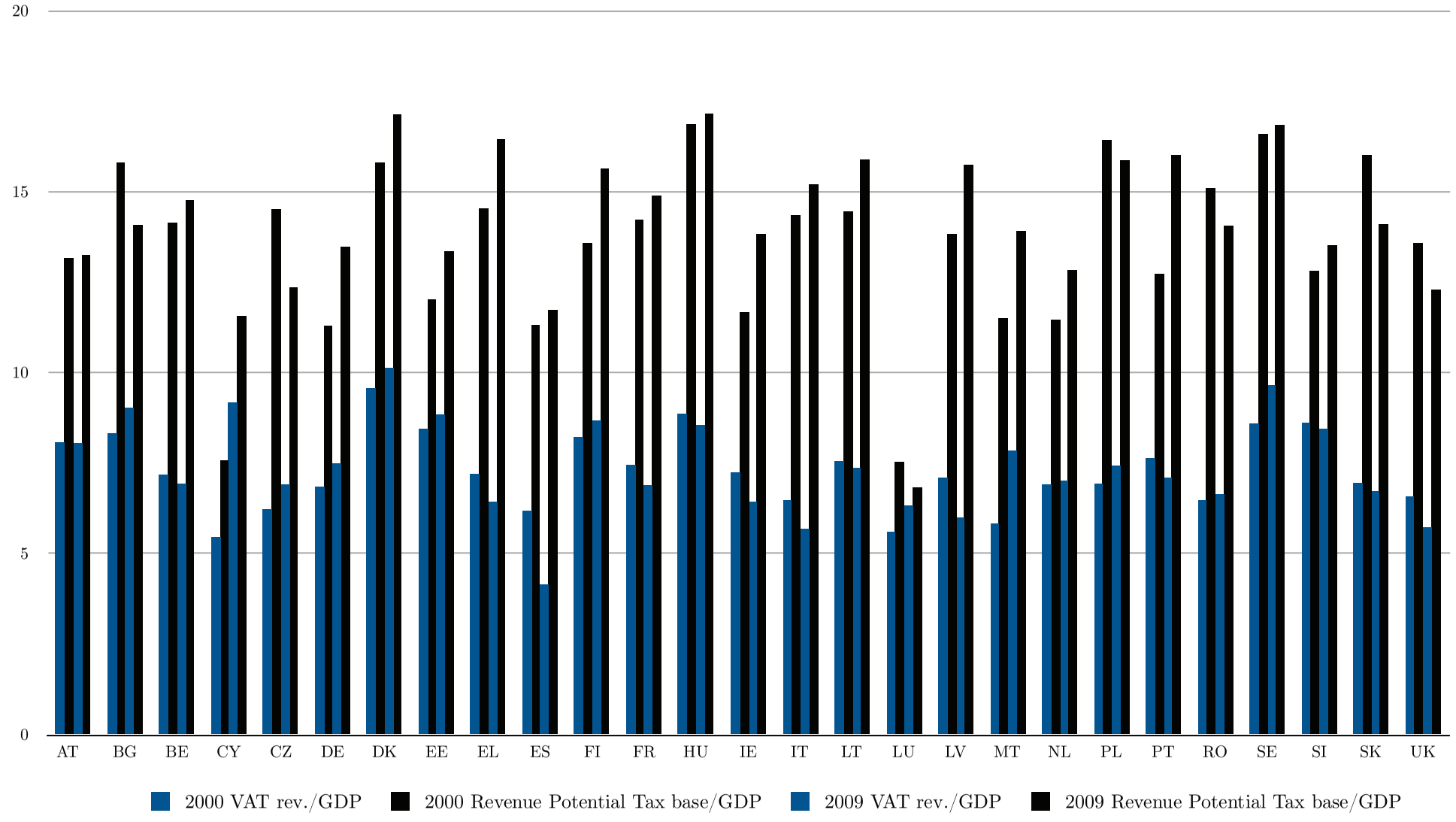
The $VRR$ is a combination of two efficiency ratios, the Policy efficiency ratio, which demonstrates the degree to which current VAT legislation deviates from a uniform tax on consumption, and the Compliance efficiency ratio – measuring compliance (OECD, Various Years). For the purposes of my estimation, ideally I would use the Compliance Ratio. It, however, entails the calculation of the theoretical tax revenue from actual tax law, or VAT revenue under full compliance, which is a daunting task, inevitably prone to error, and thus far attempted only by Reckon LLP and by some individual countries' tax administrations.

To better understand fluctuations in $VRR$, one needs to take a closer look at the specific legislative changes affecting the actual tax base in a given country. In terms of rates coverage and exemptions over the 2000-2009 period, very few changes with a likely minimal impact on revenue occurred in the tax bases of Austria, Belgium, Germany, Denmark, Netherlands, Finland, Italy, Luxembourg, Ireland, Sweden, and the UK, while in Spain there were no changes at all as shown in the Appendix. Out of these countries, Germany, Netherlands, Finland, Ireland and the UK increased the standard VAT rate modestly.

The CEE countries were the major VAT reformers, mostly due to their accession in the EU. The Czech Republic, and especially Hungary, expanded and changed VAT's coverage considerably in order to comply with the list of goods and services, which can be subject to reduced rates as listed in Annex H to the Sixth VAT Directive. Nevertheless, the new member states negotiated various derogations, most of which expired in 2010. Given its aggressive base expansion, and despite having a 5 percentage points (pp) lower standard rate in 2006-2008 compared to previous years, Hungary raised $SVAT$ back to 25% in 2009. Narrowing of the VAT tax base is observed in France, Portugal, and especially Greece. $SVAT$ in Greece and Portugal grew by 1pp and 3pp from 2000 to 2009 and then by further 4pp and 1pp in 2010, respectively. Registration thresholds are generally higher in 2009-2010 in Western Europe, and especially in Ireland and the UK, whereas in CEE they decrease, albeit from a very high level.

In Figure 1, the dynamics of actual VAT revenue ($VRR$'s numerator) as a % of GDP in 2000 and 2009 is compared to revenue from the potential tax base under a single VAT rate, no exemptions and full compliance ($VRR$'s denominator), again as a % of GDP. Five countries stand out due to large falls in $\frac{\text{VAT Revenue}}{\text{GDP}}\%$ and simultaneous increases in the potential tax base receipts driven by jumps in SVAT and/or stronger final consumption – Spain, Ireland, Latvia,

Figure 1: COMPARISON OF ACTUAL VAT REVENUE WITH REVENUE FROM A POTENTIAL TAX BASE AS A % OF GDP: 2000 VS 2009




Note: Revenues from a potential tax base equal (Final consumption - VAT rev.)*Standard VAT rate.

Greece, and Portugal. While the reduced revenue in Greece, Portugal and Ireland may be due to the possibility that the base narrowing effect of VAT reforms outweighed the increase in rates, the 2.03 pp drop in collected VAT to GDP in Spain in 2009 is hard to explain, given that there were virtually no alterations in VAT's legislation since 2000 and no major fluctuations in consumption. Revenues stabilised at 5.5% of GDP in 2010, after Spain raised $SVAT$ by 2 pp. One possible factor behind the revenue decline may be the 15% decrease in the number of VAT registered traders and the overall effect of the financial crisis. In Hungary, however, in spite of a significant base expansion accompanied by higher $SVAT$ and reduced rates, revenue fell by 0.30 pp suggesting that compliance issues may be at play.

To distinguish between methods of payment, the main explanatory variables used are the value of card transactions by all cards issued in the reporting country and the value of ATM cash withdrawals (again pertaining to cards issued in the reporting country) both sourced from the ECB's Data Warehouse. ATM cash withdrawals are an imperfect measure of cash transactions, but they are by no means an insignificant one. ATM cash ranges from 30% of GDP in Estonia in 2001 and similar high values in other Baltic countries to less than 2% in Denmark. In fact, ATM cash withdrawals nearly perfectly coincide with Denmark's currency in circulation, once I exclude the value of the largest banknote – 1000 DKK, which is rarely used for retail payments.

Figures 2 and 3 show the growth rates of $\frac{Cash}{GDP}$ and $\frac{Cards}{GDP}$ separately for CEE and the so-called 'Old' member states (EU-15) covering Austria, Belgium, Germany, Denmark, Luxembourg, Finland, the UK, France, Italy, Sweden, Malta, the Netherlands, Ireland, Portugal, and Spain. After 2004, a convergence in the growth rates of cash and cards occurred for the two regions of Europe, with card transactions growing by more than 30% per annum in CEE before 2005 and less than 10% after 2006. Cash growth was negligible and negative for the EU-15, and turned negative in CEE only in 2010. Cash withdrawals, however, remain a very stable share of GDP in most EU economies as is clear from Table 1. Additionally, the mean value of the number of ATMs ($\frac{ATM}{POPM}$) has increased steadily, while point of sale terminals ($\frac{POS}{POPM}$) per million inhabitants have more than doubled from 2000 to 2010. The majority of the POS terminals are EFTPOS (electronic fund transfer at point of sale) terminals for debit and credit cards.

In principle, it would have been optimal to additionally include over-the-counter (OTC) cash withdrawals in the measure of cash, but this variable is available for a very limited set of countries (the Czech Republic, Greece,Germany, Spain, Finland, UK, Hungary, Italy, Latvia, Netherlands, Romania and Slovakia) and only for some years between 2000 and 2010. OTC transactions and ATMs are the two major sources of cash to the public, and hence the main indicators of retail payments done in cash. OTC withdrawals in Greece are several times higher than GDP, suggesting that they include additional payments, which are not mentioned in the description of the variable. For this reason, Greek data is not considered in Figure 4. Such high values apply to the CEE region in general, with OTC withdrawals being 52% of GDP on average compared to only 12% in the EU-15 countries, for which information is available. Even though the data should be viewed with caution, it is useful to see how OTC withdrawals change, especially in light of the fact that both ATM cash withdrawals and card payments grow as a

Figure 2: GROWTH RATE OF VALUE OF CARD PAYMENTS AS A % OF GDP

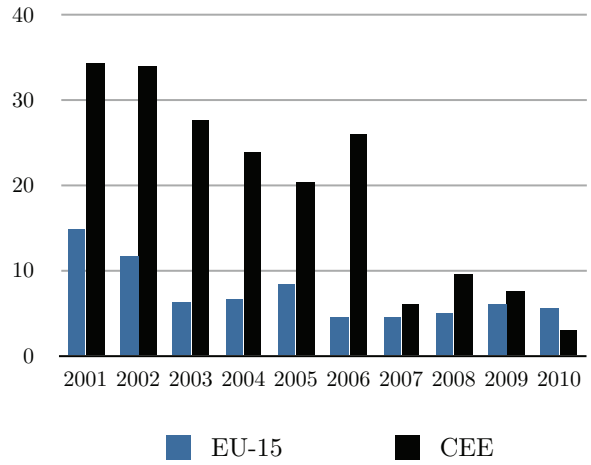



Figure 3: GROWTH RATE OF VALUE OF ATM CASH WITHDRAWALS AS A % OF GDP

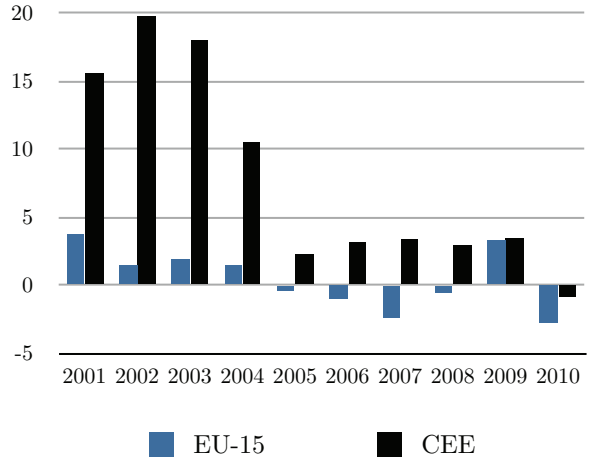
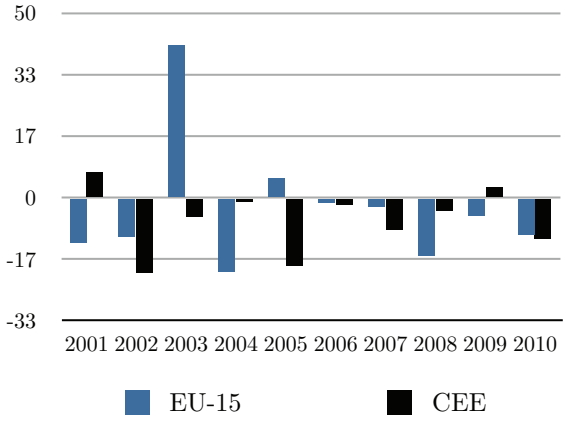



Figure 4: GROWTH RATE OF VALUE OF OTC CASH WITHDRAWALS AS A % OF GDP




Data for OTC withdrawals covers only the Czech Republic, Germany, Spain, Finland, the UK, Hungary, Italy, Latvia, Netherlands, Romania and Slovakia. Source: ECB.

Table 1: DESCRIPTIVE STATISTICS

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $VRRM$ | 10.6 | 10.4 | 10.4 | 10.5 | 10.7 | 11.3 | 11.4 | 11.6 | 11.1 | 10.4 | 10.8 | 286 |
| | (1.94) | (1.87) | (1.86) | (1.86) | (1.99) | (1.99) | (2.08) | (2.02) | (2.18) | (2.4) | (2.06) | |
| $CeffM$ | 9.58 | 9.41 | 9.42 | 9.47 | 9.7 | 10.1 | 10.3 | 10.4 | 10.0 | 9.38 | 9.78 | 286 |
| | (1.57) | (1.51) | (1.51) | (1.51) | (1.61) | (1.6) | (1.66) | (1.61) | (1.76) | (1.97) | (1.67) | |
| $EffR$ | 7.34 | 7.24 | 7.26 | 7.32 | 7.44 | 7.74 | 7.78 | 7.74 | 7.59 | 7.32 | 7.56 | 286 |
| | (1.00) | (0.95) | (0.95) | (1.00) | (1.07) | (1.10) | (1.19) | (1.17) | (1.24) | (1.34) | (1.12) | |
| $\frac{Cards}{GDP}$ | 6.8 | 6.66 | 7.49 | 8.10 | 8.79 | 9.73 | 10.36 | 10.93 | 11.60 | 12.29 | 12.96 | 281 |
| | (5.91) | (6.10) | (5.54) | (5.58) | (5.76) | (5.73) | (5.91) | (5.97) | (6.18) | (6.22) | (6.11) | |
| $\frac{Cash}{GDP}$ | 9.58 | 10.02 | 10.74 | 11.55 | 12.12 | 12.27 | 12.82 | 12.94 | 13.21 | 13.66 | 13.42 | 273 |
| | (5.71) | (5.98) | (5.44) | (5.51) | (5.72) | (5.75) | (5.99) | (6.09) | (6.29) | (6.31) | (6.19) | |
| $CIT$ | 31.83 | 30.94 | 29.39 | 28.45 | 27.5 | 26.16 | 25.85 | 25.56 | 24.46 | 24.43 | 24.08 | 286 |
| | (6.8) | (6.07) | (6.79) | (6.85) | (7.64) | (7.93) | (7.49) | (7.95) | (7.15) | (6.94) | (7.07) | |
| $GovExp$ | 43.85 | 43.88 | 44.36 | 44.54 | 43.99 | 43.8 | 43.38 | 43.03 | 44.55 | 48.74 | 48.45 | 286 |
| | (6.2) | (6.06) | (6.31) | (6.95) | (6.71) | (6.63) | (6.33) | (5.73) | (5.24) | (5.19) | (6.70) | |
| $Deficit$ | -.942 | -1.6 | -2.4 | -2.5 | -1.96 | -1.49 | -.926 | -.4 | -2.21 | -6.56 | -6.53 | 286 |
| | (4.09) | (3.30) | (2.96) | (2.88) | (2.71) | (3.02) | (3.27) | (2.84) | (3.32) | (3.90) | (5.89) | |
| $\frac{ATM}{POPM}$ | 483 | 503 | 532 | 568 | 601 | 625 | 657 | 711 | 738 | 750 | 736 | 285 |
| | (296) | (308) | (311) | (317) | (328) | (330) | (335) | (345) | (342) | (338) | (333) | |
| $\frac{POS}{POPM}$ | 8,907 | 10,229 | 11,030 | 11,451 | 12,196 | 12,697 | 13,731 | 15,187 | 16,474 | 17,181 | 17,661 | 280 |
| | (5,549) | (6,959) | (7,663) | (7,393) | (7,848) | (7,569) | (7,880) | (8,104) | (8,766) | (9,006) | (9,351) | |
| $Open$ | 109 | 108 | 104 | 102 | 107 | 109 | 117 | 119 | 120 | 105 | 116 | 286 |
| | (54.6) | (52.5) | (49.1) | (46.7) | (50.6) | (51.7) | (55.9) | (57.4) | (56.3) | (52.2) | (56.3) | |
| $Urban$ | 70.59 | 70.7 | 70.8 | 70.9 | 71.05 | 71.17 | 71.33 | 71.49 | 71.64 | 71.8 | 71.9 | 286 |
| | (12.45) | (12.44) | (12.44) | (12.45) | (12.45) | (12.46) | (12.46) | (2.46) | (12.47) | (12.47) | (12.48) | |
| $Unempl$ | 8.84 | 8.77 | 8.76 | 8.69 | 8.79 | 8.30 | 7.42 | 6.49 | 6.39 | 9.07 | 10.48 | 285 |
| | (4.66) | (5.13) | (4.68) | (3.94) | (3.69) | (3.18) | (2.49) | (1.97) | (1.88) | (3.68) | (4.41) | |
| $Corrupt$ | 6.23 | 6.23 | 6.25 | 6.32 | 6.4 | 6.46 | 6.52 | 6.56 | 6.47 | 6.34 | 6.3 | 282 |
| | (2.18) | (2.09) | (2.15) | (2.16) | (2.09) | (2.04) | (1.93) | (1.79) | (1.74) | (1.83) | (1.91) | |
| $ThreshGDP$ | 417 | 334 | 343 | 238 | 241 | 236 | 247 | 190 | 186 | 213 | 201 | 249 |
| | (669) | (517) | (585) | (394) | (355) | (355) | (345) | (235) | (224) | (216) | (230) | |
| $SVAT$ | 19.57 | 19.61 | 19.73 | 19.65 | 19.61 | 19.73 | 19.54 | 19.65 | 19.61 | 19.96 | 20.65 | 286 |
| | (2.92) | (2.89) | (2.87) | (2.78) | (2.60) | (2.59) | (2.36) | (2.25) | (2.24) | (2.56) | (2.44) | |
| $Range$ | 10.53 | 10.47 | 10.95 | 10.66 | 10.82 | 10.9 | 10.70 | 11.86 | 11.66 | 11.45 | 12.16 | 286 |
| | (5.32) | (5.31) | (5.79) | (4.93) | (4.53) | (4.54) | (4.47) | (3.23) | (3.21) | (3.14) | (3.28) | |
| $\frac{GDP}{POP}$ | 18,880 | 19,215 | 19,569 | 19,830 | 20,396 | 20,919 | 21,661 | 22,403 | 22,350 | 21,083 | 21,357 | 286 |
| | (13,621) | (13,745) | (13,967) | (13,965) | (14,271) | (14,612) | (14,948) | (15,429) | (15,142) | (14,194) | (14,376) | |

Note: All means are expressed in % , except $\frac{GDP}{POP}$, which is in €, *Range* in percentage points, while $\frac{ATM}{POPM}$ and $\frac{POS}{POPM}$ are pure numbers.

Table 2: DESCRIPTION OF VARIABLES AND SOURCES

| | |
|---|---|
| $VRR$ | VAT Revenue Ratio = $\frac{\text{VAT Revenue}}{(\text{Final consumption}-\text{VAT Revenue})*SVAT}$, where VAT Revenue is the actual VAT revenue, and Final consumption is item P3 of the national accounts consisting of 1) private final consumption expenditure of households and non-profit organisations serving households and 2) individual and collective consumption expenditure of general government. $VRRM = \frac{\text{VAT Revenue}}{(\text{Final consumption}-\text{VAT Revenue})*SVAT}$ is used in estimation, since $SVAT$ is used as a control variable. Source: OECD, Eurostat. |
| $Ceff$ | C-efficiency = $\frac{\text{Vat Revenue}}{\text{Final consumption*SVAT}}$. $CeffM = \frac{\text{Vat Revenue}}{\text{Final consumption}}$ is used in estimation, since $SVAT$ is used as a control variable. Source: OECD, Eurostat. |
| $EffR$ | Efficiency Ratio = $\frac{\text{Vat Revenue}}{GDP}$ |
| $\frac{Cards}{GDP}$ | Value of transactions for all cards issued in the reporting country, except e-money function scaled by the Gross Domestic Product. Source: Payments and Settlement Systems Statistics, ECB Data Warehouse. |
| $\frac{Cash}{GDP}$ | Value of cash withdrawals for all cards issued in the reporting country via customer terminals scaled by the Gross Domestic Product. Source: Payments and Settlement System Statistics, ECB Data Warehouse; Eurostat. |
| $CIT$ | Statutory corporate tax rate. Source: Eurostat. |
| $GovExp$ | Total general government expenditure as a % of GDP. Source: Eurostat. |
| $Deficit$ | General government deficit (-) surplus (+) as a % of GDP. Source: Eurostat. |
| $\frac{ATM}{POPM}$ | Number of ATMs per million inhabitants. Source: Payments and Settlement Systems Statistics, ECB Data Warehouse. |
| $\frac{POS}{POPM}$ | Number of Point of Sale Terminals per million inhabitants. Source: Payments and Settlement Systems Statistics, ECB Data Warehouse. |
| $Open$ | Imports + Exports as a percent of GDP. Source: World Development Indicators, World Bank. |
| $Urban$ | Urban population as a percent of total population. Source: World Development Indicators, World Bank. |
| $Unempl$ | Rate of unemployment. Source: Eurostat. |
| $Corrupt$ | Corruption Perceptions Index ranging from 0 (highly corrupt) to 10 (very clean). Source: Transparency International. |
| $ThreshGDP$ | A minimum turnover threshold, below which small traders are exempt from registering for VAT. % of $\frac{GDP}{POP}$. Source: European Commission, Taxation and Customs Union, OECD (Various Years), Ernst & Young Worldwide VAT, GST and Sales Tax Guides for 2003 and 2010, Various tax administration websites. |
| $SVAT$ | Standard VAT rate. A single standard VAT rate is used even in countries with several standard rates applied in specific regions, as is the case in Austria, Greece, France, Portugal and Spain. For example, standard rates are different on mainland Greece and Lesbos, Chios, Samos, and the other Greek islands. The same holds for mainland Portugal and the Azores and Madeira. Source: OECD (Various Years), Eurostat. |
| $Range$ | The difference between the standard VAT rate, $SVAT$ and the reduced rate. In countries with more than one reduced rate, the average is taken. If there is no reduced rate, $Range$ is set to zero. Source: Eurostat. |
| $Prefill$ | A dummy variable equal to 1 if a country uses fully/ partially pre-populated personal income tax returns. Source: OECD (2008). |
| $\frac{GDP}{POP}$ | Real gross domestic product per capita in Euro. Source: Eurostat. |

Figure 5: MARGINAL RELATIONSHIP: VRR VS. ATM CASH WITHDRAWALS

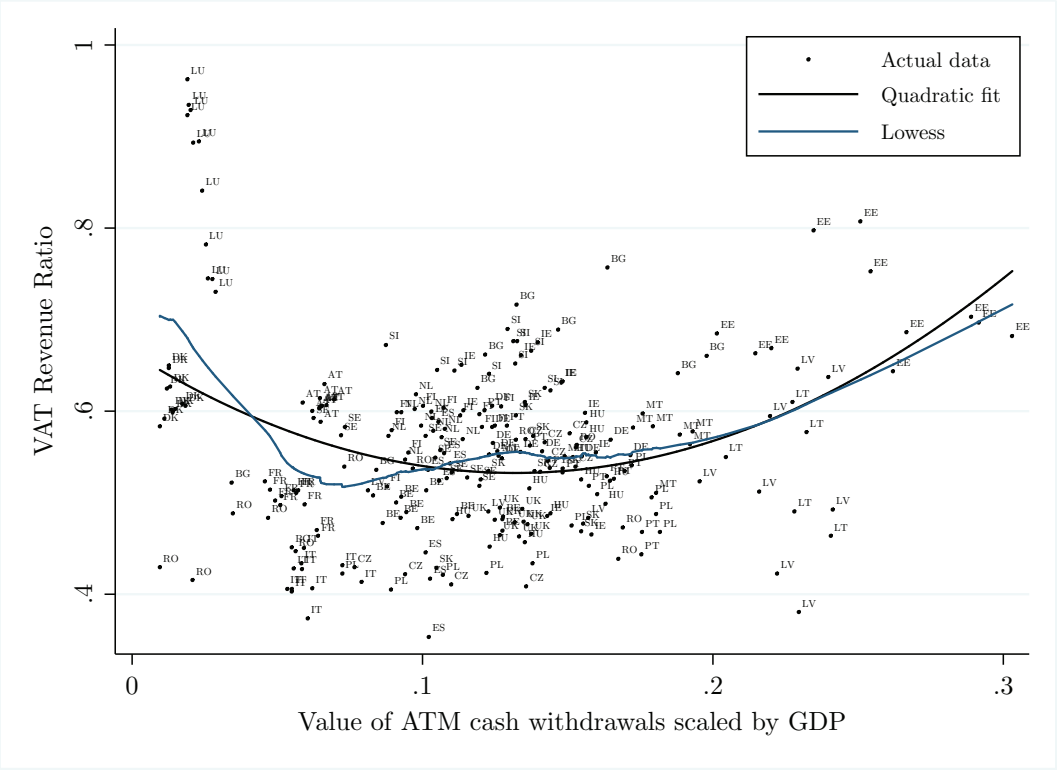
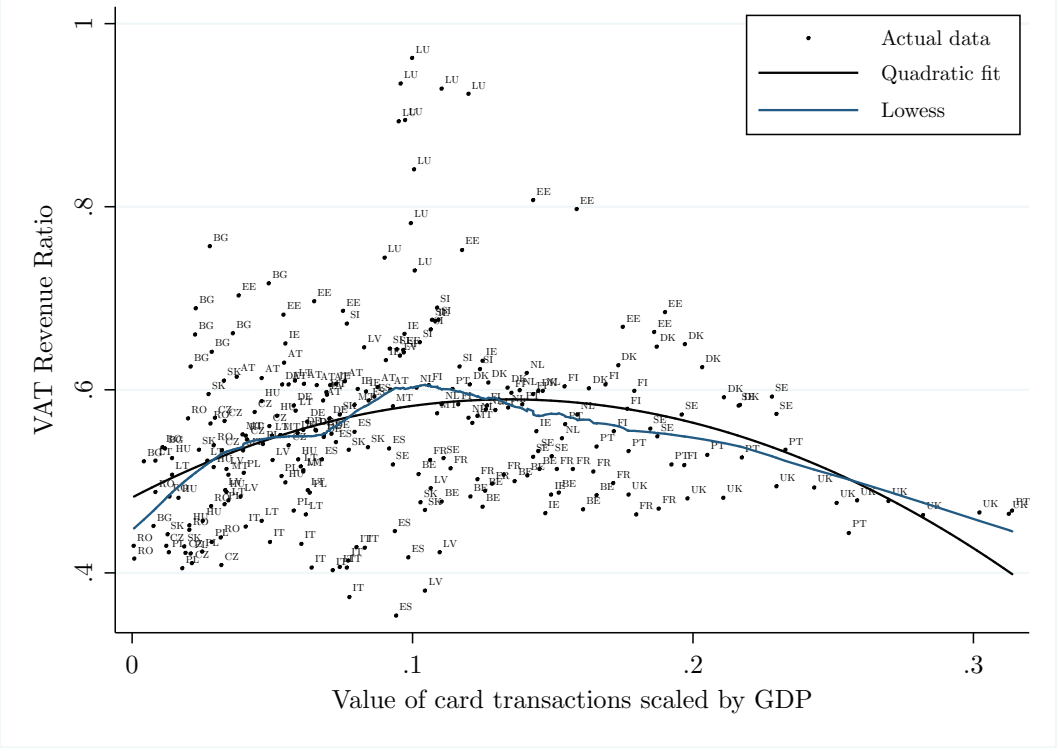



Figure 6: MARGINAL RELATIONSHIP: VRR VS. CARD TRANSACTIONS



percent of GDP, at least in CEE.

Figure 4, which depicts the growth rate of OTC cash withdrawals as a % of GDP, demonstrates that the biggest decline in the use of cash stems from vastly diminishing over-the-counter withdrawals, with Finland and Netherlands having the largest negative rates. Apart from a single substantial positive spike in 2003 driven by Hungarian and Latvian data, the growth rates are negative for both the EU-15 and CEE. If looking only at ATM cash withdrawals in CEE, one can misleadingly conclude that cash usage is growing, while in fact OTC cash is substituted with ATM withdrawals, with overall cash usage likely not trending upward, and strongly declining in the EU-15. Takala and Viren (2012) who construct a measure of cash usage in the Euro area based on both ATM and imputed OTC cash, note that bank branches' withdrawals usually involve higher denomination banknotes and large single amounts, which can be used not only as payments, but also as a store-of-value.[3]

Simple scatter plots of $VRR$ versus $\frac{Cash}{GDP}$ and $\frac{Cards}{GDP}$ depicted in Figures 5 and 6 respectively, suggest that the marginal relationships between the dependent and the main explanatory variables of interest may not be linear. In fact, a quadratic prediction plot fits the non-parametric lowess smoothing well. Nevertheless, other predictors are ignored in these plots, and since typically control variables are correlated, there can be a substantial difference between the marginal and partial effects, which I will explore below.

### 3.1 Empirical specification and results

To find out if the method of payment has any effect on VAT's collection performance, I start out with the following basic specification:

$$\begin{aligned} lnVRRM_{it} &= \alpha_i + \gamma_t + \alpha_1 ln\frac{Cards_{it}}{GDP_{it}} + \alpha_2 ln\frac{Cash_{it}}{GDP_{it}} + \beta_1 ln\frac{GDP_{it}}{POP_{it}} + \beta_2 lnSVAT \\ &+ \beta_3 ln\frac{ATM_{it}}{POPM_{it}} + \beta_4 ln\frac{POS_{it}}{POPM_{it}} + \beta_5 Range + \epsilon_{it}, \end{aligned} \tag{1}$$

where $\ln VRRM_{it} = \frac{\text{VAT Revenue}_{it}}{(\text{Final consumption}_{it} - \text{VAT Revenue}_{it})}$ in country $i$ at time $t$. As pointed out by Ebrill et al. (2001), since $SVAT$ is explicitly controlled for on the right-hand side of the regression, the specification effectively models $VRR$. $\ln\frac{GDP}{POP}$ is the log of GDP per capita, and $Range$ is the difference between the standard VAT rate, $SVAT$, and the reduced rate(s), if any. For countries without a reduced rate, $Range$ is set to zero. For this reason, it is not log transformed. 1 pp increase in $Range$ will lead to a $\beta_4 * 100\%$ change in $VRRM$. $\alpha_i$ are country fixed effects, with no assumption being made about $cov(\alpha_i, x_{it})$ for now, while $\gamma_t$ are year dummies. If the expectation that an audit would uncover any undeclared electronic sales drives firms to report these sales in full, then the effect of card transactions on $VRRM$

[3] Takala and Viren (2012) impute OTC withdrawals by using the value of new and fit banknotes withdrawn by third parties at NCB counters ($a$), and assuming the value of two recycling rates: cash-in-transit ($b$) and credit institutions' ($c$) recycling rates in the following formula: $a(1+b)(1+c)$. $a$ is sourced from the Currency Information System 2, covering only the Euro countries, with only Euro area aggregates being officially available to the public.

should be positive ($\alpha_1 > 0$). Conversely, if cash transactions are associated with greater evasion opportunities, then $\alpha_2 < 0$.

Estimates based on the baseline specification are presented in Table 3. When the relationship between $VRRM$, cash, and cards is assumed to be linear, as is the case in Column (1), neither the coefficient on $\ln\frac{Cards}{GDP}$, nor that on $\ln\frac{Cash}{GDP}$ are statistically significant, implying virtually no impact of the method of payment on VAT's collection efficiency.

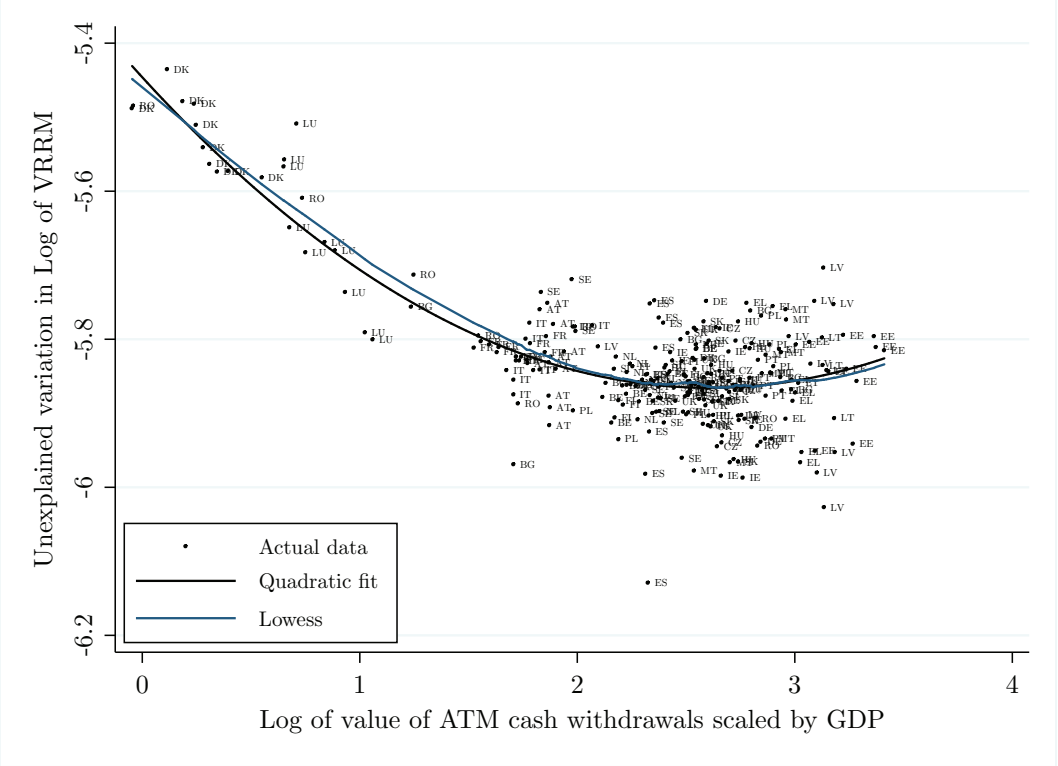
Given the non-linearity suggested by the simple scatterplots in Figures 5 and 6, I check if the relationship between $VRRM$ and $\frac{Cash}{GDP}/\frac{Cards}{GDP}$ is linear once the variables are log-transformed, and additional covariates are added to to the estimation. To do so, eq. (1) is estimated with all shown controls, except $\ln\frac{Cash}{GDP}$. The difference between the actual and predicted values of $\ln VRRM$, which constitutes the unexplained variation in the dependent variable, is then plotted against $\ln\frac{Cash}{GDP}$ in Figure 7. The same procedure is followed to obtain the plot in Figure 8, but this time $\ln\frac{Cards}{GDP}$ is excluded from the regression. The figures present a second-order polynomial fit as well as a non-parametric locally weighted scatter plot smoothing (lowess) with a bandwidth set to .4.

Both graphs indicate distinct non-linearity between the main explanatory variables and $\ln VRRM$, with the quadratic approximation almost matching the non-parametric plot for cash, and fairly closely following the lowess smooth for cards. VAT's collection efficiency decreases with increases in cash use, but for high values of cash withdrawals, the curve bends upwards, showing a convex relationship. Cards, conversely, exhibit a concave relation with $\ln VRRM$, improving collection up to a point, after which their effect turns negative.

When the quadratic terms are added in Column (2) of Table 3, their coefficients are both significant at 5%. I assume that $cov(\alpha_i, x_{it}) \neq 0$, so that the presented estimates are obtained through a fixed effects regression, which centres the variables around their means within each cross-section. $\ln\frac{Cards}{GDP}$ remains insignificant, but cash has a strong negative effect on VAT's collection. 1% rise in GDP per capita is associated with .35% higher $VRRM$. Even though at conventional statistical levels the effect of cards on the dependent variable is nil, the number of point of sale terminals do have a positive impact on VAT's performance, a result, which remains consistent across various specifications. Jumps in the VAT rate lead to a less than proportionate increase in the VAT revenue to consumption ratio. According to Ebrill et al. (2001), who obtain similar estimates for a cross-section of approximately 90 countries, the less than 1 elasticity can be explained with narrower tax bases, although reduced compliance is likely to be a contributing factor as well. Neither the number of ATMs per million of inhabitants, nor *Range* are precisely estimated.

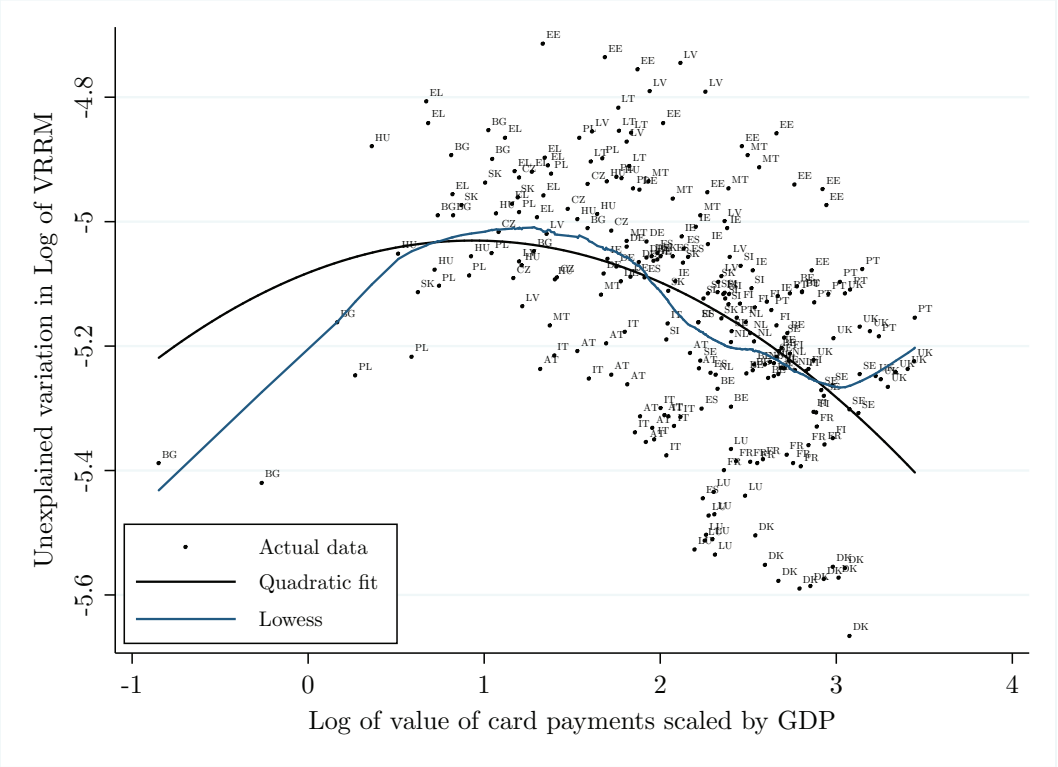
Note that in Column (2) the non-linear relationship is not identified by pure within variation. In fact, as argued by McIntosh and Schlenker (2006), if $y$ is a globally quadratic function of $x$, deviations from group means cannot be used to identify the data generating process, since the marginal effects must depend on the un-centred values of $x$. Identification, therefore, stems from elements of between variation, as $x$ is first squared, and then demeaned. In this way, the group

Figure 7: lnVRRM VS $\ln\frac{\text{CASH}}{\text{GDP}}$




Note: The Y-axis variable is log$VRRM$ net of the estimated effect of $\ln\frac{Cards}{GDP}$, $\ln\frac{GDP}{POP}$, $\ln\frac{ATM}{POPM}$, $\ln\frac{POS}{POPM}$, ln$SVAT$, and $Range$, but excluding $\log\frac{Cash}{GDP}$ and $\left(\ln\frac{Cash}{GDP}\right)^2$. The regression was estimated with clustered standard errors, year and country dummies.

Figure 8: ln$VRRM$ VS $\ln\frac{\text{CARDS}}{\text{GDP}}$




See note under Figure 7. This time $\ln\frac{Cash}{GDP}$ is included, and $\ln\frac{Cards}{GDP}$, $\left(\ln\frac{Cards}{GDP}\right)^2$ excluded.

means are re-introduced into the regression (McIntosh and Schlenker, 2006).[4,5]

The C-efficiency ratio and VAT revenue to GDP, or the Efficiency Ratio, replace VRRM as dependent variables in Columns (3) and (4), respectively. There is virtually no change in the estimated coefficients and their significance when $\ln CeffM$ is used instead of $\ln VRRM$. The Efficiency ratio regression, however, yields substantially lower estimates. Nevertheless, both the main and quadratic terms of cash remain significant at 10%, whereas GDP per capita is found to have no influence on the ratio.

Even though the impact of major macroeconomic shocks should be captured by the year dummies, which are present in all regressions, Column (5) removes 2008-2010 data from the estimation in order to check the extent to which the financial crisis affects the results. Apart from the finding that before the onset of the crisis a 1% increase in the VAT rate is associated with a stronger positive response of the VAT revenue to net consumption ratio, excluding the last three years of the data does not alter the estimates qualitatively or quantitatively.

The next two columns of Table 3 split the sample geographically into two groups: 1) the CEE region, herein the Baltic states, and 2) the EU-15. Besides geographical, the split is also along income lines, with CEE having an average of €8,140 GDP per capita, and the EU-15 – €29,898. Similarly to previous estimations, cards enter with a positive sign for the linear and negative sign for the quadratic term, both imprecisely estimated for the two subsets of countries. The coefficient of $\ln\frac{Cash}{GDP}$ is negative and significant at 10%, but only the quadratic term for CEE is statistically significant, suggesting that the positive effect of cash on VAT's performance is prevalent in countries, where cash continues to be a preferred method of payment. On average, ATM cash withdrawals are 6 pp higher and card payments 7 pp lower in CEE than in the EU-15. Another interesting outcome of the sample split is that *Range* is negative and highly significant for CEE: 1 pp widening of the range between $SVAT$ and the lowest reduced rate would lead to a 1% fall in $VRRM$.

The arguments against reduced VAT rates are many and succinctly summarised by Tait (1988). Perhaps the most compelling justification against rate differentiation is the inevitable increase in traders' compliance costs. There are also considerable administrative costs associated with the management of a complex VAT system, which functions with multiple rates, exemptions, and zero rating. It is further doubtful whether reduced rates achieve what they are aimed at, namely mitigating the impact of VAT's regressivity on low income households. In a cross-

[4]In the fixed effects regression, $x_{it}^2$ is transformed into $x_{it}^2 - \overline{x_i^2}$, which can be rewritten as $(x_{it} - \overline{x_i})^2 + 2(x_{it} - \overline{x_i})\bar{x_i} + (\overline{x_i})^2 - \overline{x_i^2}$.

[5]I additionally performed Random-effects (RE) GLS estimation, which uses both the cross-sectional and time-series variation in the data, and imposes the restriction that $cov(\alpha_i, x_{it}) = 0$. Compared to Column (2), there are two main differences: the coefficient on $\ln\frac{Cards}{GDP}$ doubles and becomes statistically significant at 10% (.041 with s.e. .023), while the effect of GDP per capita is close to zero. A simple Hausman test for fixed effects would be inappropriate in this context, since it can only be performed with unclustered standard errors and assumes that $\alpha_i$ and $\epsilon_{it}$ are i.i.d., which is unlikely to hold. Indeed, standard errors are substantially underestimated when observations are not clustered by country as a consequence of considering each observation to be an independent piece of new information (Cameron and Trivedi, 2009). I use, instead Schaffer and Stillman (2010) *xtoverid* test, which treats RE's orthogonality condition $E(x_{it} * \alpha_i) = 0$ as an overidentifying restriction and allows for clustered errors. The very large Sargan-Hansen statistic of 257.6 with p-value of zero strongly rejects the null hypothesis that RE is consistent. Thus, all subsequent regressions employ the within estimator.

Table 3: DETERMINANTS OF VAT COLLECTION EFFICIENCY

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | | 2000-2007 | EU-15 | CEE | Cross-section |
| DPV | ln$VRRM$ | ln$VRRM$ | ln$CeffM$ | ln$EffR$ | ln$VRRM$ | ln$VRRM$ | ln$VRRM$ | ln$VRRM$ |
| $\ln(\frac{Cards}{GDP})$ | -.016 | .021 | .020 | .029 | .028 | .069 | .004 | .244* |
| | (.035) | (.026) | (.023) | (.024) | (.022) | (.160) | (.025) | (.122) |
| $\ln(\frac{Cards}{GDP})^2$ | | -.024** | -.022** | -.008 | -.014 | -.029 | -.016 | -.045 |
| | | (.011) | (.010) | (.006) | (.010) | (.031) | (.012) | (.033) |
| $\ln(\frac{Cash}{GDP})$ | -.029 | -.326** | -.293** | -.129* | -.266** | -.367* | -.228* | -.235 |
| | (.062) | (.122) | (.109) | (.067) | (.115) | (.181) | (.111) | (.313) |
| $\ln(\frac{Cash}{GDP})^2$ | | .062** | .066*** | .028* | .067*** | .070 | .065*** | .059 |
| | | (.025) | (.025) | (.016) | (.022) | (.044) | (.020) | (.082) |
| $\ln(\frac{GDP}{POP})$ | .308** | .350** | .315** | .067 | .348*** | 1.12*** | .336** | .072 |
| | (.120) | (.130) | (.117) | (.095) | (.116) | (.236) | (.149) | (.082) |
| $\ln(\frac{ATM}{POPM})$ | .071 | .036 | .031 | .003 | .022 | .057 | -.027 | -.054 |
| | (.057) | (.055) | (.050) | (.053) | (.038) | (.067) | (.111) | (.068) |
| $\ln(\frac{POS}{POPM})$ | .045 | .066** | .060** | .044 | .057* | .012 | .109* | -.090 |
| | (.034) | (.032) | (.029) | (.028) | (.029) | (.040) | (.057) | (.062) |
| ln$SVAT$ | .460** | .517*** | .471*** | .425** | .653*** | .618*** | .443* | .654** |
| | (.181) | (.185) | (.168) | (.162) | (.117) | (.159) | (.202) | (.295) |
| *Range* | -.003 | -.005 | -.005 | -.003 | -.004 | .006 | -.010*** | -.010 |
| | (.004) | (.003) | (.003) | (.003) | (.003) | (.004) | (.003) | (.011) |
| Observations | 267 | 267 | 267 | 267 | 189 | 159 | 108 | 26 |
| Countries | 26 | 26 | 26 | 26 | 26 | 15 | 11 | |

Note: The sample in each regression pertains to 2000-2010, except in Column (6), in which 2008-2010 are excluded. The dependent variables are the logs of $VRRM$=$\frac{\text{VAT Revenue}}{\text{Finacl Consumption-VAT Revenue}}$; CeffM=$\frac{\text{VAT Revenue}}{\text{Final Consumption}}$ or EffR=$\frac{\text{VAT Revenue}}{\text{GDP}}$. All specifications include country and year fixed effects; in Column (3) results are based on GLS estimation with random effects. Standard errors are always clustered at the country level. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) level.

sectional analysis, Bogetić and Hassan (1993) estimate a negative relationship between *Range* and the Efficiency Ratio. Likewise, Agha and Haughton (1996) demonstrate that the higher the number of VAT rates, the lower the VAT compliance. Even though *Range* is found to be statistically significant only for the CEE countries, once exposure to foreign trade is taken into account, the variable becomes significant for the whole sample, as shown in Table 4.

Finally, Column (8) presents results from a cross-sectional regression, where the data has been collapsed to country means. With only 26 data points, standard errors increase substantially with most of the coefficients becoming statistically insignificant. In particular, a measure of cash calculated as an average over the 2000-2010 period is generally not significant in explaining VAT's performance, even though the estimates are virtually unchanged from the fixed effects coefficients. Interestingly, however, the linear term of cards turns barely significant at 10%, a result, which is in line with the outcome of the Random Effects regression (see footnote 4), that utilises both the time-series and cross-sectional variation in the data.

Next, Table 4 checks if the coefficients on cash and cards and their significance are sensitive to the incorporation of additional explanatory variables. The first departure from the benchmark specification is the inclusion of openness (*Open*), measured as exports and imports divided by GDP. Invariably, studies modelling VAT revenue as a function of trade openness find a positive association (Ebrill et al., 2001; Aizenman and Jinjarak, 2008). The intuition is that, all in all, more trade enhances VAT collection on imports, despite the existence of various fraudulent mechanisms exploiting the zero rating of exports at the border. In Table 4 *Open* enters with a positive sign and is aways significant at 5%. The estimated elasticity of VRRM to the level of trade is .24 in most regressions. Both the linear and quadratic terms of cash remain statistically significant and similar in magnitude to the estimates in Table 3. The quadratic term of cards is barely significant at 10%. As mentioned above, due to smaller estimated standard error, there is some indication that *Range* is negatively correlated with $VRRM$.

Column (2) adds the rate of unemployment as an explanatory variable that not only denotes the general state of the economy, but also directly affects private consumption. Not surprisingly, the coefficient of ln$Unempl$ shows that VAT's performance deteriorates as the number of unemployed rises. As long as unemployment is explicitly controlled for, GDP per capita turns insignificant. Perceptions of corruption, which can influence the willingness to pay tax, also enter with a negative sign in Column (3), albeit imprecisely estimated. Previous research has shown a positive connection between the level of urbanisation and VAT revenue, but Column (3) does not corroborate this finding (Aizenman and Jinjarak, 2008; de Mello, 2008).

By exempting the smallest traders from VAT registration, the VAT turnover threshold could potentially reduce revenue, even though, given the high number of small traders, savings in administrative costs could outweigh foregone revenue. Including the threshold as a percent of GDP per capita in Column (4) shows, at a 5% level of significance, that if $TreshGDP$ grows by 1 pp, $VRRM$ falls by 0.9%. Neither of the additional explanatory variables in Columns (2)-(4) alters the effect of cash on VRRM. Cards also remain insignificant.

One possible explanation for cards' lack of influence on $VRRM$ is that, unlike Turkey, and

more recently the US, where a clear signal is sent to firms that electronic sales are monitored, in Europe card transactions may not serve as a sufficiency powerful deterrent to evasion. In particular, it is unclear to what degree EU tax administrations match firms' card transactions to reported sales as a preventive mechanism before suspicions of non-compliance arise (before the fact) as opposed to a pursuant mechanism, once suspicion is already established and an audit is instigated as a consequence (after the fact).

Even if a specific tax policy utilising firms' card transactions for enforcement purposes is not in place, I test whether in general tax administrations that make extensive use of third-party reporting are more effective in VAT revenue collection. To do so, I introduce a dummy variable $Prefill$, which equals one for countries that use pre-populated personal income tax returns; this dummy is also interacted with $\frac{Cards}{GDP}$. A high level of pre-filled returns indicates that most salaries are paid electronically, which is also conducive to a greater use of cashless transactions, provided that an adequate payment infrastructure exists. In Column (5), the coefficient of $Prefill$ is identified from countries (Estonia, France, Netherlands, Portugal, Belgium, and Slovenia) that switched fully or partially between taxpayer submitted returns to pre-populated returns in the period 2000-2010. Use of third-party reporting for personal income taxation was pioneered by Denmark in 1988, followed by Sweden and Finland in 1995 (OECD, 2008). In view of the results in Column (5), however, I cannot find evidence that third-party reporting for individuals, or card transactions given third-party reporting have any effect on VAT revenue proportionate to consumption.

Last but not least, Column (6) explores the possibility of the endogeneity of the VAT rate. On the one hand, higher $SVAT$ can translate into higher collected revenues. On the other hand, if revenue realisations do not meet a government target, $SVAT$ can be adjusted accordingly.[6]

Among various sets of instruments, the following three variables met the relevance and validity criteria best: the natural logs of corporate income tax rate and government expenditure, and, due to numerous negative values, the non-transformed government deficit. At least before the financial crisis, hikes in the VAT rate were generally compensated with cuts in the CIT rate and/or PIT deductions. Since raising $SVAT$ is a quick way to generate more revenue, I expect that fluctuations in government's deficit and expenditure would closely correspond to the dynamics of the VAT rate. The results of a fixed-effects instrumental variable regression with clustered errors are reported in Column (6). The first-stage F-statistic testing for the joint significance of the excluded instruments is 6.10 with a P-value of 0.0031, indicating that the instruments are relevant. Further, given a Hansen-J statistic of 1.417 ($\chi^2(2)$ P-value=0.4923), I cannot reject the null hypothesis that the full set of orthogonality conditions are valid.

Overall, instrumenting for the VAT rate produces higher coefficients in absolute value, especially when it comes to $SVAT$, which increases four times. Both GDP per capita and the unemployment rate are significant in Column (6) as opposed to previous regressions, in which

[6]To detect the presence of reverse causality – revenue driving the rate rather than vice versa, one can replace the dependent variable with the VAT rate, keeping VAT revenue on the right-hand side. In such a regression, it turns out that $VRRM$ does have a statistically significant effect on $SVAT$, which poses the question of whether the results for cash and cards will change if $SVAT$ is instrumented for.

Table 4: DETERMINANTS OF THE VAT COLLECTION EFFICIENCY: ROBUSTNESS CHECKS

| | (1) | (2) | (3) | (4) | (5) | (6) IV |
|---|---|---|---|---|---|---|
| $\ln\left(\frac{Cards}{GDP}\right)$ | .012 | .019 | .007 | .017 | .022 | .046 |
| | (.026) | (.026) | (.023) | (.019) | (.027) | (.051) |
| $\ln\left(\frac{Cards}{GDP}\right)^2$ | -.020* | -.020 | -.020* | -.014 | -.023 | -.040** |
| | (.011) | (.012) | (.010) | (.009) | (.013) | (.015) |
| $\ln\left(\frac{Cash}{GDP}\right)$ | -.275** | -.293* | -.282** | -.291** | -.330** | -.446** |
| | (.117) | (.144) | (.130) | (.109) | (.149) | (.222) |
| $\ln\left(\frac{Cash}{GDP}\right)^2$ | .051** | .054* | .047* | .041** | .062** | .097** |
| | (.022) | (.026) | (.023) | (.019) | (.026) | (.048) |
| $\ln\left(\frac{GDP}{POP}\right)$ | .362*** | .130 | .179 | .050 | .151 | .635*** |
| | (.116) | (.152) | (.174) | (.176) | (.147) | (.234) |
| $\ln\left(\frac{ATM}{POPM}\right)$ | .045 | .051 | .074 | .119*** | .062 | -.017 |
| | (.049) | (.050) | (.043) | (.033) | (.054) | (.093) |
| $\ln\left(\frac{POS}{POPM}\right)$ | .070** | .077** | .076** | .065** | .072** | .077* |
| | (.029) | (.029) | (.032) | (.029) | (.029) | (.044) |
| $\ln SVAT$ | .594*** | .619*** | .526*** | .540*** | .621*** | 2.63*** |
| | (.167) | (.138) | (.131) | (.102) | (.137) | (.513) |
| $Range$ | -.006* | -.006* | -.006* | -.009** | -.006* | -.024*** |
| | (.003) | (.003) | (.003) | (.003) | (.003) | (.006) |
| $\ln Open$ | .242** | .237** | .242** | .226** | .244** | .336* |
| | (.097) | (.096) | (.098) | (.100) | (.097) | (.174) |
| $\ln Unempl$ | | -.094** | -.082* | -.095** | -.092** | -.121* |
| | | (.042) | (.042) | (.040) | (.040) | (.066) |
| $\ln Corrupt$ | | | -.025 | -.061 | | |
| | | | (.092) | (.099) | | |
| $\ln Urban$ | | | -.217 | -.923 | | |
| | | | (.681) | (.633) | | |
| $ThreshGDP$ | | | | -.009** | | |
| | | | | (.004) | | |
| $Prefill$ | | | | | -.103 | |
| | | | | | (.132) | |
| $\ln\left(\frac{Cards}{GDP}\right) * Prefill$ | | | | | .046 | |
| | | | | | (.050) | |
| F-stat. of excl. instruments | | | | | | 6.10 |
| P-Value | | | | | | .0031 |
| Hansen-J | | | | | | 1.417 |
| P-Value | | | | | | .4923 |
| Observations | 267 | 266 | 264 | 233 | 266 | 265 |

Note: The sample in each regression pertains to 2000-2010. The dependent variable is the log of $VRRM = \frac{\text{VAT Revenue}}{\text{Final Consumption-VAT Revenue}}$. All specifications include country and year fixed effects. In Column (6) $\ln SVAT$ is instrumented with $Deficit$, $\ln CIT$ and $\ln GovExp$; estimation is performed with xtivreg2 (Schaffer, 2010). In all specifications, standard errors are clustered at the country level. Asterisks denote significance at the 1% (***), 5% (**), and 10% (*) levels.

only unemployment mattered. The linear and quadratic terms of cash almost double and remain significant at 5%. A similar increase is observed for cards, but the linear effect does not change its statistical significance.[7]

# 4 Conclusion

The exceptional amount of firm-related information tax administrations nowadays could or already have access to leads to the gradual implementation of policies whose aim is to prevent rather than pursue tax evasion. If these policies require traders to transition from cash to electronic payment systems, compliance costs are unavoidable. It is therefore important to study such practices and their expected effect on enforcement.

In itself card payments' traceability could improve compliance by increasing the perceived probability of detection, even if no explicit policy using electronic transactions data as a preventive mechanism is in force. It is this particular aspect of cards that this paper focused on. Given the data, the visibility of electronic payments does not appear to influence VAT's collection efficacy in a significant manner. It is possible that a more proactive tax policy following the example of the US and Turkey can induce a considerable impact on compliance. Alternatively, it is equally possible that the outcome could be limited if those firms that are bent on evading, are inventive enough to find the means to do so. The picture is more clear-cut with respect to cash, whose negative effect on VAT's performance is unambiguous, at least in the countries where card payments are well-established.

[7] Another robustness check was performed with a different measure for cash, namely net currency in circulation, taken from ECB's data warehouse and defined as the number of banknotes/coins in circulation, where for banknotes, circulation equals created notes minus destroyed notes less stock of the National Central Bank (NCB). This measure is readily available for the EU members, which are not part of the monetary union, and is not reported by the ECB for the Euro area countries. Currency in circulation for the Euro zone states was obtained from the individual countries' NCB websites, and in the case of Germany, Spain and Portugal, it was estimated. The derivation is performed by assuming that the notes put in circulation are proportional to the countries' subscription key to the ECB's share capital minus the 8% ECB's share of total euro banknotes issued. An analogous analysis to the one performed in Figures 7 and 8 showed that a quadratic term for net currency in circulation is not justified and that the relationship between $\ln VRRM$ and currency in circulation is negative. Replacing ATM cash withdrawals with net currency in circulation in eq. (1) yields a negative estimated coefficient of -.045, which however is not statistically significant (standard error is .034).

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# Appendix

CHANGES AFFECTING THE TAX BASE

| | 2000 | 2009 |
|---|---|---|
| AT | No zero rate; Lower rate 10%. Standard rate 20%. General registration threshold (GRT) €22,000. Aggregate administrative costs for tax functions as % of GDP (AAC): 0.22%. Number of VAT registered traders, millions (NVT): 0.69. | Lower rate [added]: water supply; refuse (waste) collection; sewage; dwelling; passenger transport; hotel accommodation; restaurant services (except drinks); medicine. GRT: €30,000. AAC: 0.19%. NVT: 0.82 No change in rates and exemptions. |
| BE | Zero rate; Lower rates 6%, 12%. Standard rate 21%. GRT: €5,580. AAC: -. NVT: -. | Lower rate [added]: some labour intensive services (small repair services) [2003]; construction work leading to the construction of new private housing and the sale of new private housing (subject to conditions, limitations and of temporary character)[2009 to 2010]. GRT: €5,580. AAC: 0.35%. NVT: 0.7. No change in rates and exemptions. |
| CZ | No zero rate; Lower rate 5%. Standard rate 22%. GRT: €85,567. AAC: -. NVT: -. | Zero rate on international passenger transport; Lower rate 9%. Standard rate 19%. Scope of lower rate reduced from covering most services in 2000 to: supply of water; disposal or waste water; accommodation; construction of private dwellings and social houses; healthcare and domestic care services; cleaning in households; funeral; sport activities. Exemptions [removed]: supplies of enterprises. GRT: €39,904. AAC: 0.20%. NVT: 0.53. |
| DE | No zero rate; Lower rate 7%. Standard rate 16%. GRT: €16,620. AAC: -. NVT: 4.87. | Standard rate 19%. Lower rate [added]: plants; flowers; devices for the disabled; museums; zoos; circuses; authors' rights [2003]. GRT: €17,500. AAC: 0.29%. NVT: 5.70. |
| DK | Zero rate; No lower rate. Standard rate 25%. GRT: €2,680. AAC: -. NVT: 0.39 | First time sale of artistic work valued over DKK300,000 taxed at 5%. Exemptions [added]: sale of products of artistic work valued under DKK300,000; [removed]: supply of all land and buildings. GRT: €6,711. AAC: 0.3%. NVT: 0.43. |
| EL | No zero rate; Lower rate 8%. Standard rate 18%. GRT: €6,070. NVT: 1.45. | Lower rate 9%. Standard rate 19%. Exemptions [added]: legal and artists' services; authors' rights; public radio and TV; supply of water by public bodies [2003]; supply of new buildings [2005]; welfare and social security works; supply of goods used exclusively in an exempt activity, services included in the taxable value of imported goods; postage and other similar stamps [2009]. [removed] supply of new buildings [2007]. Lower rate [added]: books [2003]; cultural and sporting events; collection and treatment of waste; some labour intensive services [2005]; gas; live animals; seeds; fertilisers; pharmaceutical products; charitable work; plants and flowers [2009]. GRT: €10,000. NVT: 1.10. |
| ES | No zero rate; Lower rate 7%. Standard rate 16%. GRT: None. AAC: -. NVT: 3.3. | No change in rates, exemptions, and lower rate coverage. GRT: None. AAC: 0.13%. NVT: 2.8. |

CHANGES AFFECTING THE TAX BASE Contd.

| | 2000 | 2009 |
|---|---|---|
| FI | Zero rate; Lower rates 8%, 17%. Standard rate 22%. GRT: €8,500. AAC: 0.21%. NVT: 0.5. | Zero rate [removed]: international transport [2003]. Lower rate [added]: works of art supplied by their creators or imported [2003]. Exemptions [removed]: products of visual art sold by the artist [2003]. No change in rates. GRT: €8,500. AAC: 0.22%. NVT: 0.58. |
| FR | No zero rate; Lower rates 5.5% Standard rate 19.6%. GRT: €76,300. AAC: 0.39%. NVT: -. | Lower rate [added]: most foods and drinks [2007]; gas; electricity; pharmaceutical products; farm products, gardens, plants and flowers; refuse collection; sewage [2009]; [removed]: museums. Exemptions [added]: construction, work on monuments; cemeteries and graves of war victims; commodity futures transactions, services rendered by resource consortia to their members that are VAT exempt [2003]. No change in rates. GRT: €80,000. AAC: 0.23%. NVT: 4.20. |
| HU | Zero rate; Lower rate 12%. Standard rate 25%. GRT: $7,544. AAC: 0.57%. NVT: 0.55. | No zero rate; Lower rates 5%, 18%. Lower rate [removed]: food, electricity, live animals, water, pharmaceutical products, transportation, veterinary, movie, art, library and bath services, etc. [added] musical notes. Exemptions [removed]: mass sports events; services rendered by intermediaries; lending of buildings for education, sport, or cultural purposes; transfer of creditors and ownership rights, compulsory social security insurance, public administration. GRT: €17,921. AAC: 0.39%. NVT: 0.52. |
| IE | Zero rate; Lower rate 12.5%. Standard rate 21%. GRT: €51,000/$26,050. AAC: 0.26%. NVT: 0.22. | Lower rate 13.5%. Zero rate [added]: certain aircraft and sea-going vessels [2005]; Lower rate [added]: gas; recreational and sports services; certain nursery and garden centre stock [2009]. Exemptions: [added] child care [2003] and [removed] [2005]. GRT: €75,000. AAC: 0.28%. NVT: 0.28. |
| IT | Zero rate (scrap iron); Lower rate 10%. Standard rate 20%. GRT: €2,400. AAC: - . NVT: -. | No zero rate; Lower rate [added]: accommodation let by building enterprises [2003]; Exemptions [added] taxi; [removed] municipal passenger transport [2009]. GRT: €30,000. AAC: 0.20%. NVT: 5.26. |
| LU | No zero rate; Lower rates 5%, 12%. Standard rate 15%. GRT: €10,000. AAC: -. NVT: 0.076. | Lower rate [added]: accommodation; cultural, sporting events; certain labour intensive services; children's' clothing; electricity; construction of dwellings; gas, passenger transport, pharmaceutical products etc. Rates and exemptions unchanged. GRT: €10,000. AAC: 0.24%. NVT: 0.06. |
| NL | No zero rate; Lower rates 6%. Standard rate 17.5%. GRT: €1,345. AAC: 0.69%. NVT: 1. | Standard rate 19%. Lower rate [added]: cut flowers and plants; hotel and holiday accommodation; lending of books [2005]; cleaning of dwellings and hairdressing [2009]; [removed] lending of books [2009]. Exemptions unchanged. GRT: €1,345. AAC: 0.36%. NVT: 1.45. |

CHANGES AFFECTING THE TAX BASE Contd.

| | 2000 | 2009 |
|---|---|---|
| PL | Zero rate; Lower rate 7%. Standard rate 22%. Exemptions: agriculture, taxi, R&D, cremation and cemetery, and attorney services; funeral. GRT: €20,833. AAC: 0.18%. NVT: 1.3. | Zero rate [removed]: new dwelling immovable property; agricultural means of production. Lower rate [added]: basic agricultural means of production; restaurant, cemetery, certain construction, and reception of broadcasting services; certain foodstuffs and beverages; passenger transport, etc. All goods/services subject to lower rate in 2000 removed. Exemptions: students' accommodation; public radio and TV. GRT: €24.390. AAC: 0.36%. NVT: 2.14. |
| PT | Zero rate; Lower rates 5%, 12%. Standard rate 17%. GRT: €10,000. AAC: 0.36%. NVT: -. | Standard rate 20%. Lower rate [added]: devices for the disabled, medical services, natural gas, hotels, social housing; some goods used in agriculture; restaurant services; tools, machines or other equipment used for collecting and using alternative energy sources, etc. GRT: €12,000. AAC: 0.23%. NVT: 1.50. |
| SE | Zero rate; Lower rates 6%, 12%. Standard rate 25%. GRT: None. AAC: 0.27%. NVT: 0.84. | Standard rate 15%. Lower rate [added]: books; newspapers; magazines; zoos [2003]. Exemptions [added]: creative artists; investment gold [2007]; [removed]: certain memberships, publications [2003], authors' rights [2005], investment gold [2009]. Rates unchanged. GRT: None. AAC: 0.18%. NVT: 1. |
| UK | Zero rate; Lower rate 5%. Standard rate 17.5%. GRT: €82,258. AAC: 0.33%. NVT: 1.73. | Standard rate 15%. Lower rate [added]: certain grant-funded installations of heating equipment; children car seats; certain pharmaceutical products. Exemptions [added]: works of art. GRT: €80,000. AAC: 0.28%. NVT: 1.9. |

Sources: OECD (Various Years), OECD (2004, 2009), Eurostat. Used abbreviations: AAC Aggregate administrative costs for tax functions as % of GDP; GRT General registration threshold; NVT Number of VAT registered traders (millions). In the 2000 column, the value of NVT is for 2003, as this data is not available for previous years. 2000 is the benchmark year. For coverage of lower rates and exemptions in 2000, refer to the 2001 edition of OECD (Various Years). The 2009 column lists only the low rate goods and services/ exemptions, which have been added/removed as compared to 2000.