Electronic Payment Technology and Tax Compliance:

Evidence from Uruguay's Financial Inclusion Reform

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Abstract

The idea that the digitization of transactions in an economy might increase tax compliance has been prominent in the academic literature and in policy debates. This paper studies the effect of financial incentives on the adoption of electronic payment technology by firms and consumers and on tax compliance by firms. Exploiting administrative tax and transaction records and quasi-experimental policy variation from Uruguay, we present three findings. Consumer VAT rebates for credit/debit card transactions trigger an immediate 50% increase in the number of card transactions. Firms' use of POS terminals, however, increases only on the intensive margin but not on the extensive margin. Tax compliance is unaffected. Endogenous POS adoption and the fact that electronic sales constitute less than 30% of total reported sales among firms with a POS can rationalize the findings.

JEL classification: H26, H32, G18, O16.

Keywords: Credit/debit card payment, tax compliance, value-added tax, financial inclusion.

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1 Introduction

The idea that electronic transactions limit tax evasion has been a core argument made by the proponents of digitization, from Ken Rogoff's beststelling book "The Curse of Cash" to the World Bank's campaign for Financial Inclusion and India's demonetization initiative. Unlike cash transactions, electronic transactions are processed by a third-party, distinct from the two transacting partners, creating a paper trail which governments can access for tax compliance purposes. The existence of such a third-party paper trail, combined with a tax audit function which leverages the information, can deter firms from under-reporting taxable transactions (Kleven et al. 2011, Pomeranz 2015, Naritomi 2019). This would increase reported taxable sales and hence tax liabilities. Following this logic, governments in numerous countries have attempted to accelerate the pace of digitization through fiscal incentives, including VAT rebates, lotteries and income tax deductions for transactions conducted with electronic payment methods.[1]

Yet, whether such policies have the intended effect on tax compliance depends on endogenous technology adoption decisions by firms and consumers and on the share of transactions ultimately covered by electronic records. If only firms which are already tax compliant respond to the incentives, or if electronic records cover a smaller share of transactions than the share which firms already report for tax purposes, an increase in electronic transactions might not affect tax compliance.

We study the effect of VAT rebates on the adoption of electronic payment technology and on tax compliance, exploiting quasi-experimental policy variation in Uruguay. The rebate program was introduced in August 2014, at a time when Uruguay lagged behind peer countries in key financial inclusion measures, such as the use of bank accounts and of credit and debit cards (Figure 1). There was thus significant scope to increase the use of electronic payment technology, and the reform program provided large and salient incentives: the rebates reduced the VAT payable on debit card transactions by up to 40%. The rebates were immediately granted to customers paying by card (instead of in cash), without the need for refunds claims or other hassle costs or delays. We evaluate this program using transaction-level data on all electronic transactions and monthly firm-level VAT declarations for 2006-2015.

Leveraging various quasi-experimental strategies, we document three main results. First, we use the high frequency of our data and a regressions discontinuity design in time to show that the introduction of the rebates lead to an immediate 50% increase in the number of debit

[1] Table A.2 provides a non-exhaustive list of countries employing incentive schemes similar to those we study in this paper.

and credit card transactions, and a 30% increase in the volume of card transactions. Consumers are thus extremely responsive to the incentives. Firms, on the other hand, are less responsive. The number of point-of-sales (POS) terminals in use increases by only 10% in early August 2014, and this effect is entirely driven by firms which already used a POS prior to the reform. The number of firms with at least one POS does not increase discontinuously with the reform, and there is no acceleration in the POS adoption trend after the reform. We also study the consumer response to a second reform in August 2015, which lowered the size of the VAT rebates. We find that the number and volume of card transactions does not decline, suggesting that temporary incentives can generate a lasting increase in consumer use of electronic payment technology.

Second, we examine the impact of the rebate-triggered increase in card transactions on tax compliance, leveraging a difference-in-difference estimation that compares treated retail sector firms to wholesale sector firms. This is motivated by the fact that retailers are ex-ante less tax compliant than wholesalers, as the VAT self-enforcement mechanisms typically breaks down at the point of sale to the final consumer (Naritomi 2019). Besides, only retailers are directly treated by the reform, as the VAT rebates do not apply to firm-to-firm transactions. We find that retail and wholesale sector firms exhibit parallel trends in reported sales and other outcomes prior to the introduction of the VAT rebates, and no divergence thereafter. The difference-in-difference treatment effect is close to zero and precisely estimated. Consistent with this, the treatment effect on reported output VAT and net VAT liability is also very small and statistically indistinguishable from zero.

Finally, we discuss how to reconcile the large consumer response to the VAT rebates with the null-effect on tax compliance. One explanation for the results is that firms self-select into using POS, weighing costs and benefits. The costs include variable and fixed costs for POS usage and a potential increase in required tax payments, while the benefits are attraction or retention of customers and the speeding up of transactions. Our results suggest that the strong increase in consumer demand for card payments after the VAT rebate introduction was not sufficient to increase POS adoption by firms on the extensive margin. This is consistent with the fact that firms experience a sharp increase in their tax liability after adopting a POS, as we show in monthly event studies. It is also consistent with firms' response to the introduction of a subsidy for POS rental fees in September 2012. Take-up of the subsidy expanded very gradually. Only 6.5% of eligible retail firms took up the subsidy, and 87.7% of these firms started using a POS many months before requesting the subsidy. Our results suggest that accelerating firms' adoption of POS would require much larger financial incentives or a mandate obliging firms to

offer card payment facilities.

The second explanation for our results is the fact that, even among firms with a POS, card sales constitute less than 30% of total reported sales. This means that firms already report a large share of their cash sales. Even if the possibility of cross-checks between the card sales and firms' self-reported sales, combined with audits on misreporters, puts a lower bound on what firms report to for tax purposes, the relatively high compliance level means that firms have room to increase card sales without increasing their total reported sales.

This study relates to three connected sets of literature [NB: the literature review still to be updated]. First, the literature on taxation and development has emphasized third-party reported paper trails as a key tool to enhance compliance. The influential contribution by Kleven et al. (2011) proposes this mechanism theoretically and evaluates it empirically in Denmark. More generally, Kleven et al. (2016) and Jensen (2019) argue that the expansion of third-party information trails is a core driver of increases in tax capacity as countries develop. Pomeranz (2015) and Naritomi (2019) show that third-party reporting improves tax compliance in Chile and Brazil respectively. Naritomi (2019) studies monetary incentives for consumers to request receipts from retailers, and is thus most closely related to our study, with the difference that the incentives in Brazil cover both cash and non-cash transactions.[2] More recent studies in this literature include Mittal and Mahajan (2017), who show that third-party reporting in New Delhi increased compliance by the top 1% of firms, and Fan et al. (2018), who show that the digitization of VAT annexes in China lead to increases in VAT payment, with larger effects observed in the short run (driven by improved tax compliance) than in the long run (when output has decreased and total factor productivity adjusted), and Bellon et al. (2019) who estimate the effect of e-invoicing on VAT compliance in Peru. All of these studies evaluate the effect of third-party information that is collected by tax authorities with the specific purpose of increasing tax compliance. We show that third-party information generated as a byproduct of accelerated financial inclusion does not lead to increases in tax compliance on the intensive margin, as the information trails cover only a small fraction of the transactions, among taxpayers which are already relatively tax compliant.[3]

Second, our studies relates to the literature documenting wide-ranging benefits from fi-

[2] Carrillo et al. (2017) and Slemrod et al. (2017) show that third-party reporting is not a panacea, since firms might offset increased third-party reporting (and hence tax compliance) on the sales margin by increasing reported costs. Such offsetting behavior is not a concern for our study, as we do not even detect an increase in reported sales.

[3] On the expenditure side of public finance, our study relates to a small but growing literature that shows how technology can improve the targeting of public spending and prevent leakages (Muralidharan et al. 2016, Banerjee et al. 2020, Barnwal 2018), and help monitor government employees (Duflo et al. 2012).

nancial inclusion for firms and consumers. Financial inclusion is shown to decrease financial transaction costs (Schaner 2016, Bachas et al. 2018), increase investment (Dupas and Robinson 2013, Brune et al. 2016, Prina 2015), increase resilience to shocks (Jack and Suri 2014, Blumenstock et al. 2016) and reduce poverty (Burgess and Pande 2005). Overall, financial inclusion can spur inclusive growth (Demirguc-Kunt et al. 2017, Klapper and Singer 2014). Given these diverse benefits, it is not inconceivable that financial inclusion also impacts state capacity more broadly. Yet, our findings suggest that only extensive margin adoption of financial technology by firms would help improve state tax capacity. Intensive margin increases in financial inclusion through consumer transactions do not affect tax compliance. It is of course possible that intensive margin increases in card transactions affect state capacity through other channels, for instance by provided a better information set for policy design.

Finally, we contribute to the finance literature. Leveraging variation in financial incentives provided by payment card companies to consumers, this literature has shown that consumers are highly responsive to incentives (Klee 2008, Bolt et al. 2010, Loke 2007, Agarwal et al. 2007). We confirm this finding in a different context and leveraging variation in a different type of incentives, provided by the government rather than by the private sector. The finance literature also highlights that the decision of adopting electronic payment technology is more complex for firms, involving trade-offs between costs (fixed costs, variable costs and tax costs) and benefits, in terms of retaining and attracting consumers (Dalton et al. 2018, Arango and Taylor 2008b, Arango and Taylor 2008a, Beck et al. 2018). Our results of firms' unresponsiveness to incentives is consistent with this. However, our results differ from a recent study by Higgins (2018), who studies financial technology adoption in Mexico, showing that a quasi-experimental increase in the number of consumers with debit cards leads retailers to adopt POS technology. It is likely that contextual differences explain the different results. While card processing firms in Uruguay report all electronic transactions to the government, that is not the case in Mexico, where the government can access this financial information only in case of a full-fledged audit.

The paper is organized as follows. Sections 2 and 3 lay out some conceptual considerations and present the policy background and the data we use. Sections 4 and 5 examine the impact of VAT rebates on the use of electronic payment technology and on tax compliance. Section 6 discusses the interpretation of the results and Section 7 concludes.

2 Conceptual Considerations

To guide our empirical analysis, we briefly discuss how the expansion of card transactions may affect tax compliance. Consider that firms have true sales $S = C + E$, where C are cash sales and E are electronic sales, i.e. sales paid for by electronic payment methods. Reported sales R may be smaller than true sales, $R \leq S$. That is, firms may misreport their true sales to minimize their tax liability. However, it is reasonable to assume that firms have to report at least $R_{min} = E$, given that electronic sales are reported to the tax authority by credit/debit card companies and are routinely used to cross-check firms' tax declarations. Reporting $R < E$ would thus trigger a discontinuously higher audit probability, as discussed in Carrillo et al. 2017.[4]

Define R_0 as the level of reported sales prior to the introduction of VAT rebates and R_1 as the level of reported sales after the introduction of VAT rebates. Define E_0 and E_1 analogously, so that ΔE is the increase in electronic sales triggered by the VAT rebates. For simplicity, we assume $\Delta E = -\Delta C$, so the VAT rebates lead consumers to switch from paying in cash to paying by card, but do not affect overall consumption. We are interested in whether $R_1 > R_0$. Given the above-mentioned audit rule, firms have to report $R_1 \geq E_0 + \Delta E$ after the introduction of VAT rebates. So firms' reporting behavior will change if $R_o < E_0 + \Delta E$, that is, if the consumer response $\Delta E / E_0$ to the VAT rebates is sufficiently large and the share of true sales reported to the government prior to the reform, R_0/S, is sufficiently low.

In this framework, the adoption of a card machine on the extensive margin may or may not trigger an increase in reported sales. Define E_A as the level of electronic sales a firm would process after adopting a POS machine. The level of E_A captures the extent to which a firm's consumers have credit/debit cards and are willing to use them to make a purchase, and the extent to which the firms can attract additional consumers by offering card payments. POS adoption will lead to an increase in reported sales if $R_0 < E_A$, that is, if the level of pre-adoption compliance is sufficiently low and the share level of electronic sales is sufficiently high. Firms' decision to adopt a POS takes into account the trade-off between attracting new customers (or retaining existing customers) and the costs in terms of potentially increased tax payments and fixed and variable costs for POS use. Modeling this decisions is beyond the scope of this paper.

[4] Our discussion focuses on revenue reporting, as any change in compliance in our setting should be driven by a change in reported sales. Since there is no evidence for a change in reported sales in response to the VAT rebates, there is no reason for reported costs to change. We thus do not model the latter.

3 Background and Data

This section describes the relevant aspects of Uruguay's tax system, the policy variation generated by the financial inclusion reforms and the data we use.

3.1 Tax System

Firms in Uruguay are liable for an annual corporate income tax (CIT) at 25% and remit a monthly VAT. The VAT is levied at a standard rate of 22%, with a reduced rate of 10% for necessity goods such as basic food products. Large firms which are part of the large taxpayer office called CEDE (*Control Especial de Empresas*) file and pay the VAT monthly. All other firms (henceforth called non-CEDE firms) file the VAT annually, but report output VAT, input VAT and net VAT for each month in their annual VAT declaration. In 2015, there were 4099 CEDE firms and 60,640 non-CEDE firms registered. Credit and debit card companies in Uruguay report all card transactions of their client firms (i.e. firms using their POS) to the tax authority. The tax authority uses the card transaction reports to cross-check taxpayers' self-assessment declarations, and to strengthen the credibility of enforcement among taxpayers with discrepancies between self-reported and third-party reported income.[5]

Firms below certain size thresholds can opt into a simplified tax regime. The *monotributo* regime for micro firms unifies all taxes and social security contributions. The *literal E* regime for small firms unifies the CIT and VAT into a monthly lump-sum payment and allows firms to pay social security contributions at a reduced rate. Firms in these two regimes thus do not remit VAT on their sales nor claim credit for VAT paid on their inputs. As eligibility is partly based on turnover, and credit and debit card reports can help the tax administration confirm a firm's true turnover, the financial inclusion reforms might have generated an increase in the number of firms graduating from the simplified tax regimes into the general VAT regime. However, conditional on a firm remaining in a simplified regime, its tax liability and compliance behavior should not be affected by the financial inclusion reforms.

[5]We do not know the details of how these cross-checks work and how the detected compliance gaps are dealt with. Credit and debit card companies also withhold a small share of the transactions they process as an advance tax payment for the firms (Brockmeyer and Hernandez 2019). The withholding rate varies across fiscal regimes and over time, between 1% and 6%. This variation does not coincide with the financial inclusion reforms we study (see Figure A.2).

3.2 VAT Rebates for Consumers

The main policy variation we exploit in this paper is generated by large VAT rebates for consumers using electronic payment methods. These rebates became available on August 1, 2014, and apply to all types of goods and services purchased by final consumers.[6] The rebate rates differ across card types and transaction amounts, and vary over time, as show in Figure A.3.

Debit card transactions of up to 500 USD (4,000 *Unidades Indexadas*) initially received the highest subsidy rate of 4 percentage point (ppt). Larger debit card transactions, other electronic payments and credit card transactions of up to 500 USD were granted a 2 ppt rebate. In August 2015, the rebates for debit and credit card transactions up to 500 USD were decreased to 3 ppt and 1 ppt respectively. Further rate changes took place in later years, but these are not considered in this study. The moderate VAT rates mean that the VAT rebates granted for card payments are very large, implying a 40 percent tax reduction in the case of reduced-rate goods of a value of less than 4000 UI purchased with a debit card.

The logistical functioning of the rebate system is illustrated in Figure A.4. Importantly, consumers pay the tax-inclusive price net of the rebate at the time of purchase, so rebates are immediately devolved to consumers. Put differently, consumers do not have to request a refund nor incur a hassle cost. The rebate is stated on a consumer's transaction receipt, which makes it highly salient, as show in Figure A.5. Firms should file their VAT declaration as if they had charged the consumer the full VAT, at either the standard or the reduced rate, whichever applies. Credit and debit card companies processing the card transactions observe the amount of VAT rebates a firms' consumers have been granted. These companies then provide a fiscal credit of the aggregate firm-specific rebate amount to their client firms. These fiscal credits are transferred to firms together with the processed transaction amounts. The credit and debit card companies are then reimbursed for these credits by the government. These reimbursements happens monthly, so that firms should not experience a significant change in liquidity due to the granting of VAT rebates.

Figure A.7 shows that the VAT rebates were indeed granted starting in August 2014, as per the legislation. The figure displays a sharp increase in the share of firms registering VAT rebates to consumers in August 2014. The share of retail firm registering VAT rebates reaches almost 50%. In contrast, only 15% of wholesale firms registered any VAT rebates, as these firms sell largely to other firms, with only a small share of their output going to final consumers.

[6] Decree 203/014. Rebates are granted only for firm-to-consumer transaction, and not for firm-to-firm transactions, i.e. any transactions in which the client requests the tax ID number of the seller.

Two earlier types of VAT rebates are worth mentioning, as they explain why the share of firms registering VAT rebates is slightly above zero prior to August 2014. First, starting in January 2006, consumers received a 9 percentage point (ppt) VAT rebate on credit/debit card purchases in hotels and restaurants.[7] The reform predates data availability, and is thus not part of this study. Second, starting in September 2012, users of social security debit cards (*Tarjeta Uruguay Social* or *BPS Prestaciones*) benefited from a 22 percentage point reduction – i.e. a complete elimination – of the VAT and firms benefited from a waiver of VAT withholding on these transactions.[8] We do not study this reform as it should affect tax compliance only in upstream firms and not in the directly affected firms selling to incentivized consumers.

3.3 Other Financial Inclusion Measures

It is important to note that the VAT rebates were not introduced in isolation, but rather as part of a package of measures aimed at enhancing financial inclusion for its many benefits. The 2014 reforms were also accompanied by a large media and public engagement campaign raising awareness about the benefits of financial inclusion. Aside from the VAT rebates, the most important policy measures included the lowering of commissions for POS usage, subsidies for POS rental for firms, mandates for wages and pensions to be paid into bank accounts and the provision of free bank accounts with debit cards to all citizens. While these other policies can amplify the effect of the VAT rebates, none of them is introduced concurrently with the VAT rebates. We now discuss each policy measure in turn.

The lowering of commission fees, i.e. the variable fee that card processing companies charge for transactions, preceded the main financial inclusion reform. Starting January 1, 2012, the maximum commission for debit card payments was reduced from 7% to 2.5%, and the maximum commission for credit card payments to retailers of food, pharmacies and a specified number of other sectors fell to 4%. For foreign payment cards and some other types of transactions, the commission were capped at between 4.5% and 4.9%. These commission caps, affecting 96% of all transactions, were self-imposed by the card processing industry.

In exchange, the government introduced legislative changes to facilitate the inter-operability of card networks, and provided financial subsidies to expand the use of POS. Starting from January 2012, card network businesses investing in POS and POS accessories that would be rented out to firms were granted tax credits for their investments. In addition, starting from Septem-

[7] Law 17.934 and decree 537/005. The retail and wholesale sector does not include hotels and restaurants, but sector codes are prone to errors, so we expect a certain degree of misclassification.

[8] Decree 288/012.

ber 1, 2012, firms with a turnover below UI 4,000,000 [9] (approximately USD 500,000) and newly created firms were eligible for a subsidy for POS rental fees. Eligibility was determined based on a firm's turnover reported in the last corporate income tax declaration, and the high turnover threshold implied that roughly 80% of all firms were eligible for the subsidy.[10] Until December 2013, the subsidy rate was 100% of the rental price of a POS, which is equivalent to approximately 10 USD per month. Starting in January 2014, the subsidy rate was reduced to 70%, and remained at this level until December 2017.

Together with the passage of the financial inclusion law on April 24, 2014, it was announced that many types of payments would gradually have to be made through electronic payment channels. The law set out a schedule for these mandates to enter into effect over 2014-2015 (see Table A.3), though several of the timelines were ultimately postponed. Most importantly, wage earners and pensioners were given the option to request payment into a bank account (rather than in cash) starting in October 2015. To prepare for the implementation of the mandates, the financial inclusion law immediately required banks to offer free bank accounts that fulfilled certain criteria (specified numbers of free transfers, withdrawal etc).[11]

3.4 Data

To study the effect of electronic payments on tax compliance, we merge multiple datasets. First, we use transaction-level card payment data, which contain the universe of transactions between 2007 and 2016. The data contain the transaction date, transaction amount, VAT rebate amount, the tax ID of the firm, and a POS identifier. We can thus count the number of POS a firm uses. We collapse the data at the firm-month level.[12] While we refer to these data as the card payment data for simplicity, it is important to note that these data contain all electronic transactions (e.g. including transactions via apps such as paypal, square etc). The transaction amount variable in this data is a total for each transaction, meaning that there is no information on quantities and prices, nor on the type of good purchased. The data do not

[9] Four millions UI is also a threshold for other laws and regulations. For example, firms whose income in the previous fiscal year was above 4 millions UI are required to have formal accounting and no longer qualify for the simplified income tax regime (Decree 150/007, article 168).

[10] Decrees 288/012, 319/014 and 351/015. Very few firms that were not eligible for the subsidy received it. There is little mass and no bunching in the distribution of turnover at the eligibility threshold, suggesting no manipulation of the eligibility criteria. There is also no discontinuity in any of the outcomes studied below at the turnover threshold.

[11] For wage earners and social benefit recipients who did not exercise this option to create a bank account by June 2016, the employer or social security agency had to choose a financial institution for the beneficiary by September 2016. It became mandatory for wages and pensions to be transferred into bank accounts from May 2017 onwards. In 2014, about 30 percent of households had a debit or credit card (Household Financial Inclusion Survey, Sanroman et al. 2016).

[12] A variable indicating the type of card transactions (debit or credit card) is available only since August 2014.

contain credit/debit card (i.e. consumer) identifiers.

We merge the card transaction data with monthly VAT returns, containing all line items from the tax return. Our main outcome variables are output VAT (i.e. VAT on sales), input VAT (i.e. VAT paid on inputs and deducted from output VAT), and the net VAT liability (max(0, output VAT - input VAT)).

Information on firms' sector of activity is obtained for the firm registry, which contains the six-digit CIIU industry code for all firms (*Clasificación industrial internacional uniforme*). In the CIIU, retail firms are contained in division number 46, while wholesale firms are contained in division number 47. The first two digits of the CIIU code capture the division.

Finally, we have access to the list of firms that received the subsidy for POS rental, with the months during which the firm received the subsidy and the total subsidy amount each month. We use corporate income tax records only to confirm firms' turnover and hence their eligibility for the POS rental subsidy.

Table A.1 provides summary statistics for the full sample, and for retail and wholesale firms, the treated and control firms for part of our analysis. Retail firms are very similar to wholesale firms in terms of the distribution of their annual sales and VAT liability, except at the top of the distribution, where wholesale firms are larger. The key distinction between the two groups is that 52% of retail firms used a POS terminal even in 2013, before the reform, but only 16% of wholesale firms did. This is close to the population average of 17%.

4 Use of Electronic Payment Technology

We begin our analysis by evaluating the impact of VAT rebates on the use of electronic payment technology. As the rebates became available to all consumers nation-wide on the same day, we examine the effect of the rebates on aggregate outcomes, leveraging a regression discontinuity estimation in time. In the following sections, we present our empirical strategy and the results.

4.1 Empirical Strategy

We consider the following outcome measures to capture the use of electronic payment technology, on the extensive and intensive margin: the aggregate number and volume of card transactions, the number of POS in use, and the number of firms with a POS. Figure 2, Panel A, plots the raw time series of these outcomes between January 2010 and June 2016.

Some of the series, especially the number and volume of transactions, exhibit some seasonal

variation with peaks in December and during the holiday season. We thus de-seasonalize the data by estimating

$$log(Z_{t,m}) = g_m + \sum_{k=0}^{p} \left[\beta_k \cdot t^k + \gamma_k \cdot PostJuly2014_t \cdot t^k\right] + u_t, \tag{1}$$

where $Z_{t,m}$ is the aggregate outcome in time period t and month-of-year m, g_m are month-of-year fixed effects, the $PostJuly2014$ dummy indicates months after July 2014 (i.e. post-reform months), p is the degree of the polynomial we fit (either 1 or 2), and u_t is the error term.[13] The inclusion of the post-reform indicator and its interaction with the time trend allows both the trend and the level of the outcome to change with the reform.[14] In our preferred specification, we set $p = 1$, fitting a linear trend, but the results are robust to allowing for higher-order polynomials (Figure B.2). Figure 2, Panel B, plots the de-seaonalized outcomes $\tilde{Z}_t = Z_t - \hat{g_m}$.

To assess whether the introduction of VAT rebates is associated with a statistically significant jump in the time series, we estimate the following regression discontinuity model around the time of the reform on a subset of the de-seasonalized data around the time of the reform:

$$log(\tilde{Z}_t) = \alpha + \sum_{k=0}^{p} \left[\beta_k \cdot t^k + \gamma_k \cdot PostJuly2014_t \cdot t^k\right] + \epsilon_t, \tag{2}$$

where ϵ_t is the error term. Our coefficient of interest is γ_0, which measures the VAT-rebate-driven change in the outcome, under the assumption that no other policy or economic change coincides with the reform to provoke a jump in the outcome. We are also interested in the estimate of γ_1, indicating whether the reform was associated with a change in the growth rate of the outcome.

Our preferred specification uses weekly outcome data and weeks as running variable. Weeks are defined such that the first day of a week coincides with the first post-reform day. Estimating equation 2 is equivalent to estimating equation 1 if we use the same level of aggregation and bandwidth in both estimations. In practice, to maximize precision in estimating the month-of-year fixed effects, we run the regression to de-seasonalize the data on the full 2010-2016 data. The subsequent regression discontinuity estimations are run on shorter subsets of the data. We present robustness tests with varying bandwidths below (Figure B.2).

[13] Here, t can be a week or a month. For weeks that stretch across two months, we consider that each week falls into the month in which it has more days.

[14] In Figure B.4 we also allow for a trend break in January 2013, when the POS subsidies for firms were phased in. These subsidies were technically available starting September 2012, but take-up did not pick up until January 2013. Figure D.1, discussed in Appendix D, provides suggestive evidence that the roll-out of POS subsidies may have slightly increased the use of electronic payment technology on some margins. Figure B.4 shows that allowing for a trend break in January 2013 in our RD estimations does not substantially alter our results compared to our main specification.

4.2 Results

Considering first the raw and de-seasonalized data (Figure 2), it is clear that the number of card transactions jumps sharply in August 2014, precisely when the VAT rebates first become available. This immediate and large response is not surprising, as the VAT rebates were introduced with great media fanfare (Figure A.8) , were very salient to consumers, and considering that at least 30 percent of Uruguayan households already had bank accounts with debit or credit cards at this point in time. The large size of the financial incentives can also help explain the strong consumer take-up. The second outcome of interest, the volume of card transactions, also increases with the reform, but the increase here is less pronounced. The increase in the number of transactions is hence driven by smaller transactions, consistent with the fact that the VAT rebates were smaller for larger transaction amounts, and that a larger share of large transactions would have already been carried out through electronic payment methods before the introduction of VAT rebates. The number of POS in use and the number of firms with at least one POS is also increasing over time, but only the former series displays a slight jump around the time of the reform.

To precisely estimate the size of the discontinuity in outcomes in August 2014, we now turn to our regression discontinuity estimations, the results of which are displayed in Figure 3, Panel A. The introduction of the VAT rebates is associated with a 50% increase in the number of card transactions, and an almost 30% increase in the volume of card transactions. Despite this massive increase in consumer demand for card payments, the number of POS in use increased by only 10% in the month of the reform. It is possible that firms need time to adjust to the increase in consumer demand, in which case the response in the number of POS would be delayed compared to the consumer response. However, there is no sign of an acceleration in the growth trend in POS after the reform.

To test more formally for a change in the average growth rate, we compare the month-on-month growth rate of our outcomes between July and August 2014 to monthly growth rates in the pre and post-reform periods. Figure 3, Panel B, shows the distributions of growth rates. The graphs and associated t-tests (reported below each panel) confirm that the introduction of VAT rebates is not associated with an acceleration in the month-on-month growth rate in any of the outcomes.

The histograms also reveal that the reform-month growth rates for the number and the volume of card transactions are extreme outliers compared to the pre and post-reform growth rate distributions. This supports our interpretation of these effects as being driven by the

introduction of the VAT rebates as opposed to being driven by other policy changes or random variation over time. For the number of POS, the reform-month growth rate also lies statistically significantly above the mean of the distribution. A different result emerges, however, when considering the number of firms with a POS, for which the reform-month growth rate is in fact close to the mean and mode of the distribution of growth rates. There is thus no evidence for a reform-triggered increase in POS-take-up on the extensive margin, above and beyond the gradual growth over time in the number of firms that employ POS. The reform did, however, trigger an increase in POS take-up on the intensive margin, among firms that were already using POS. This is not surprising, as the cost of adopting another POS is likely much smaller for firms already using POS.[15]

In Figure B.2, we illustrate the robustness of our RD results to varying the bandwidth and the degree of the polynomial. The results are similarly robust to varying the level of aggregation of outcomes, which can be daily, weekly or monthly (results not shown).

Lastly, we note that none of the outcomes considered in Figure 2 exhibits a discontinuity in August 2015 (marked by a dashed line), when the VAT rebates were decreased.[16] Figure B.3 formally shows that there is no statistically significant jump in any of the outcomes in August 2015. This is consistent with two possible explanations. Either the introduction of the VAT rebates induced a permanent change in consumer behavior which persists even after the incentives are reduced, or consumers respond more strongly (maybe exclusively) to extensive margin changes in rebate rates than to extensive margin changes.

5 Tax Compliance

Having established that the VAT rebates lead to a large increase in the number and volume of card transactions, and to a smaller but still non-negligible increase in the number of POS in use, we now turn to analyze the impact on tax compliance. Applying an RD estimation, as used in the previous section, to aggregate monthly VAT payments of retail firms reveals no detectable discontinuity in August 2014 (Figure B.5). This is not surprising, as aggregate tax revenues are disproportionately driven by a small number of large firms. A tax compliance impact is more likely to arise among smaller firms. We therefore study the tax compliance impact through a difference-in-difference estimation, comparing retail-sector firms to wholesalers. The following

[15] When comparing the reform-time growth rate estimates in the RD estimations and in the histograms, note that the numbers are not identical as the former are based on weekly data and the latter are based on monthly data.

[16] The rebates on debit card transactions up to 4000 UI decrease from 4 to 3 percent, and the rebates for credit card transactions up to 4000 UI decrease from 2 to 1 percent.

sections describe our methodology and the results.

5.1 Empirical Strategy

Our difference-in-difference estimation is inspired by Naritomi (2019) who studies the tax-compliance effect of consumer incentives to request e-receipts in Brazil. We rely on the fact that retailers sells almost exclusively to final consumers, whereas wholesalers sell predominantly to other firms. The VAT compliance chain often breaks down at the stage of the business-to-consumer sale, as consumers have no incentive to request a receipt. Retailers are thus typically less tax compliant than wholesalers. In addition, only retailers are directly affected by the VAT rebates we study, which apply to business-to-consumer sales and not to business-to-business sales. Wholesalers are the most suitable control group, as they experience a similar time trend and seasonality as the retail sector.[17] We thus estimate

$$log(Y_{it}) = a_i + g_t + \beta \cdot Retailer_i \cdot PostReform_t + u_{it}, \tag{3}$$

where Y_{it} is the outcome for firm i in time period t, a_i and g_t are firm and time period fixed effects, $Retailer_i$ indicates retail-sector firms, and u_{it} is the error term. The policy impact is measured by the coefficient β on the $Retailer_i \cdot PostReform_t$ interaction term. The identifying assumption is that the outcome for retail-sector firms would have evolved in parallel to the outcome for wholesalers in the absence of the reform. To confirm this is the case, we estimate the following event-study version of equation 3:

$$log(Y_{it}) = a_i + g_t + \sum_{k \neq -1, k=-3}^{2} \beta_k \cdot Retailer_i \cdot 1_k(k = t) + \epsilon_{it}, \tag{4}$$

and plot the β_k coefficients for each time period.

Our main outcomes variables are total taxable sales, reported output VAT, and the net VAT liability ($= max(outputVAT - inputVAT, 0)$). We use annual data for our main analysis and later show robustness of our results using monthly data. This is because non-CEDE firms report taxable sales – a key outcome variable – only annually, and they report output VAT and net liability monthly but retrospectively at the end of a each year.[18] In our preferred specifications, we winsorize the outcome variables at the 99th percentile within each treatment

[17] Inspection of other sectors indeed confirms that they are not suitable controls due to differences in pre-reform trends and seasonality.

[18] For the annual specification, $PostReform_t$ indicates the years 2014 and beyond, taking into account that the year 2014 is partially treated as the VAT rebates enter into effect in August.

group × year, and we confirm robustness of the results to more conservative top-coding.

5.2 Results

Our main DiD results are shown in Figure 4. Each column pertains to a different outcome variable. In the top row, we show the normalized trends over time in the treatment and control group, and the DiD point estimate $\hat{\beta}$ on the $Retailer_i \cdot PostReform_t$ interaction from equation 3. In the bottom row, we plot the period-specific β_k estimates from Equation 4 to confirm that we cannot reject the parallel trends assumption.

If the expansion of electronic transactions triggered an improvement in tax compliance, it should first manifest through an increase in reported taxable sales. However, we observe parallel trends in this outcome and hardly any divergence between the treatment and the control group. We estimate that taxable sales in the treatment group increased only by an additional 3.2% after the reform, compared to the control group, an effect which is statistically indistinguishable from zero (Figure 4, column A). The fact that reported sales do not change differentially in the treatment group after the reform, and that the statutory VAT rates did not change, would imply that the output VAT remitted should also be unchanged. Indeed, we find that the DiD point estimate on report output VAT is also close to zero (-2.6%), which is again statistically indistinguishable from zero (column B). While it is possible that a reform impact emerges gradually over time, the results contradict this, as the event-study estimates for 2015 are smaller than those for 2014 (bottom row). Consistent with the absence of an impact on reported sales and output VAT, the effect on the reported net tax liability is also close to zero and statistically insignificant (column C). The reform thus had no impact on treated firms' reporting behavior or tax remittance. Our findings starkly contrast with the findings in Naritomi (2019), who shows that the roll-out of e-receipts in Brazil increased reported sales of retail firms by at least 21%.

In Table 1, we demonstrate the robustness of our results to different specifications. In columns 1, 5 and 9, we reproduce the results from our preferred specification from Figure 4 for comparison purposes. In columns 2, 6 and 10, we show that the results are very similar when considering a balanced sample of taxpayers who file regularly during 2011-2015.[19] All point estimates are small and statistically indistinguishable from zero. The same result emerges when we winsorize the outcome variables more conservatively, at the 95th percentile (columns

[19] We require taxpayers to file at least once in each of those years, and to file once in 2010 and at least once in the last three months of 2015. The additional sample restrictions are required to avoid that 2010 and 2015 contain a disproportionate share of firms filing less than 12 months.

3, 7 and 11). It thus does not seems to be the case that smaller or larger firms are affected differently. Finally, we still obtain the same results when extending our main specification to include observations for the year 2016 (columns 4, 8 and 12). The 2016 data we have access to is only partial, covering CEDE firms and about 3500 non-CEDE firms. The results are hence tentative, but they do not provide any indication that a treatment effect emerges over the medium-term horizon. Graphic representations of these results and confirmations of the parallel trends assumption in each estimation are show in Figure C.1.[20]

6 Interpreting the Results

Overall, we find that the introduction of VAT rebates lead to a large increase in the number and volume of card transactions, but had no effect on tax compliance among retail firms. We now discuss the two main factors that explain the lack of a tax compliance response.

First, firms self-select into POS adoption based on a cost-benefit trade-off, and the VAT rebates did not significantly increase POS adoption on the extensive margin. As the analysis in Section 4.2 showed, the expansion of electronic payment transactions occurred almost exclusively in firms that already had a POS machine, despite a large increase in consumer demand for electronic transactions. Only firms that already used POS increased the number of POS in use. This is consistent with the fact that using a POS is costly for firms that are not yet very tax compliant. Indeed, an event study of firm behavior around the time of POS adoption (Figure 5, Panel A) shows that a firm's reported output VAT and net liability increases sharply with POS adoption. The lack of an extensive-margin POS adoption response to the VAT rebates is also consistent with the slow and gradual update of POS subsidies for firms, which became available in September 2012 (Figure 5, Panel B). In fact, only 6.5% of eligible retail firms had taken up the subsidy within two years of its introduction (2.2% of all eligible firms). More importantly, since the subsidy was not restricted to firms that had never used a POS, 87.7% of firms that took the subsidy already had used a card machine before. It is thus likely that most of the firms that benefited from the subsidy would have adopted a POS even in the absence of the subsidy program. In other words, the subsidy program had little impact on the use of the

[20] In addition, we show in the Appendix that we obtain very similar results when using monthly data. Figure C.2 show the results from the preferred specification, where the outcome is $log(Y_{it}+1)$. We also show that results hardly change when adding additional controls (e.g. region $\times$ year/month and firm-size deciles $\times$ year/month fixed effects). These latter controls do little to reduce the variance of the estimates, as treated and control firms are almost equally distributed across the firm-size deciles and the overwhelming majority of firms is located in the capital city. The results are show in Tables C.1-C.2 for the annual and monthly data and then balanced an unbalanced sample respectively.

technology (see Appendix D for additional results consistent with this). These findings suggest that it may be difficult to increase POS take-up among firms via financial incentives. Much larger incentives or a mandate might be needed.[21]

As a second reasons for the lack of a tax compliance impact, we highlight that firms that already used a POS prior to the introduction of VAT rebates registered a relatively low share of electronic transactions in total reported sales. As Figure 5, Panel C, shows, the mean (median) share of card sales in total reported sales was 36% (12.4%) in 2013. This suggests that firms already report a large share of their non-card sales to the government, meaning that there is room for an increase in card sales with no change in reported sales. Consistent with the gradual expansion of electronic payments, the distribution shifts right-ward over the years, and especially between 2014 and 2015 with the implementation of consumer VAT rebates. However, the share of card sales in total sales is still very small for many firms, and below 15% for the majority of firms. Hence, given the low starting point, even the large increase in the number and volume of card sales in 2014 did not push the share of card sales towards close to 1. Even if firms consider third-party reported (card) sales as as lower bound to their self-reported sales, as a reporting sales lower than third-party reported sales might trigger an audit, third-party reported sales do not constitute a binding constraint.

In light of the low share of card sales in firms' total reported sales, it is also unlikely that the VAT rebates would have had an impact on tax compliance if more households had access to credit/debit cards. Indeed, the poorer households, which are less likely to have a debit or credit card are also more likely to shop in more informal shops where POS usage is less common (Bachas et al. 2021).

7 Conclusion

Testing the idea that the digitization of transactions may improve tax compliance, we have evaluated the effect of VAT rebates on the adoption of electronic payment technology and on tax compliance by firms in Uruguay. We find that consumers are highly responsive to VAT rebates for credit/debit card payments, but firms are largely unresponsive, increasing POS use only on the intensive margin. The consumer-driven increase in card transactions is not sufficient to generate an increase in tax compliance, as it applies to firms that already have a

[21] Figure A.6 suggests that the presence of relatively high tax withholding rates applied by card processing firms is not a key deterrent for POS take-up. The reduction of the withholding rate from 5% to 2% for non-CEDE firms in January 2012 did not accelerate the pace of take-up, compared to CEDE Firms for whom the withholding rates remained at 5% after January 2012.

card machine and are relatively tax compliant, reporting a large share of non-electronic sales for tax purposes.

It is important to point out that our study focuses on short-term responses to the VAT rebates. It is possible that the expansion of electronic payment technology has a larger effect on tax compliance in the longer run, but our data and policy variation do not allow us to causally estimate such effects.

Our findings suggest that an impact on tax compliance is more likely to be achieved with policies that successfully incentivize firms to adopt POS. To generate a substantial response among firms that have not yet adopted a POS, it may be necessary to provide much larger financial incentives than those used in Uruguay or impose a mandate. Unlike firms, consumers are highly responsive to financial incentives, which suggests that even reduced and more targeted incentives, e.g. only for small card payments, could still generate a sizeable increase in card transactions. Consumer incentives have a smaller effect on larger transactions, which are more likely to be conducted electronically anyways. As we find that consumers respond only to the introduction but not to the reduction in VAT rebates, it is likely sufficient to use temporary incentives to encourage consumers to adopt the habit of paying by card permanently.

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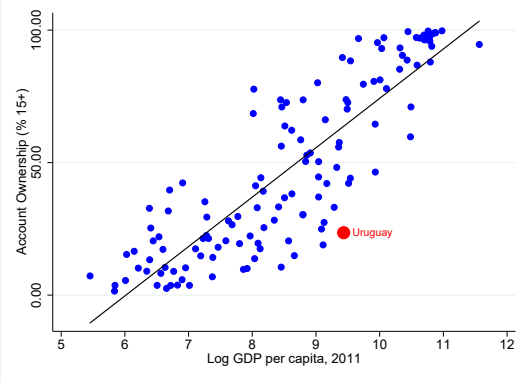
Figures and Tables

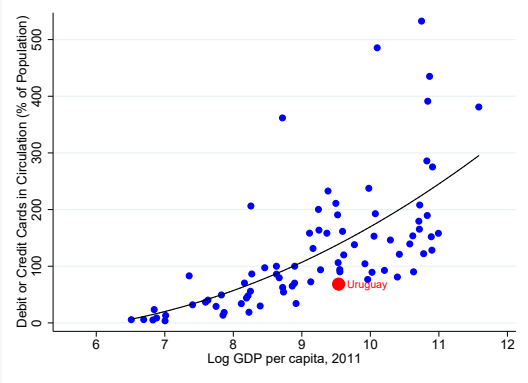
Figure 1: Financial Inclusion and Tax Compliance
Uruguay in a Cross-Country Comparison

A. Financial Inclusion Indicators

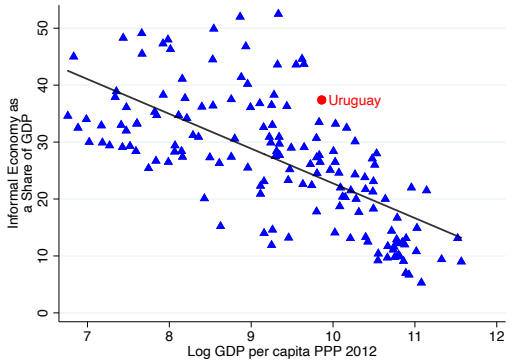
A.I: Account Ownership



A.II: Credit/Debit Cards in Circulation



B. Size of the Informal Economy

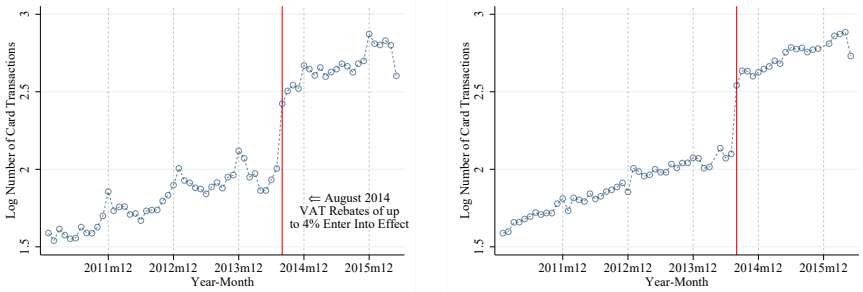


Notes: As discussed in the Introduction, Uruguay lags behind peer countries in terms of financial inclusion. Panel A plots the cross-country relationship between financial inclusion and GDP per capita in 2011. Panel A.1 display data on account ownership, as measured by the percentage of the population (15 years +) with an account any formal financial institution. Panel A.2 display data on debit and credit card circulation, as measured by the percentage of the population (15 years +) with ownership of a debit and/or credit card. The GDP data is from the World Bank World Development Indicators Database and the financial inclusion data are from the World Bank Global Findex Database, which is based on nationally representative surveys in more than 140 countries. Panel B plots the cross-country relationship between the size of the informal economy (measured as a share of GDP) and GDP per capita for 158 countries in 2012. The measure for the size of the informal economy is from Medina and Schneider (2018). The GDP data is from the World Bank World Development Indicators Database.

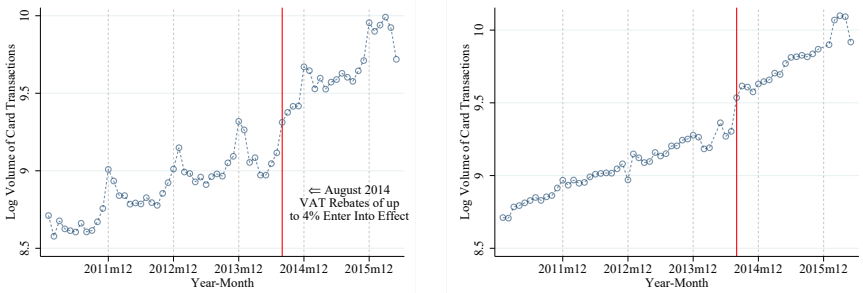
Figure 2: The Effect of VAT Rebates on the Use of Electronic Payment Technology
Raw and De-Seasonalized Data

A. Raw Trends B. De-seasonalized Trends

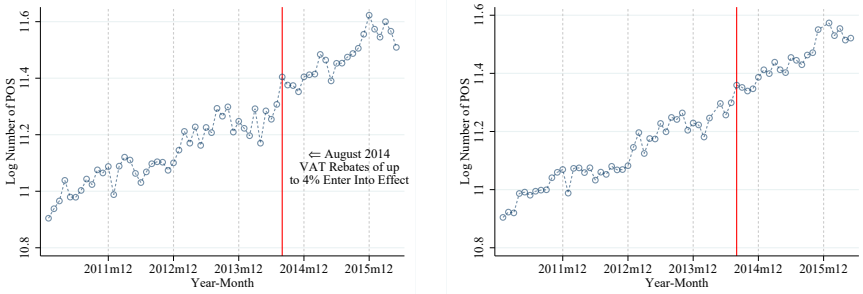
I. Number of Card Transactions



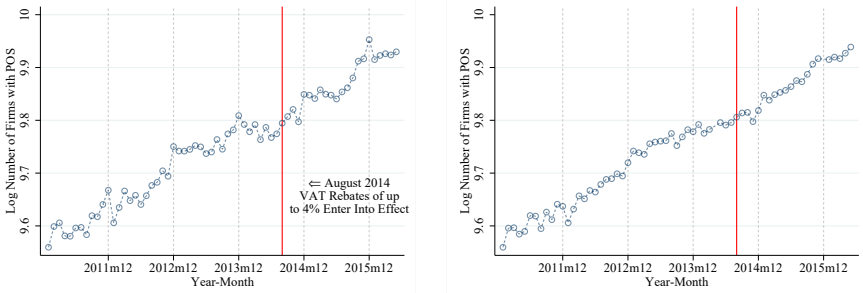
II. Volume of Card Transactions



III. Number of POS



IV. Number of Firms with a POS

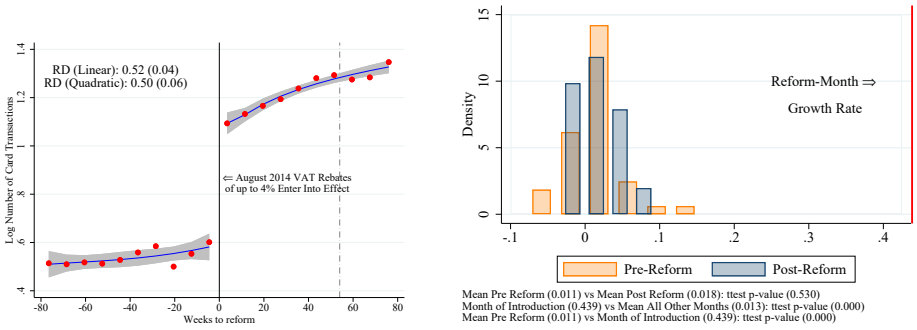


Notes: Panel A plots the monthly aggregate values for each of the outcomes. We average over the month of April and May 2014, for reasons discussed in Figure B.1. Panel B plots the de-seasonalized trends after taking out month-of-year fixed effects, as per equation 1 (linear specification). This Figure is discussed in Section 4.1.

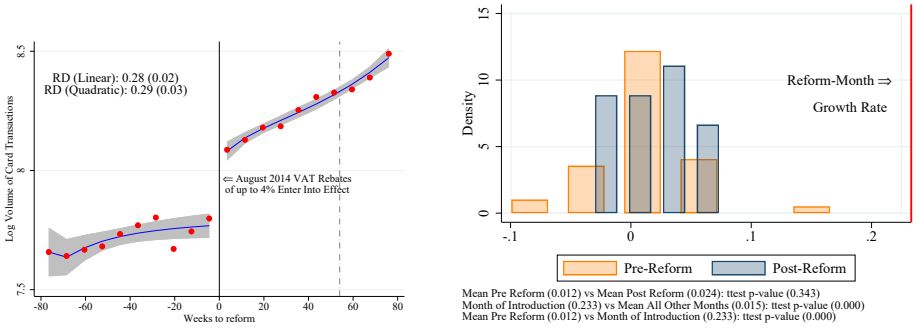
Figure 3: The Effect of VAT Rebates on the Use of Electronic Payment Technology
Regression Discontinuity Estimates and Month-on-Month Growth Rates

A. RD Estimation B. Month-on-Month Growth Rates

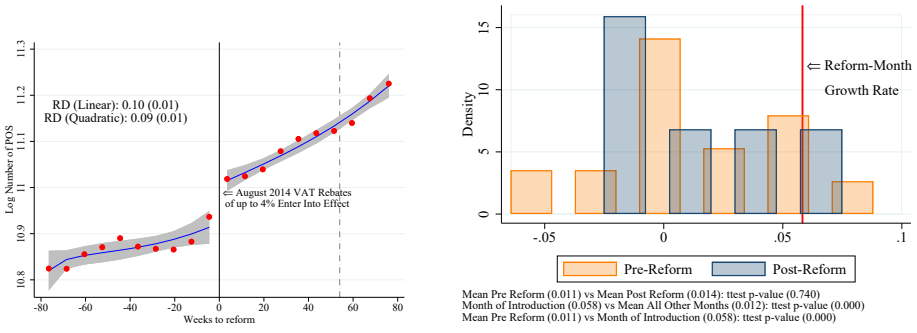
I. Number of Card Transactions



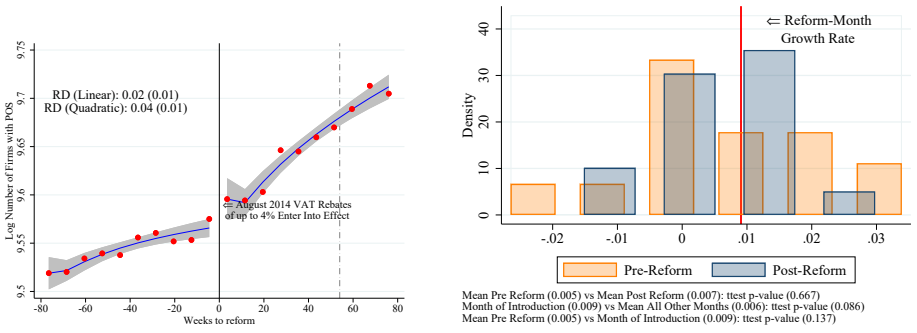
II. Volume of Card Transactions



III. Number of POS

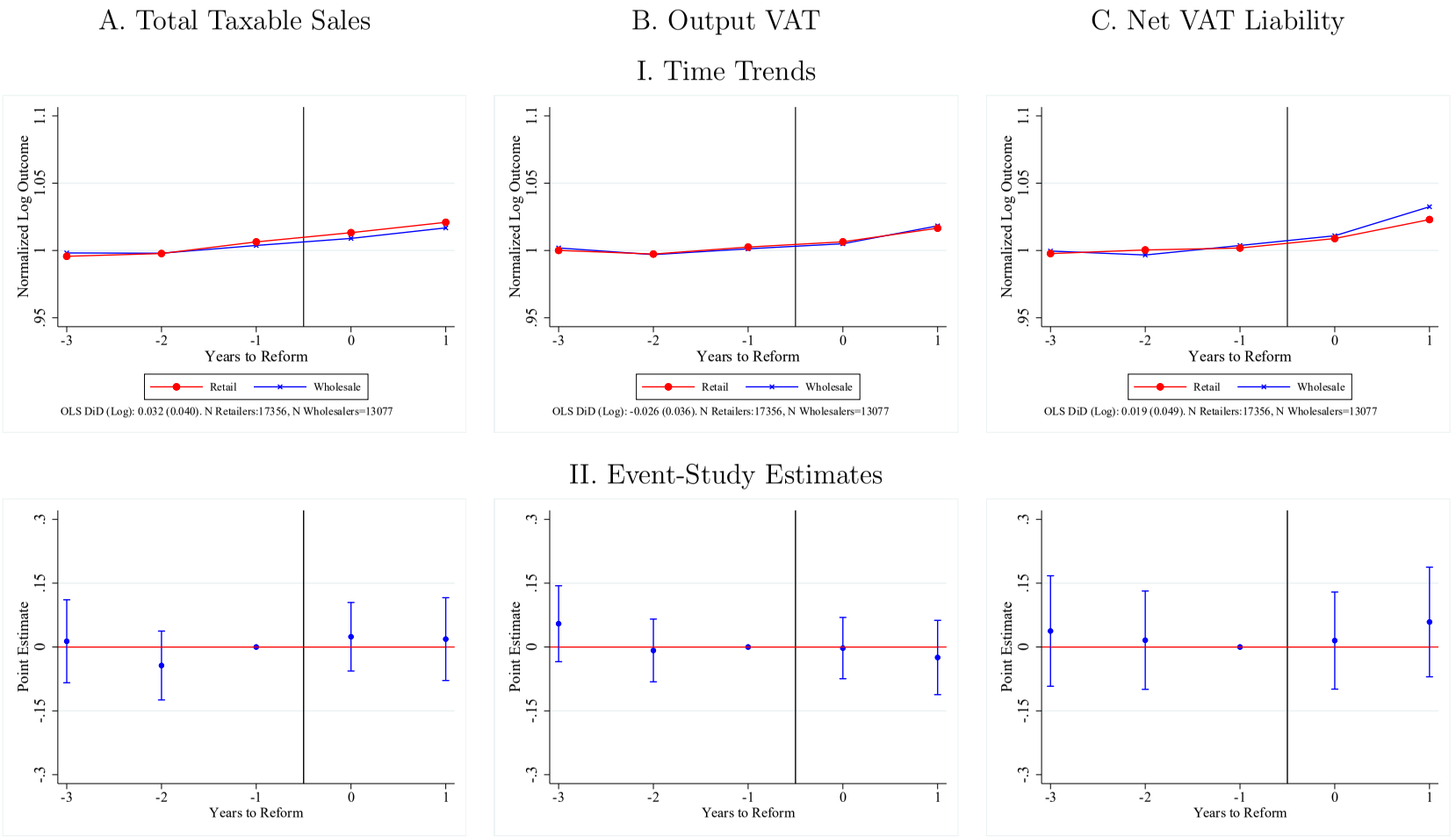


IV. Number of Firms with a POS



Notes: Panel A implements an RD estimation around the time of introduction of the VAT Rebates. The red dots represent the mean outcome in equally spaced weekly bins. The solid blue lines (grey areas) depict a fitted second-order polynomial (the corresponding 95% confidence intervals). The notes display the RD estimate γ_0 from equation 2. Standard errors are robust to heteroscedasticity. Panel B plots the distribution of monthly growth rates (log difference) between January 2011 and December 2015. The vertical red lines represent the growth rate corresponding to the month of introduction of VAT rebates (August 2014). This Figure is discussed in Section 4.2.

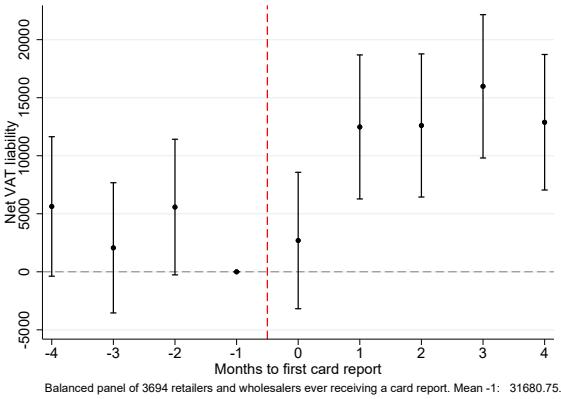
Figure 4: The Effect of VAT Rebates on Tax Compliance
Retailers vs Wholesales Difference-in-Difference Estimation



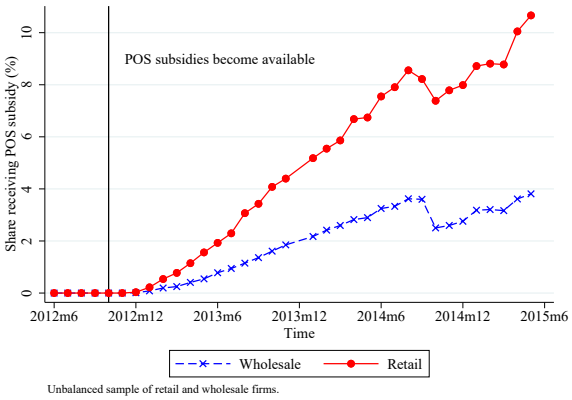
Notes: These graphs implement a DiD estimation comparing retail firms (treated) to wholesale firms (control) around the introduction of the VAT rebates in 2014 (year 0). Panel I shows the normalized time trends and the DiD estimate β on the $Retailer_i \cdot PostReform_t$ interaction from equation 3. Panel II shows the event study estimates β_k from Equation 4. Standard errors are robust to heteroskedasticity. This Figure is discussed in Section 5.2. Table 1 shows the robustness of the results to various alternative specifications.

Figure 5: Explaining the Absence of a Tax Compliance Effect

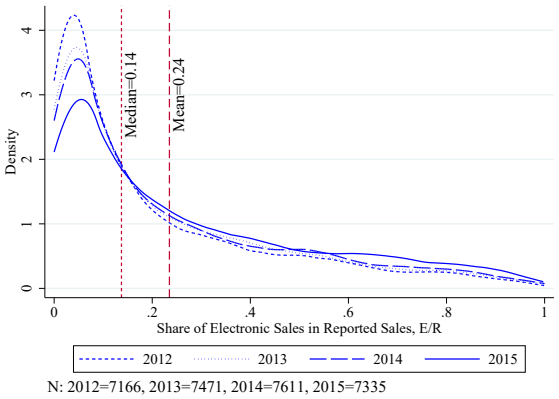
A. Net Liability Response to POS Adoption



B. Gradual Take-up of VAT Subsidies



C. Share of Card Transactions in Total Sales



Notes: Panel A displays event studies estimates of firm behavior after adopting a credit/debit card machine (POS) from $Y_{it} = a_i + g_t + \sum_{k=a}^{b} \delta_k \cdot D_{it}^k + u_{it}$, where Y_{ite} is the outcome for firm i in month t, a_i and g_t are firm and month fixed effects respectively, D_{it}^k are relative event time indicators. The panel presents the evolution of Net VAT liability around the month of POS adoption. The sample is composed of retail and wholesale firms that used a POS for the first time before January 2016 and are observed for four month before and after the event. Standard errors are clustered at the firm level and the outcome variable is winsorized at the 99th percentile. Panel B plots the share of firms receiving a subsidy for renting a credit/debit card machine (POS) (as a share of all observed firms in each sector). Panel C plots the distribution of electronic sales as a share of a firm's total self-reported sales, for retail and wholesale firms that use a card machine in 2012-2015. We exclude a firm-year observation if the firm uses the card machine for less than 11 months in a particular year. This means that we exclude firms in the year in which they adopt a card machine, unless they adopt it in January or February. This Figure is discussed in Section 6.

Table 1: The Effect of VAT Rebates on Tax Compliance
Difference-in-Difference Estimates

	Taxable Sales				Output VAT				Net VAT Liability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Retailer · PostReform	.032	-.065	.043	.06	-.026	.047	-.027	.004	.019	-.022	.02	.026
	(.04)	(.046)	(.04)	(.041)	(.036)	(.041)	(.036)	(.037)	(.049)	(.074)	(.049)	(.049)
Unbalanced Sample	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Balanced Sample	No	Yes	No	No	No	Yes	No	No	No	Yes	No	No
Winsor at p99	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes
Winsor at p95	No	No	Yes	No	No	No	Yes	No	No	No	Yes	No
Includes 2016 Data	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
N Treated	17356	2822	17356	17416	17356	2822	17356	17416	17356	2822	17356	17416
N Control	13077	3014	13077	13176	13077	3014	13077	13176	13077	3014	13077	13176

Notes: This table documents the robustness of our main DiD specification discussed in Section 5.1. The table displays the DiD estimate β from equation 3 for the different outcomes. Columns 1, 5 and 9 reproduce our preferred specification (as shown in Figure 4). In Columns 2, 6 and 10 we show that the results are very similar when considering a balanced sample of taxpayers who file every year during 2011-2015. Columns 3, 7 and 11 show the robustness of our results to more conservative top coding (winsorizing at p95). Lastly, columns 4, 8 and 12 show the robustness of our results to an extended sample which include observations for the year 2016. Figure C.1 shows the graphical representation of these results.

Online Appendix: Not for Publication

This appendix contains additional information and analyses. Appendix A provides additional contextual information. Appendix B provides additional results and robustness tests for the regression discontinuity estimation. Appendix C provides additional results and robustness tests for the difference-in-difference estimation. Appendix D examines the effect of the subsidies for POS rental fees introduced in September 2012.

A Context Appendix

Table A.1: Summary Statistics

				Percentile				
		Mean	SD	5th	25th	50th	75th	90th
All Firms	Total Annual Sales	8,760	27,089	0	13	1,663	5,679	16,523
	Input VAT	1,301	4,049	0	0	135	672	2,572
	Output VAT	1,911	5,786	0	0	264	1,072	3,785
	Net VAT Liability	546	2,305	-36	0	54	326	1,181
	Net VAT Liability > 0	0.63	0.48					
	Has POS	0.17	0.37					
	Number of Card Transactions	1.93	5.21	0.00	0.06	0.33	1.39	4.33
	Volume of Card Transactions	2,587	5,791	9	124	603	2,287	8,085
	Share of Electronic Sales	0.22	0.25	0.00	0.03	0.11	0.32	0.59
Retail Firms	Total Annual Sales	8,324	13,695	16	1,438	3,564	8,790	20,609
	Input VAT	2,075	4,934	0	160	492	1,412	5,008
	Output VAT	2,464	5,761	0	206	599	1,681	5,904
	Net VAT Liability	346	1,512	-58	12	83	283	923
	Net VAT Liability > 0	0.81	0.39					
	Has POS	0.52	0.50					
	Number of Card Transactions	3.06	7.23	0.01	0.12	0.48	1.85	7.83
	Volume of Card Transactions	3,499	7,848	11	160	688	2,499	9,169
	Share of Electronic Sales	0.22	0.25	0.00	0.03	0.12	0.33	0.60
Wholesale Firms	Total Annual Sales	18,276	42,005	0	626	3,686	13,401	45,521
	Input VAT	2,788	6,007	0	16	427	2,161	7,888
	Output VAT	3,703	8,331	0	20	611	2,752	10,092
	Net VAT Liability	792	2,384	-94	0	87	518	2,014
	Net VAT Liability > 0	0.67	0.47					
	Has POS	0.16	0.37					
	Number of Card Transactions	0.94	1.39	0.00	0.04	0.24	1.13	4.21
	Volume of Card Transactions	1,903	2,622	11	120	641	2,420	8,085
	Share of Electronic Sales	0.22	0.25	0.00	0.02	0.11	0.33	0.60

Notes: This table reports summary statistics of relevant variables for all firms, retail firms and wholesale firms in 2013. The number and volume of card transaction and the share of electronic sales are limited to firms with a POS. All monetary values and the number of card transactions are winsorized at the 99th percentile and displayed in thousands of Uruguayan pesos (1 USD= 43 UYU). This Table is discussed in Section 3.4.

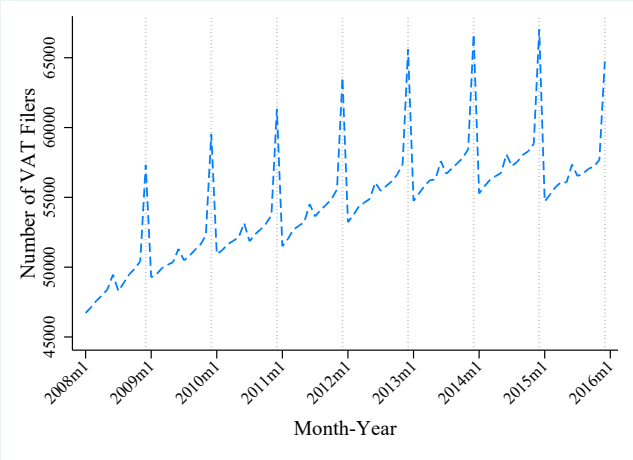
Table A.2: Policies Incentivizing the Use of Electronic Payment Technologies

A. VAT Rebates	
Argentina	5 percent VAT refund on debit card purchases <ARS 1000 (USD 51) [2001-2017] 3 percent VAT refund for credit cards [2003-2009]
Colombia	2 percentage points VAT rebate for card purchases [2004-2014]
Japan	2 or 5 percentage points rebates for consumers making cashless purchases at registered business [2019-]
South Korea	VAT tax credit for merchants. 0.5% of credit card sales [1994], 1% [1996-2000] and 2% [2000-], with 5 million won ceiling
Uruguay	2-4 percentage point VAT rebates for card payments [2014-]
B. Income Tax Rebates	
Colombia	Cash payments deductible only below certain thresholds
Greece	Income tax discount of up to 22% of electronic purchases, up a threshold proportional to income [2017-]
Mexico	Allowable deductions of a company's expenditure must be backed by a digital tax receipt or electronic transaction if >2000 pesos (107$)
South Korea	Share of electronic payments deductible from taxable labor income: 10% of transaction amount [1999-2002] up to a ceiling of 3 million won or 10% of total labor income; rate was revised over the years, reaching 30% for some years
C. POS Subsidies	
Argentina	Up 50% of monthly POS rental fee can be claimed as fiscal credit by merchant; no transaction fee and rental fee waver for small merchants in first two years [2016-]
Japan	Subsidies to installing cashless payment systems to 2 million eligible small and medium sized businesses [2019-]
Malaysia	Subsidized POS terminals
Mexico	Free POS installation and fixed monthly merchant fee up to certain transaction volume [2004-]; Ministry of Finance subsidized tablet equipped with MPOS
Uruguay	Eligible merchants can claim an income tax exemption of up to 100% of the value of the POS investment (subsidy rate revised over time) [2012-]
D. Lotteries	
Greece	Lotteries for consumers [October 2017-]; automatic participation when paying by electronic means; tickets awarded correspond to aggregate monthly amount spent by electronic means
India	Lotteries for merchants and consumers [2016-]
Mexico	Lotteries (cars) for consumers [2004-]
Netherlands	Lotteries for merchants and consumers [2002-]
South Korea	Lotteries for merchants and consumers, one credit card invoice stub per month randomly chosen as winner

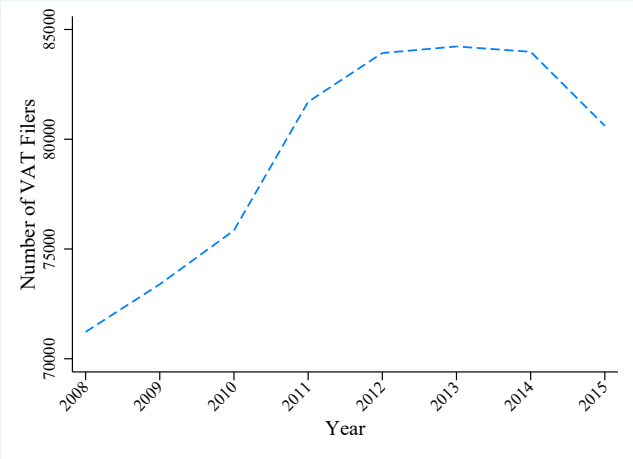
Notes: This table compiles a non-exhaustive list of different financial and fiscal policies to incentivize the use of electronic payment technology, as described in World Bank Group (2014) and Nicolaides (2014). This Table is discussed in Section 1.

Figure A.1: VAT Filers

A. VAT Filers by Month

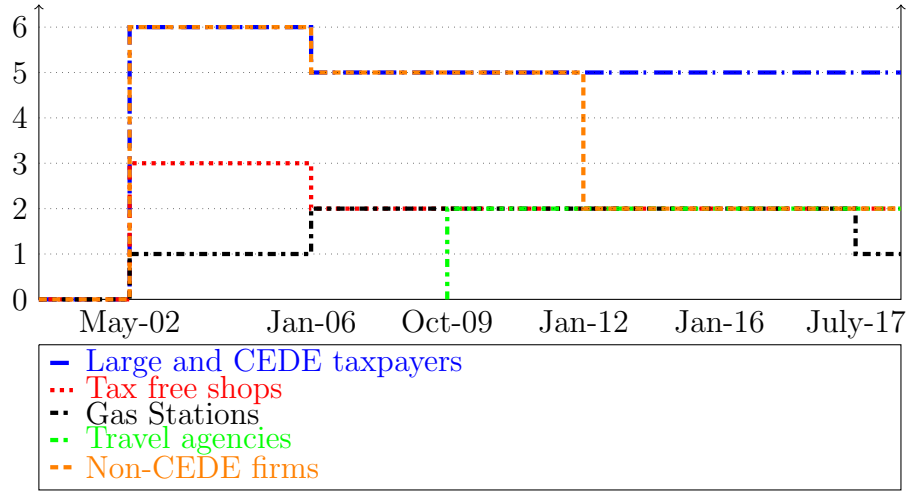


B. VAT Filers by Year



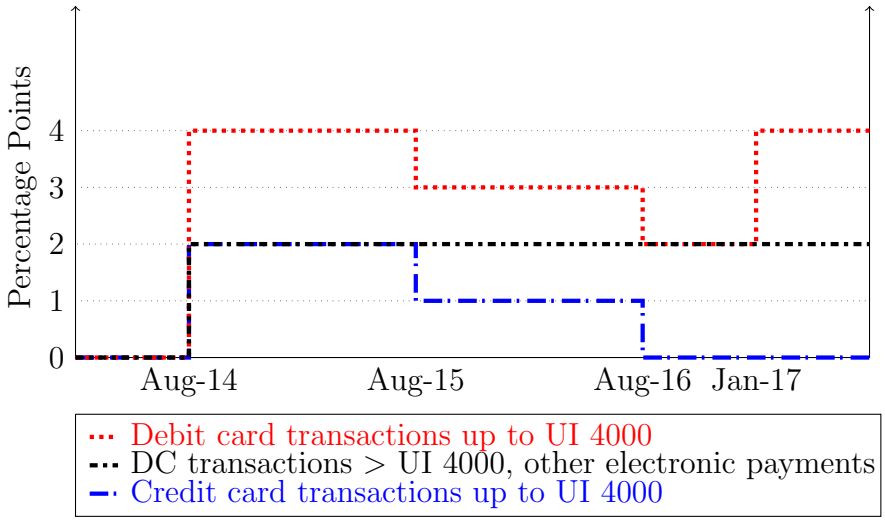
Notes: This figure plots the number of unique VAT filers in each month (Panel A) and year (Panel B). The dotted vertical lines in Panel A mark the month of December each year.

Figure A.2: Withholding Rates Applied to Credit/Debit Card Sales



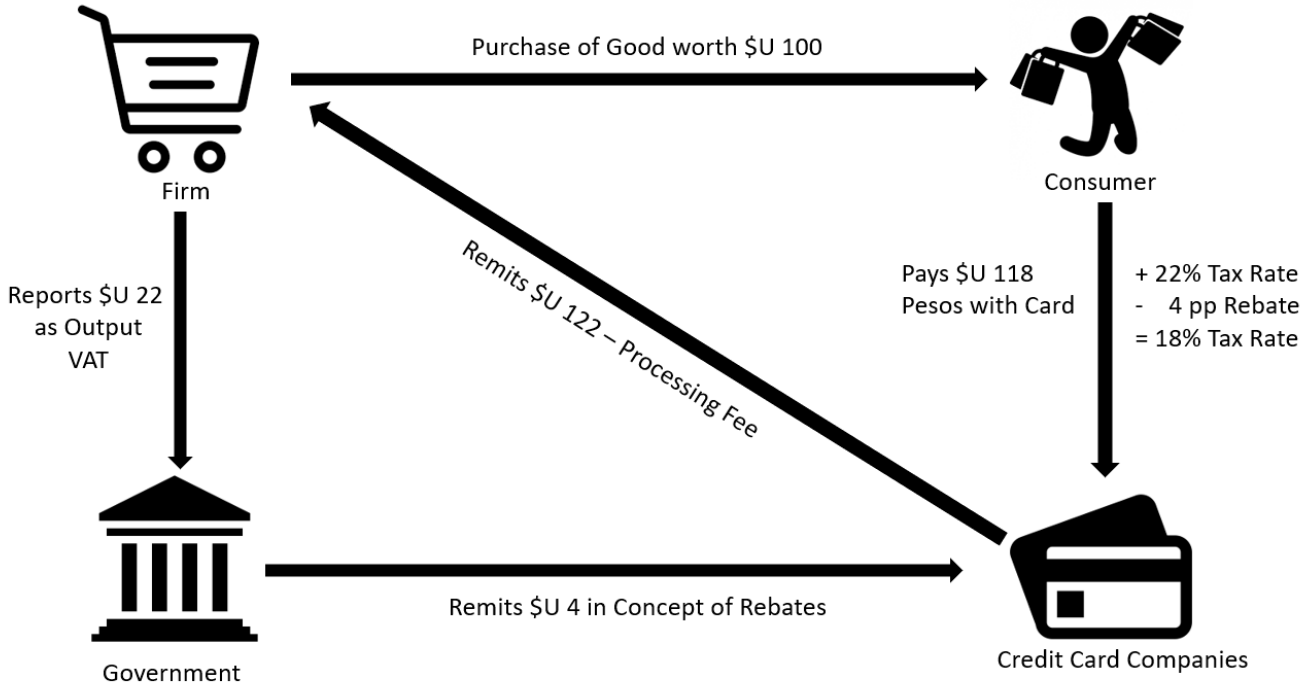
Notes: This figure displays the withholding rates applied by credit/debit card companies to firms making sales using a POS. The rates are differentiates by type of firm (receiving the income from the transaction). CEDE (*Control Especial de Empresas*) is the Uruguayan equivalent of the large taxpayer unit. This figure is discussed in Section 3.1.

Figure A.3: VAT Rebates Applied to Credit/Debit Card Purchases



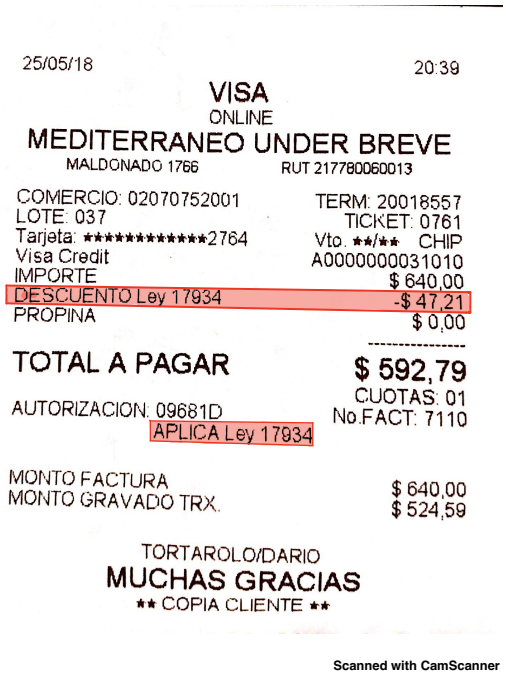
Notes: As discussed in Section 3.2, this figure displays the size of the VAT rebates (in percentage points) granted to consumers for various type of transactions with electronic payment technology. The rebate rates are differentiated by type of payment method and by transaction amount as measured in Unidades Indexadas (UI). In August 2014, 4,000 UI were equivalent to approximately USD 500. The standard VAT rate in Uruguay was 22 percent during the period of the study, and the reduced rate was 10 percent. A four percentage point rebate thus implies that the consumer paid a VAT of 18 percent on standard-rated goods and a rate of 6 percent on reduced-rate goods. This Figure is discussed in Section 3.2.

Figure A.4: VAT Rebates Logistics



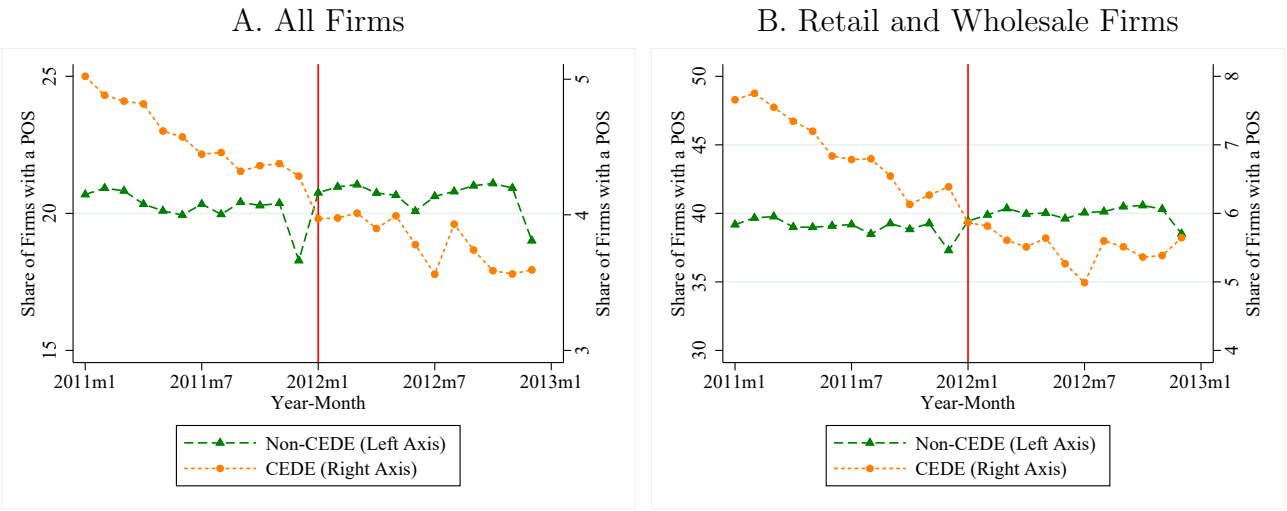
Notes: This Figure illustrates the VAT rebate logistics for all parties involved, as discussed in Section 3.2.

Figure A.5: Purchase Receipt with VAT Rebate



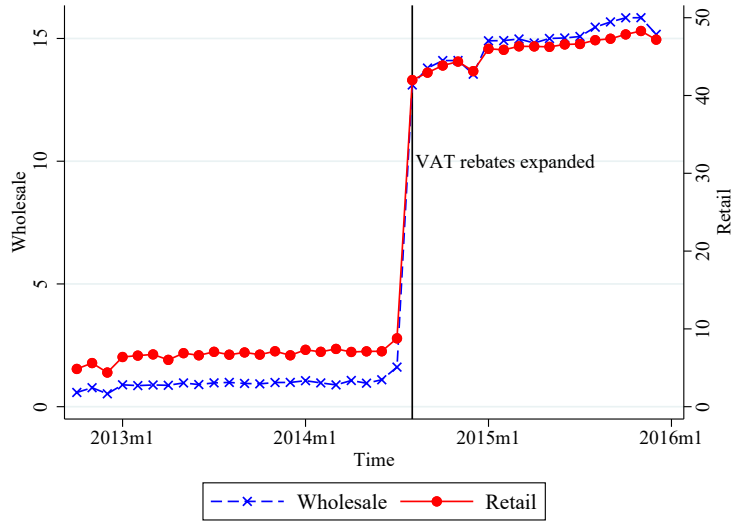
Notes: This figure shows an example of a receipt where a VAT rebate ("Descuento Ley 17934") was applied. This is discussed in Section 3.2.

Figure A.6: Share of Firms with a POS Around January 2012



Notes: This figure plots the share of firms that had a POS around January 2012, when withholding rates applied by credit/debit card companies on card purchases from non-CEDE firms were reduced. CEDE (*Control Especial de Empresas*) is the Uruguayan equivalent of the large taxpayer unit. This Figure is discussed in Section 6.

Figure A.7: Share of Firms Registering VAT Rebates for Consumers Paying by Card



Notes: This figure shows that the VAT rebates were indeed implemented starting on August 2014, as stipulated by the Financial Inclusion Reform. The figure plots the percentage of firms registering VAT rebates for consumers paying by credit/debit card, as captured in the card transaction data. Wholesale firms are on the left y-axis and retail firms on the right y-axis. The share of firms receiving VAT rebates prior to the reform is not zero, as card purchases at hotels, restaurants and tourism businesses have been subject to a 9 ppt VAT rebate since 2006. These firms should not be part of the retail or wholesale sectors in the ISIC classification, but there is some measurement error in firms' sector classifications. This figure is discussed in Section 3.2.

Figure A.8: News Coverage of the VAT Rebates

A. Information about VAT Rebate Introduction

B. Guide on How to Benefit from VAT Rebates

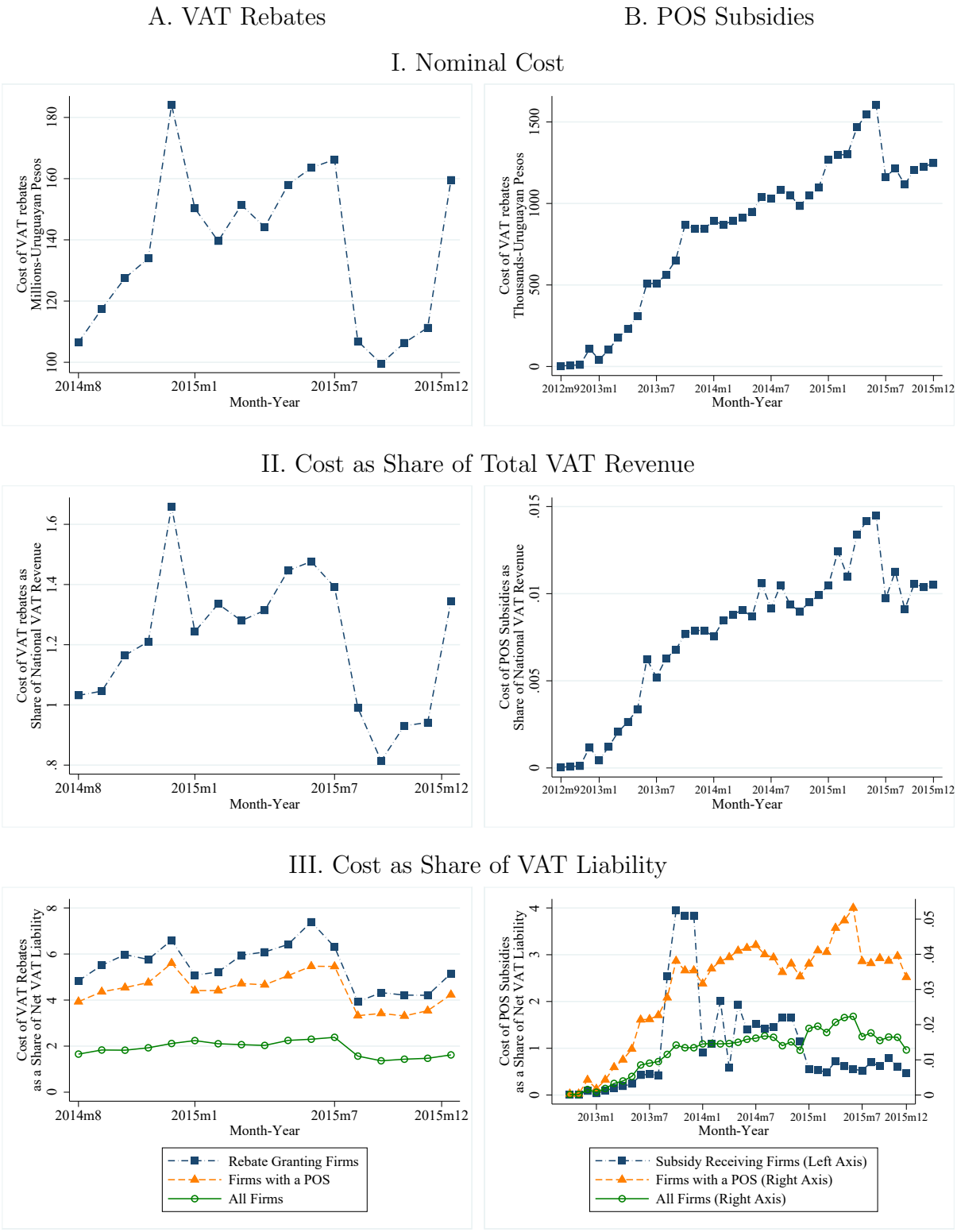
Notes: The figure displays examples of the media coverage of the VAT rebate introduction on August 1, 2014. The article in Panel A (published in June 2014) informs about the introduction on the VAT rebates, while the article in Panel B (published in August 2014) describes the steps consumers should follow to maximize their benefit from the VAT rebates. This is discussed in Section 4.2.

Table A.3: Mandates for Payments to be Conducted Electronically

Type of Transactions	**Initial Deadline**	**Final Deadline**
Tax payments	06/01/2015	06/01/2015
Payments to service providers to the state	12/01/2014	07/01/2015
Rental payments	12/01/2014	12/01/2015
Purchase of apartments/houses, cars, any transactions > UI 160,000 (USD 20,000)	06/01/2015	12/01/2015
Payments over 60,000 UI (180,000 USD) to professional service providers	05/01/2016	05/01/2016
Wages, pensions, social security contributions	11/01/2015	05/02/2017

Notes: This table shows the types of payments which the financial inclusion law mandated to be done through electronic payment methods, and the deadlines by which these mandates were initially meant to enter into effect, as well as the final deadlines which were ultimately applied, if applicable. Several of the deadlines had to be revised due to private sector opposition or logistical challenges. This table is discussed in Section 3.3.

Figure A.9: The Cost of VAT Rebates and POS Subsidies

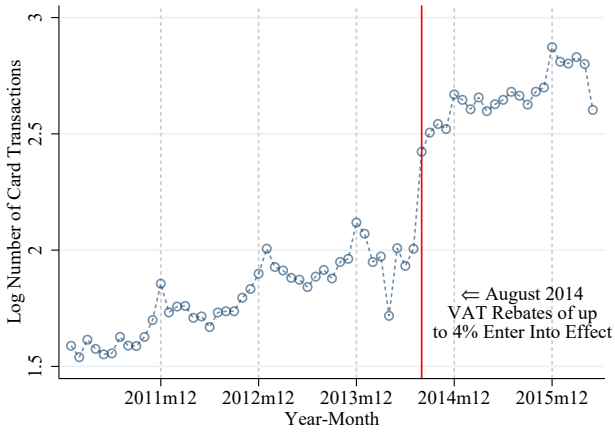


Notes: This figures examines the cost of the VAT rebates and POS subsidies. Panel A1 plots the nominal cost (in millions or Uruguayan pesos) of the VAT rebates. Panel A2 plots the cost of the rebates as a share of total VAT revenue (extracted from dgi.gob). Total VAT revenue includes domestic VAT revenue and VAT collected at customs. Panel A3 plots the cost of the VAT rebates of VAT-filing-firms relative to the net VAT liability of three different groups of firms, as per the labels. Panel B displays similar measures for the POS subsidies. For panel B, the values for November and December 2013 are an average over the two months, as we observe no subsidy payments in December 2013, and a disproportionately high number in November, suggesting that December payments were erroneously recorded in November.

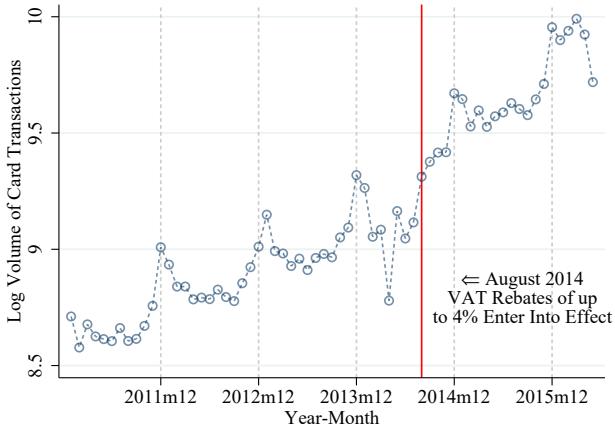
B Regression Discontinuity Appendix

Figure B.1: Raw Data with Outlier in April 2014

A. Number of Card Transactions

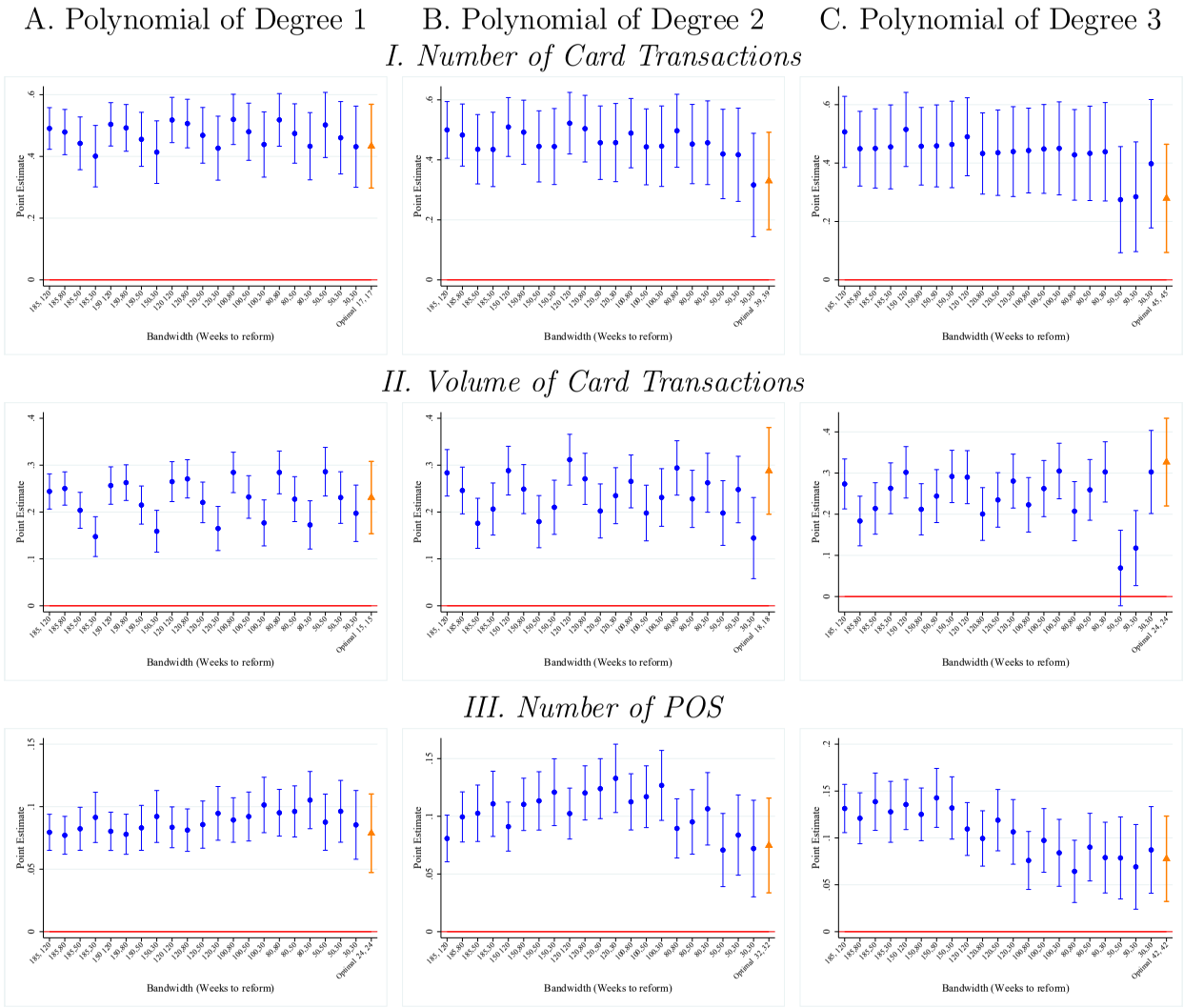


B. Volume of Card Transactions



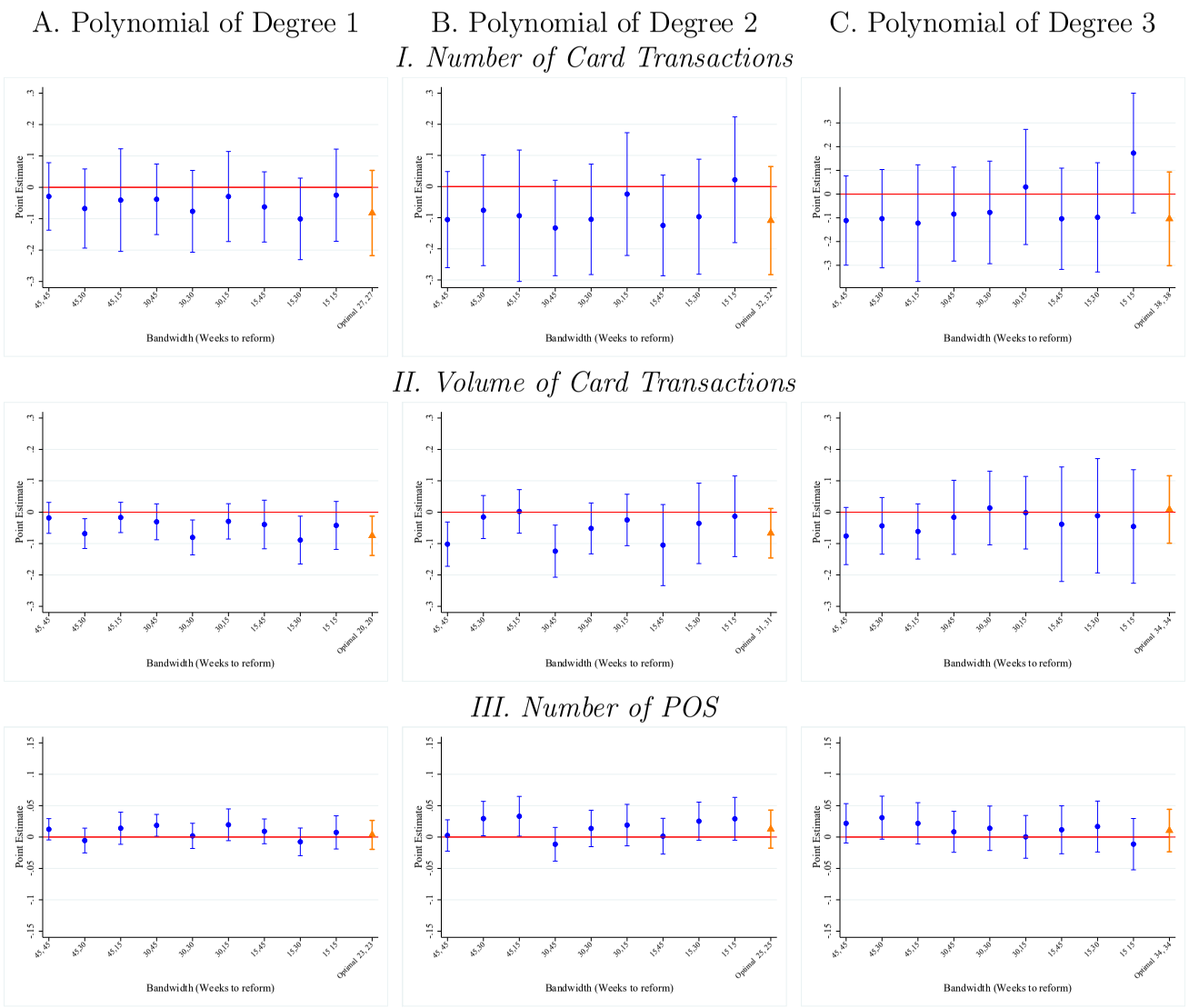
Notes: This figure shows that the months of April and May 2014 constitute outliers in terms of the number of card transactions and the volume of transactions, with a short-lived drop in both outcomes in April 2014 and a strong recovery in May 2014. We hypothesize that this might be due to consumers temporarily postponing purchases in anticipation of the passage of the financial inclusion reform. The VAT rebate provisions were indeed widely debated in the media and consumers might have falsely expected those provisions to enter into effect imminently. After realizing that the rebates would not enter into effect until August, they conducted in May the purchases they had initially postponed in April. To account for this, we average these two outcomes over April and May 2014, in Figures 2 and 3 and the subsequent robustness tests.

Figure B.2: Robustness of RD Estimates to Different Bandwidths and Degrees of Polynomial



Notes: This figure documents the robustness of the RD estimations discussed in Section 4.1 and displayed in Figure 2. Each panel plots the RD estimate γ_0 from equation 2 and the 95 percent confidence intervals, for different bandwidth values (weeks to reform). Each row reports results for a different outcomes, and each column presents the estimates for a different order of polynomial. The orange triangle marker indicate the result from an RD estimation with optimal bandwidth as in (Calonico et al., 2014).

Figure B.3: The Effect of the Reduction of VAT Rebates in August 2015 - RD Estimates

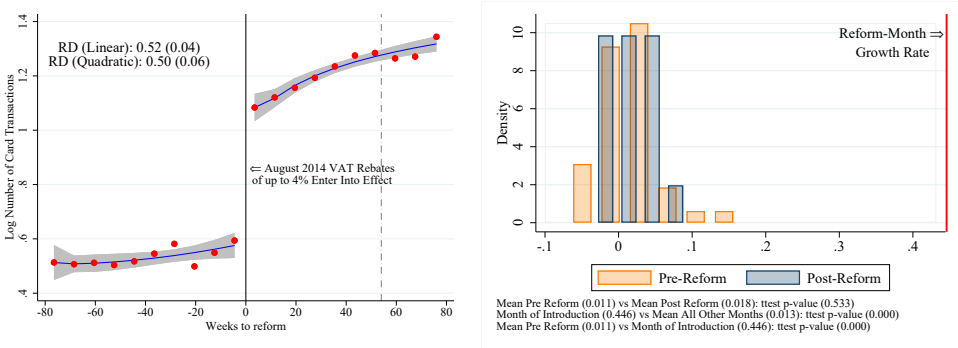


Notes: This Figure is similar to Figure B.2, but documents the RD estimates around the reduction of the VAT rebates in August 2015, showing that the reduction did not have a statistically significant effect on any of the outcomes.

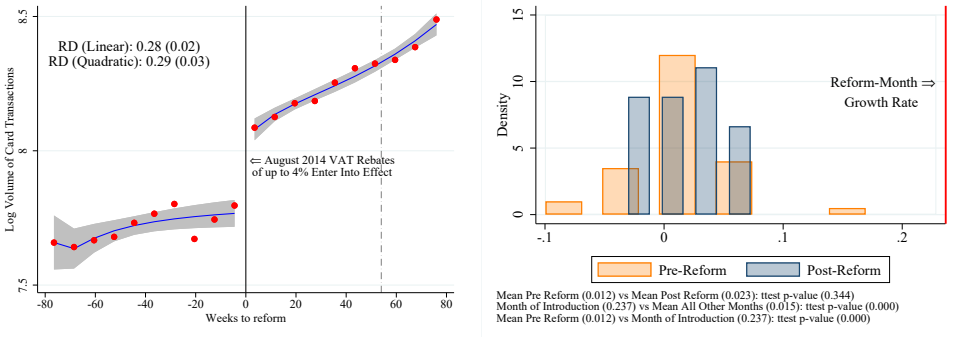
Figure B.4: Robustness of RD Estimates to Controlling for POS Subsidy Roll-Out

A. RD Estimates B.Month-on-Month Growth Rates

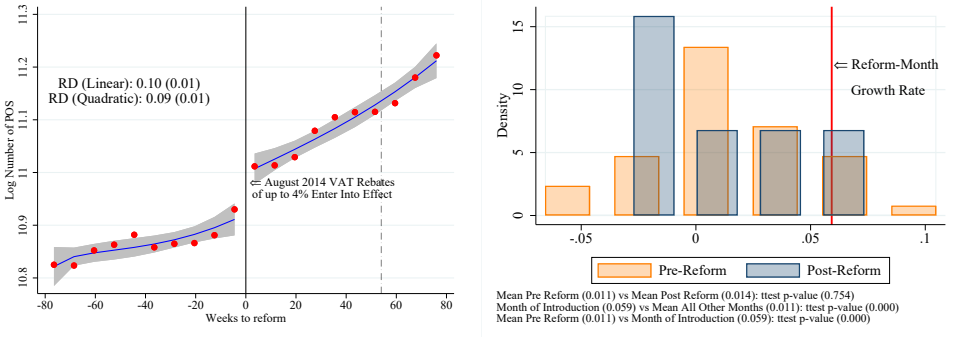
I. Number of Card Transactions



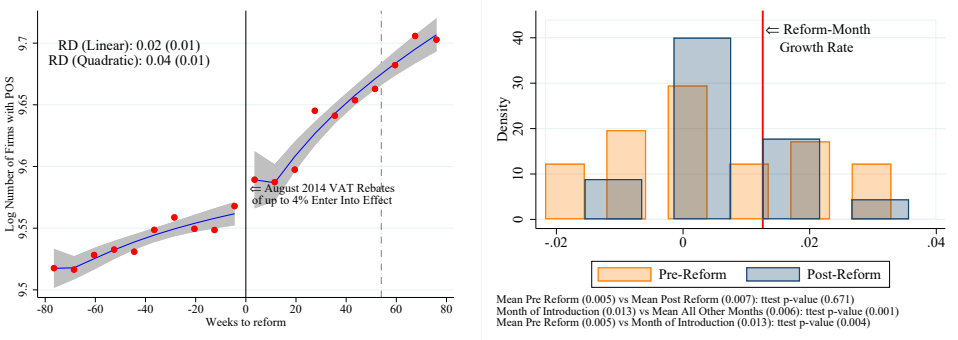
II. Volume of Card Transactions



III. Number of POS

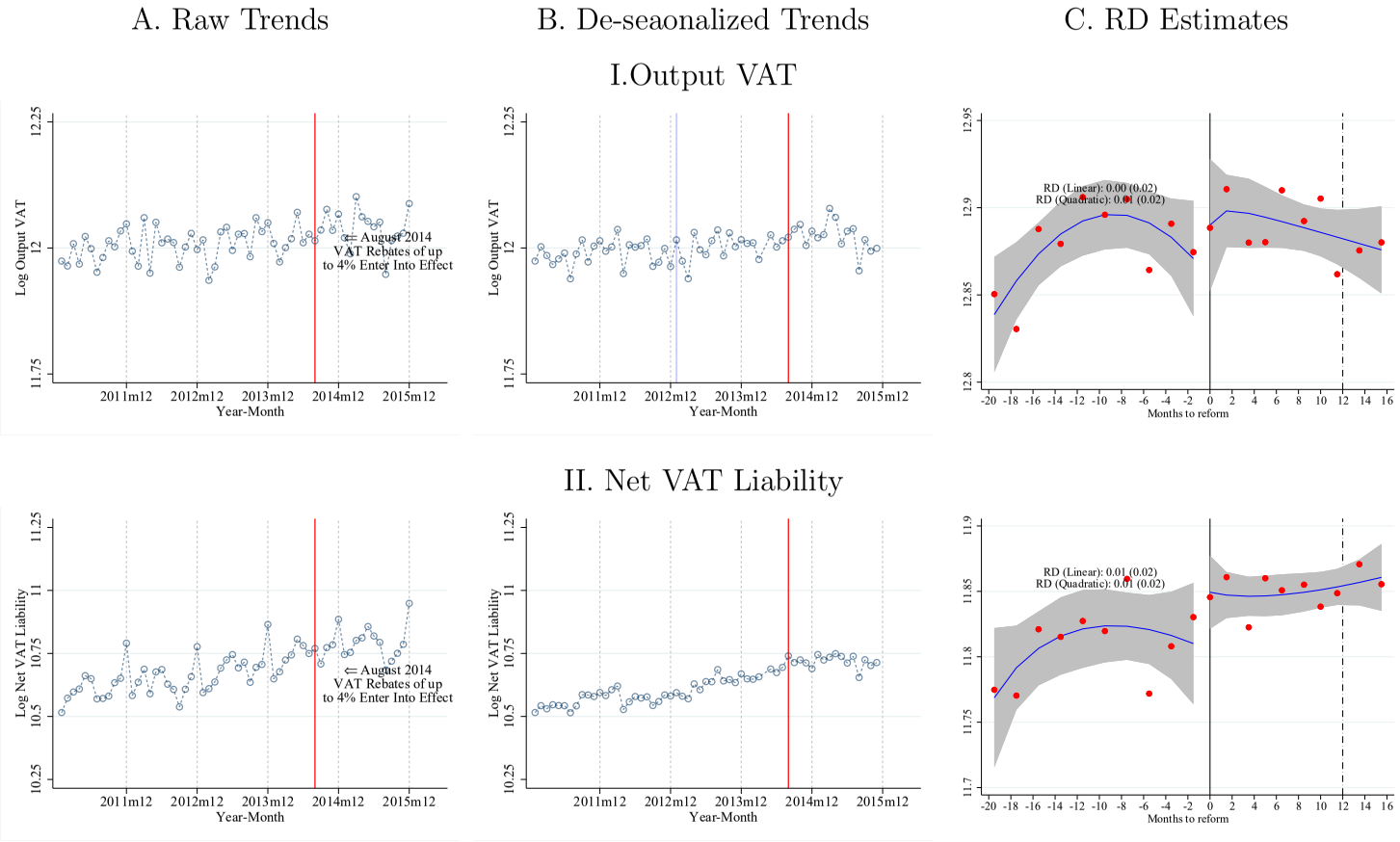


IV. Number of Firms with a POS



Notes: This Figure is similar to Figure 3, except that, when de-seasonalizing the data and estimating the RD and month-month growth rates, we include an additional term that allows for a trend break in January 2013, when the roll-out of the POS subsidies for firms began. This additional control does not substantially alter our results compared to our main specification.

Figure B.5: The Effect of VAT Rebates on the Use of Electronic Payment Technology
Raw Data, De-seaonalized Data and Regression Discontinuity Estimates for Monthly Aggregate VAT Outcomes



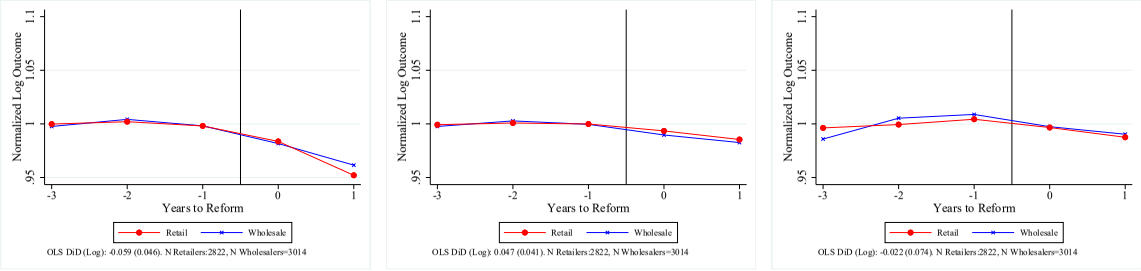
Notes: This figure examines the effect of the VAT rebate introduction on reported output VAT and net VAT liability. Note that the rebates are disbursed directly to consumers, with no change to how firms file their VAT declaration. The rebates should therefore affect VAT liability only through a compliance channel. Panel A plots the monthly aggregate values for each of the outcomes. Panel B plots the de-seasonalized trends of monthly outcomes as per equation 1 (with $p = 1$, i.e. a linear time trend). Panel C implements the RD estimation similar to equation 2 but using monthly aggregated data, and month to reform as a running variable. This Figure is discussed in Section 5.

C Difference-in-Difference Appendix

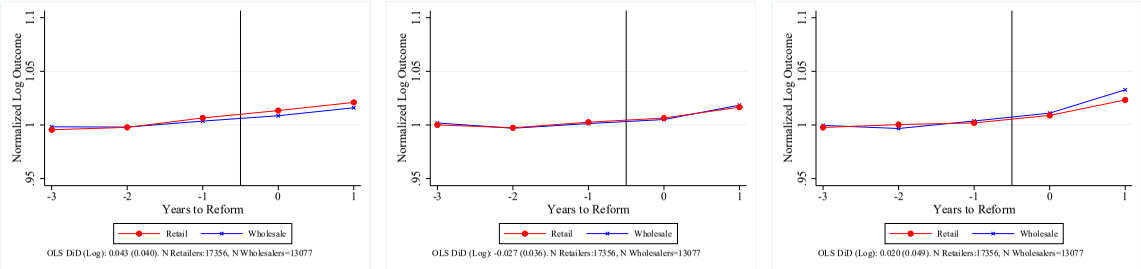
Figure C.1: Robustness of Difference-in-Difference Estimations to Alternative Specifications

A. Total Taxable Sales B. Output VAT C. Net VAT Liability

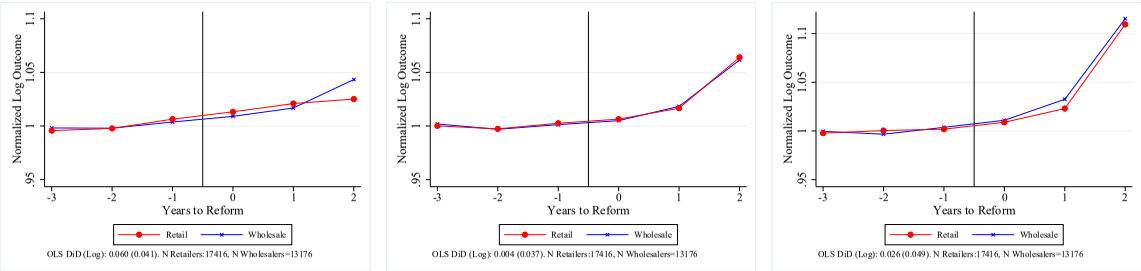
I. Balanced Sample, Winsorizing at p99, Excludes 2016 Data



II. Unbalanced Sample, winsorinzing at p95, Excludes 2016 Data

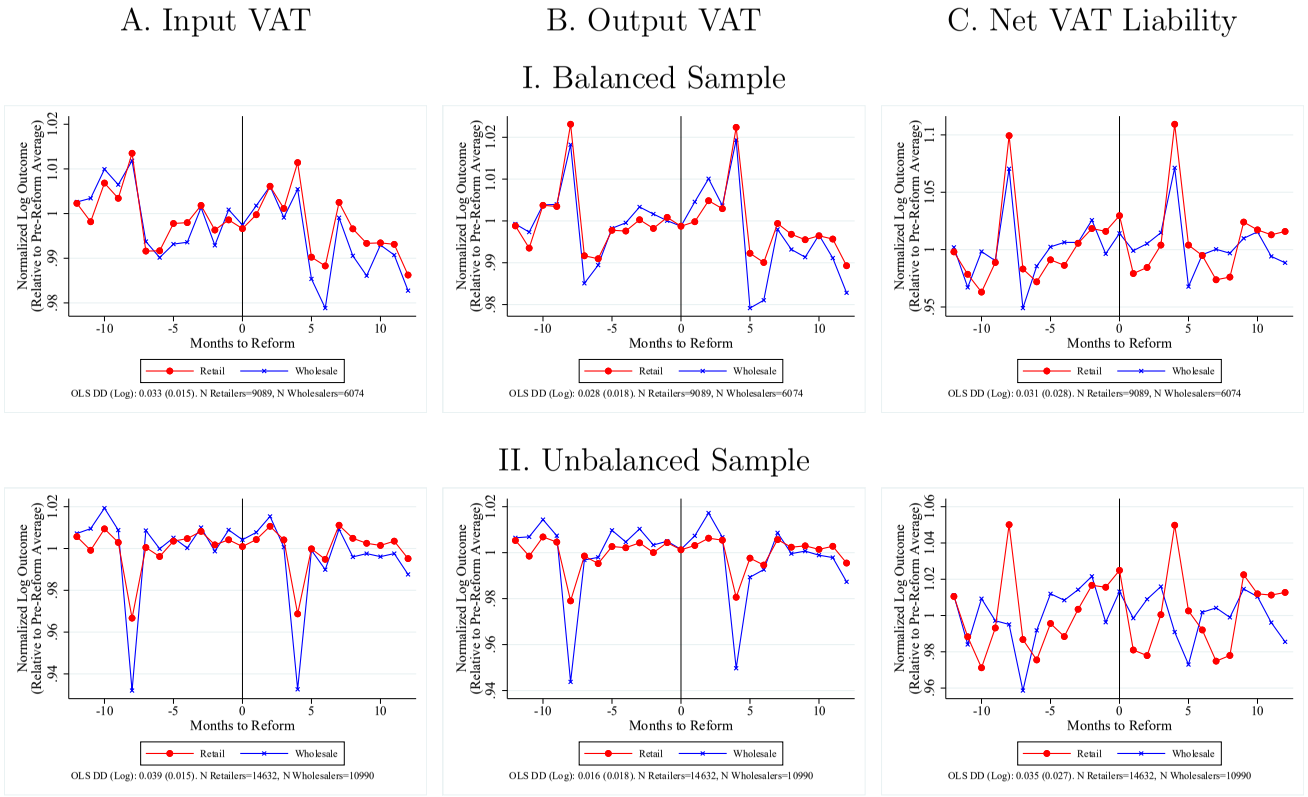


II. Unbalanced Sample, winsorizing at p 99, Includes 2016 Data



Notes: This figure is similar to Figure 4. It provides the graphical representation of the robustness tests presented in Table 1 and discussed in Section 5.2.

Figure C.2: The Effect of VAT Rebates on Tax Compliance
Difference-in-Difference Estimation on Monthly Data



Notes: These graphs implement the DiD estimation from Section 5.1, equation (3), using monthly data. The figure is constructed in the same way as Figure 4, except that the outcome variable is the monthly $log(y_{it}+1$. The vertical black line marks August 2014. For the unbalanced sample, both output VAT and input VAT exhibit a drop in the month of December due to the increase of firm filing a return just for that month (seasonal vendors), which lowers the average amounts.

Table C.1: The Effect of VAT Rebates on Tax Compliance
Difference-in-Difference Estimates, Annual Data

(a) Balanced Sample

	Taxable Sales		Output VAT		Net VAT Liability	
	(1)	(2)	(3)	(4)	(5)	(6)
Retailer · PostReform	-.059	-.056	.047	.037	-.022	-.065
	(.046)	(.046)	(.041)	(.041)	(.074)	(.077)
State · Year FE	No	Yes	No	Yes	No	Yes
Firm Size Decile · Year	No	Yes	No	Yes	No	Yes
N Treated	2822	2822	2822	2822	2822	2822
N Control	3014	3014	3014	3014	3014	3014

(b) Unbalanced Sample

	Taxable Sales		Output VAT		Net VAT Liability	
	(1)	(2)	(3)	(4)	(5)	(6)
Retailer · PostReform	.032	.018	-.026	-.045	.019	-.01
	(.04)	(.041)	(.036)	(.037)	(.049)	(.051)
State · Year FE	No	Yes	No	Yes	No	Yes
N Treated	17356	17356	17356	17356	17356	17356
N Control	13077	13077	13077	13077	13077	13077

Notes: This table displays estimates from equation 3. The estimation compares retail firms (treatment group) and wholesale firms (control group) between 2011 and 2015 to capture the effect of VAT rebates for electronic purchases introduced in August 2014 in different tax compliance outcomes (as per panel titles). Estimations in panel (a) use a balanced sample of firms that file a VAT return at least once in every quarter between 2010-2016. Estimations in panel (b) includes all firms that file a VAT return at any time between 2010-2016. For each outcome we display the base specification and an additional specification introducing group specific (state and firm size decile) trends as controls. The firm size decile is constructed using the average annual sales during the pre reform period (2011-2013). Outcome variables are winsorized at the 99th percentile. Standard errors are robust to heteroskedasticity and clustered at the firm level.

Table C.2: The Effect of VAT Rebates on Tax Compliance
Difference-in-Difference Estimates, Monthly Data

(a) Balanced Sample

	Output VAT				Net VAT Liability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Retailer · PostReform	.0278	-.0377	.0284	-.037	.0304	-.001	.03	-.0004
	(.0177)	(.0063)	(.0177)	(.0063)	(.0281)	(.01)	(.0282)	(.01)
State · Year FE	No	No	Yes	Yes	No	No	Yes	Yes
Firm Size Decile · Year	No	No	Yes	Yes	No	No	Yes	Yes
OLS (Log)	Yes	No	Yes	No	Yes	No	Yes	No
PPML	No	Yes	No	Yes	No	Yes	No	Yes
N Treated	9089	9089	9089	9089	9089	9089	9089	9089
N Control	6074	6074	6074	6074	6074	6074	6074	6074

(b) Unbalanced Sample

	Output VAT				Net VAT Liability			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Retailer · PostReform	.0159	-.0379	.0167	-.0372	.0351	.011	.0362	.0118
	(.0182)	(.0061)	(.0182)	(.0061)	(.0266)	(.0095)	(.0266)	(.0095)
State · Year FE	No	No	Yes	Yes	No	No	Yes	Yes
OLS (Log)	Yes	No	Yes	No	Yes	No	Yes	No
PPML	No	Yes	No	Yes	No	Yes	No	Yes
N Treated	14632	14632	14632	14632	14632	14632	14632	14632
N Control	10990	10990	10990	10990	10990	10990	10990	10990

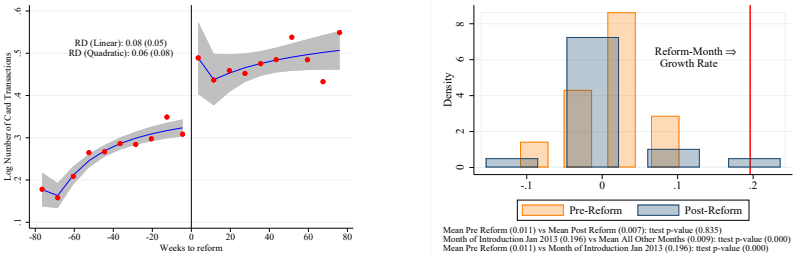
Notes: This table displays estimates from equation 3. The estimation compares retail firms (treatment group) and wholesale firms (control group) between August 2013 and August 2015 to capture the effect of VAT rebates for electronic purchases introduced in August 2014 in different tax compliance outcomes (as per panel titles). Estimations in panel (a) use a balanced sample of firms that file a VAT return at least once in every quarter between the third quarter of 2013 and the third quarter of 2015. Estimations in panel (b) includes all firms that file a VAT return at any time between 2013-2015. For each outcome we display the base specification and an additional specification introducing group specific (state and firm size decile) trends as controls. For both specifications we show the *beta* obtained from both equations estimated via OLS and pseudo-Poisson maximum likelihood. Outcome variables are winsorized at the 99th percentile. Standard errors are robust to heteroskedasticity and clustered at the firm level.

D POS Subsidy Appendix

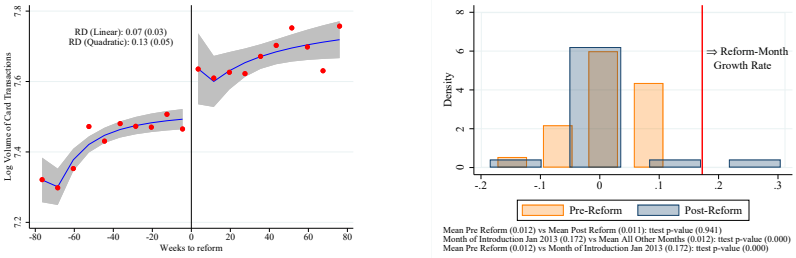
Figure D.1: The Effect of the POS Subsidy on the Use of Electronic Payment Technology
Regression Discontinuity Estimates and Month-on Month Growth Rates

A.RD Estimation B. Month on Month Growth Rates

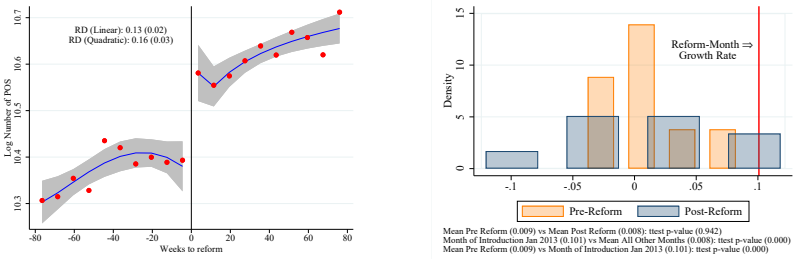
I. Number of Card Transactions



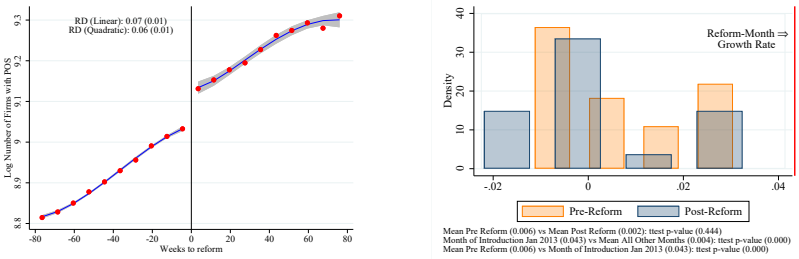
II. Volume of Card Transactions



III. Number of POS



IV. Number of Firms with a POS



Notes: This Figure is similar to Figure 2 and Figure 3 but focuses on the break around the introduction of POS Subsidies in January 2013.