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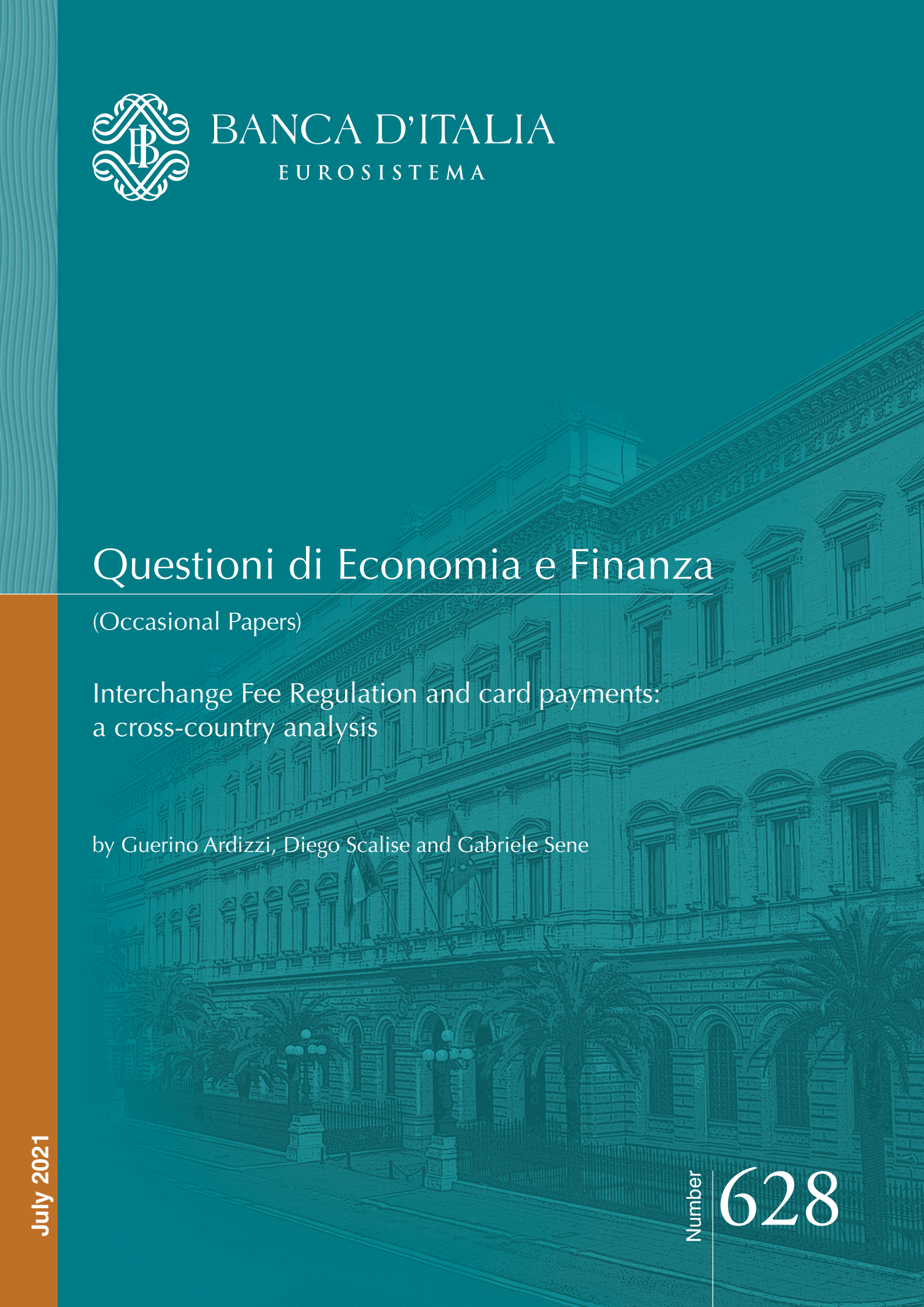

Questioni di Economia e Finanza

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INTERCHANGE FEE REGULATION AND CARD PAYMENTS: A CROSS-COUNTRY ANALYSIS

by Guerino Ardizzi[*], Diego Scalise[§] and Gabriele Sene[*]

Abstract

We study the relationship between interchange fees and card transactions in a large panel of countries and assess the impact of the Interchange Fee Regulation, introduced in 2015 in the European Union, on card usage. For our purposes, we take advantage of a newly assembled dataset covering almost 50 countries in the last decade and carry out two econometric exercises. Firstly, we estimate the relationship between card transactions per capita and average interchange fees by means of a panel estimator including both country and year fixed-effects, thus exploiting the broad heterogeneity across countries over time. Our results point toward a negative and significant relationship between the number and the growth rate of card-based transactions per capita and the level of interchange fees. Secondly, we adopt a difference-in-difference approach and compare the change in card payments in EU member countries (the treated group), before and after the implementation of the Interchange Fee Regulation in 2015, with that observed in a group of comparable countries (control group), which did not experience any change in interchange fee setting regulations. We find a strong and significant one-off impact of the Regulation immediately after its introduction and considerable propagation effects in the following years. Overall, we support the view that policy actions aiming at containing, but not eliminating, interchange fees can significantly contribute to the diffusion of electronic payments.

JEL Classification: E42, G2.
Keywords: interchange fees, regulation, card payments.
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Contents

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1. Introduction[1]

The interchange fee is the cost the merchant's bank (the acquirer) pays to the cardholder's bank (the issuer) when a card transaction is executed. In December 2015, Regulation (EU) 2015/751, known as the Interchange Fee Regulation (henceforth "IFR") came into force. The regulation harmonized interchange fees across the EU and reduced their level through a price cap (set at 0.2 per cent of the transaction value for consumer debit cards and at 0.3 per cent for consumer credit cards). One of the explicit rationale of the IFR was, indeed, to induce a reduction in final merchant fees by lowering interchange fees. Lowering merchant fees, in turn, should increase the acceptance of payment cards at the point of sale, spurring the development of electronic payments. According to the European Commission, the increase in the number of transactions was expected to compensate for the missed revenues of issuing banks[2], estimated at around €3 billion (European Commission, 2020). However, from a theoretical perspective the final effects of introducing such a cap are far from obvious. On the one hand, it can lead to higher card fees being set by issuing banks in order to compensate for losses on interchange fees, and to, reduced consumer protection, services and card rewards, therefore decreasing the use of cards even when merchants accept them. On the other hand, it may induce a reduction in merchant fees, and make more merchants willing to accept cards thus increasing card-based transactions. Many factors, such as competition between payments and merchant service providers together with consumers' elasticities to variation in transaction costs, may enter into play in determining the net effect of a change in interchange fees.

Research on the impact of regulating interchange fees is still limited and mostly confined to theoretical models; moreover, apart from a handful of within-country studies, international empirical evidence on the specific impact of the IFR on card transactions across countries is not available yet. This issue is particularly important in the current policy debate, as new payment instruments and schemes, as yet not fully regulated, are emerging in Europe as an effect of the rapid innovation witnessed by the payment industry. In this context, an impact analysis on past regulatory changes may help our understanding the potential effects of the adoption of different business models and fee schemes in less mature payment markets.

Our contribution to the literature is twofold. First, we directly study the relationship between interchange fees and card transactions using a newly assembled database that covers

[1] The views and the opinions expressed in this paper are those of the authors and do not necessarily represent those of the Bank of Italy. We would like to thank Massimo Doria, Paola Giucca, Ferdinando Sasso and Andrea Nobili for their useful comments and suggestions. All remaining errors are our own.

[2] This approach is consistent with the IMF recommendations about reform processes. Whenever possible, market equilibria compensating losers in the short period should be promoted, to weaken resistances from interest groups (Ostry et al., 2009).

almost 50 countries in the last decade. To this purpose, we employ a panel estimator including both year- and country-specific fixed-effects, with the aim of exploiting the broad heterogeneity in interchange fees and card usage across countries and over time. Second, using a diff-in-diff approach, we compare the variation in card payments in EU member countries before and after the implementation of IFR (2015) with that observed in a group of comparable countries, which did not experience any change in interchange fee setting regulation. This approach allows us to estimate the impact of the regulatory intervention in interchange fees in European countries.

We find a negative and significant relationship between the number (and the growth rate) of card-based transactions per capita and the level of interchange fees in the period 2010-19. Results are robust to the inclusion of a synthetic control of economic development (such as GDP per capita) and a very restrictive set of controls for observable and unobservable time-varying and country-specific characteristics (i.e. time and country fixed-effects). The diff-in-diff analysis confirms the results of the panel analysis and supports the anecdotal evidence (European Commission, 2020) about the spurring effect of IFR on cards usage. Finally, we show that further reductions of interchange fees, towards the "near-zero interchange fee" level, may exert unintended and negative effects on cards usage.

We organize the paper as follows. In Section 2, we provide a brief review of the background literature, while in Section 3 we describe our new dataset and present some stylized facts on interchange fees and card payments around the world in the last ten years. In Section 4, we describe our empirical analysis and present the main findings. Section 5 concludes and offers some policy remarks.

2. Background literature

A rich theoretical body of research on payment cards has flourished, along with the broader two-sided market literature, since the seminal contribution of Baxter (1983). Studies mostly concentrated on the determination of the market equilibrium for interchange fees and on the comparison of this level with the social optimum. Microeconomic models proposed (Schmalensee, 2002) stress the balancing effect of the interchange fees on different types of end-users (in the case of payment card services, the two types of end-users are consumers and merchants). Rochet and Tirole (2002) consider strategic reasons for merchants to accept payment cards, such as business stealing from other merchants, and find that the socially optimal interchange fee may be lower than the one set by banks. Among the factors affecting the market equilibrium level of interchange fees, indeed, theoretical models highlight the importance of merchants' resistance, consumer elasticity to benefits and charges, as well as competition among acquirers and issuers. High interchange fees, on the one hand, raise merchant fees and may turn

into merchants unwilling to accept cards and into steering consumers to other forms of payment, thereby decreasing the number of card transactions occurred at these merchants. On the other hand, high interchange fees can contribute to reduce card fees, enhance consumer protections, services and card rewards, and so to expand the use of cards at merchants accepting them. This highlights the basic balancing role played by an open card system's setting of interchange fees. Thus, while a decrease in interchange fees may result in greater merchant adoption, the increase in price to consumers may result in a decrease in consumer adoption and use. Considering that the number of transactions per capita, our measure of per capita card usage, can be decomposed as:

$$\frac{Number\ of\ transactions}{Inhabitants} = \frac{Number\ of\ transactions}{Number\ of\ POS} \times \frac{Number\ of\ POS}{Inhabitants} \quad (1)$$

it turns out that the expected net effect of a change in interchange fees on transactions per capita is far from obvious, encompassing the effect on consumers' adoption and use (first term[3]) and that on merchants' adoption (second term). The relationship between card transactions and interchange fees is likely to depend, among other factors, on elasticities across markets and competition in payments services, heterogeneous across countries.

However, due to a lack of specific data, testing of the theoretical framework remains rare. Empirical literature is scant and limited to within-country studies (consequently its findings are hardly generalizable). Results on European countries (Carbó Valverde et al., 2016 on Spain; Ardizzi, 2013 and Ardizzi and Zangrandi, 2018 on Italy) tend to support the view that merchant acceptance has increased because of a decline in interchange fees and hence in merchant costs. Second, consumers' adoption of cards did not seem to have significantly decreased because of lower interchange fees and higher fees or reduced benefits. As a result reductions in interchange fees led to a dramatic increase in payment card transactions, offsetting the decrease in the per transaction bank revenue. Empirical evidence for the rest of the world is mixed (see for example Kay et al., 2014 and Wang et al., 2014). To the best of our knowledge, there are no cross-country studies providing firm conclusions. This is particularly relevant since, as already discussed, country-specific factors such as the mechanism of determination of interchange fees, competition in payments market, elasticity of consumers and merchants, and cultural traits such as the preference for cash, are likely to shape the relationship between card transactions and

[3] The first term can be further decomposed into: $\frac{Number\ of\ transactions}{Number\ of\ cards} \times \frac{Number\ of\ cards}{Number\ of\ POS}$; the first term capturing consumers' usage, while the second consumers' adoption.

fees. In addition, within-country studies make it difficult, if not impossible, to control for world, regional or country-specific trends, which may be relevant in each payment card market.

3. Interchange fees and card transactions: international evidence

3.1 Data

We assemble a novel dataset covering information on interchange fees and payment cards market evolution over time, for around 60 countries in the last ten years. Our primary source of information on interchange fees are the Federal Reserve of Kansas City Reports[4] which contain detailed information on official interchange fees charged by VISA and Mastercard, for debit and credit card transactions, on an yearly basis, for a number of countries over time (2012-19). In addition to the official average rate for face-to-face transactions, rates charged for different types of cards (premium/non premium) and merchants (e.g. gas, grocery, e-commerce) are reported. We integrated and complemented this information with data reported by VISA and Mastecard for different countries, and by national central banks. As a result, we obtain a dataset covering interchange fee levels in 63 countries from 2010 to 2019. For EU28 countries, we use European Central Bank's Payment and Securities Systems Statistics data; for non-European CPMI countries, data are drawn by BIS Statistics on Payments and Financial Market Infrastructures[5]; for the remaining countries, we source data from Federal Reserve of Kansas City reports. Finally, to increase as much as possible the time and country coverage of our dataset, we filled as much missing value as we could by using data published by national central banks. We checked that information from different data sources was consistent for overlapping countries and years[6], excluding from the analysis those for which this was not the case. We normalize the total number of card payments (credit and debit) by inhabitants and take this as our main outcome variable. We take GDP per capita from the World Bank database.

Our final dataset is a pretty well balanced panel of 46 countries from 2010 to 2019, covering four years before and four after the implementation of IFR. Table 1 contains the full list of countries included in the analysis. We include countries from all the main geographical areas with a wide heterogeneity in terms of starting economic development, economic growth in the period analyzed, payment habits and payment system characteristics such as the mechanism of determination of interchange fees. Table 2 reports some descriptive statistics for our main variables of interest.

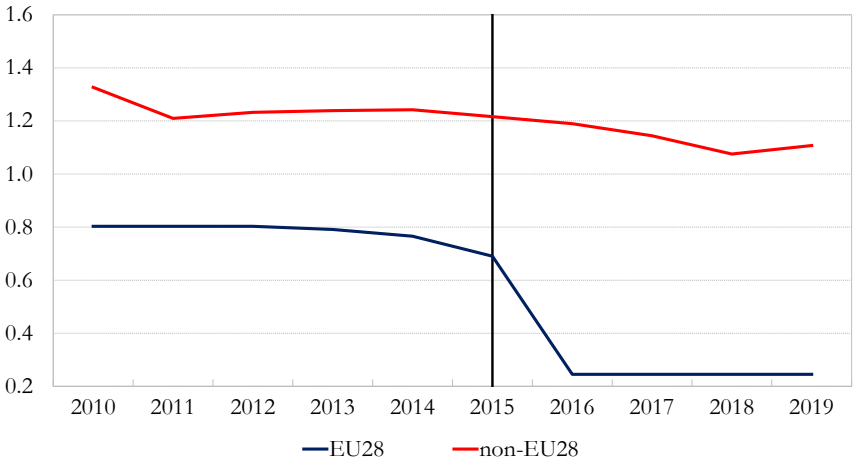
[4] Hayashi, F. (various years).
[5] We have also used data from several issues of the "ECB Blue Book Addendums" and the "BIS Red Book Statistics" to complete for some of the missing data.
[6] The correlation between the number of payments per inhabitant series from the three different data sources is always greater than 0.95 for countries kept in the analysis.

3.2 Stylized facts

Figure 1 reports the evolution over time of the average interchange fee[7] on credit and debit cards in EU28 countries, in comparison with the path observed in the other countries in the sample.

Figure 1: Average interchange fee over time

(percentage points)



Source: ECB, BIS, Fed Kansas City.

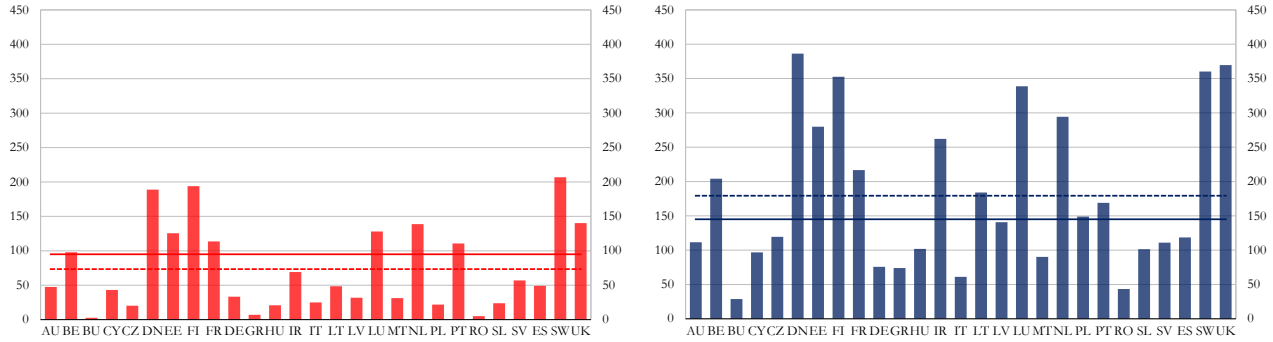
Following the implementation of the IFR, interchange fees reduced significantly in European countries, where they more than halved between 2015 and 2016, after having been stable in the previous five years. As expected, the Directive led to a harmonization across EU countries in the level of interchange fees with a rapid convergence toward the caps legally fixed (in 2010 they ranged from 0.4 to 1.6). No material changes occurred on average in the rest of the world during the same time span.

In the period 2010-19 transactions per capita at EU28 level strongly increased in all member states and they grew on average significantly more than in the rest of the countries considered (Fig. 2). A significant heterogeneity in terms of card usage characterizes European countries both at the beginning (ranging from less than 10 payment per inhabitant in Bulgaria, Romania and Greece to around 200 in Denmark, Sweden and Finland) and at the end of the observation period (with countries such as UK and Luxembourg reporting more than 350 transactions per capita).

[7] The choice of considering the simple average interchange fee is mainly dictated by data constraints, since disaggregated data on transactions made using different type of cards are not available across countries (or only for a limited subset of countries). However, fees across different card types tend to be highly correlated over time. As a robustness check, to assess the validity of the measure, we also performed a principal component analysis on the full sample: the first principal component explains more than 90 per cent of the variance and its factor loadings almost perfectly mimic the weights behind the simple average considered in the analysis.

Figure 2: Number of card payments per capita in EU28

2010 *2019*

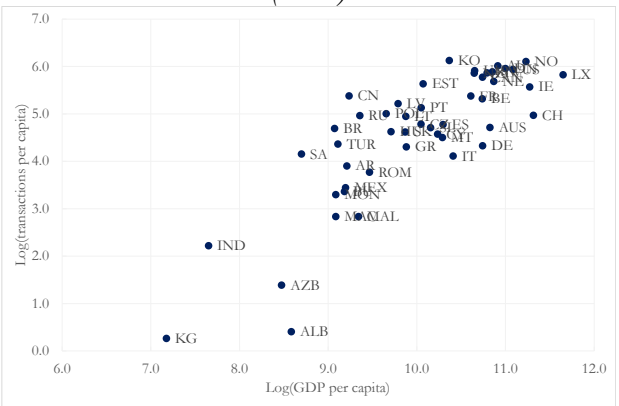


Source: ECB, BIS, Fed Kansas City. Red and blue lines indicate average values for European (dashed lines) and for extra-EU countries (solid lines).

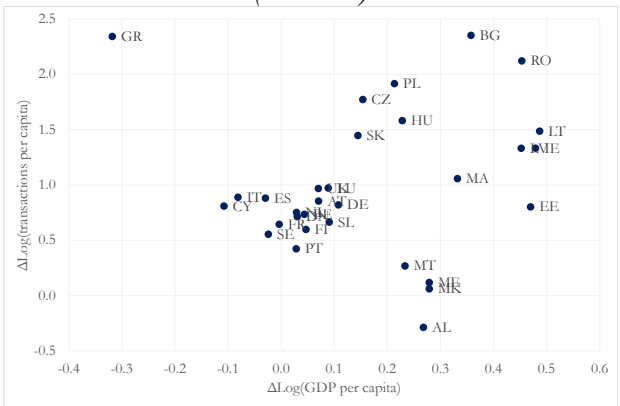
One key factor traditionally identified in the literature as a crucial driver of the differences in card payment diffusion among countries is the level of economic development (European Commission, 2020). Figure 3a confirms that countries with a higher GDP per capita generally tend to have higher volumes of card payments per capita. However, GDP only partially accounts for the observed differences in card payment levels. For instance, leading countries in card-usage, such as Denmark, Sweden, Finland and the UK, still present a significantly higher usage of cards in comparison to countries with similar GDP levels, such as Austria, Belgium and Ireland. Germany and Italy, notwithstanding a high ranking in terms of GDP per capita, are traditionally characterized by a preference for cash payments and register relatively low levels of card usage, even exhibiting significant growth rates between 2010 and 2019. Estonia also shows a high number of card payments relative to its economic development, with a volume almost as high as the one reported in the Netherlands and higher than richer countries such as Switzerland, France and Belgium. On the other hand, Albania reports a significantly lower number of card transactions than most of the countries at a similar level of economic development, both located in the same geographical area (such as Macedonia) and outside (such as South Africa and Brazil). When looking at variations in card usage across countries over time (Fig. 3b), the link with economic growth becomes considerably weaker.

Figure 3: Card payments and GDP per capita

a) Number of card payments and GDP per capita (2019)



b) Growth in card payments and GDP per capita (2010-19)



Source: ECB, BIS, Fed Kansas City and World Bank.

A simple correlation analysis (see Table 3) confirms that higher volumes of card transactions per capita tend to correspond to higher levels of GDP per capita.[8] Moreover, card transactions appear to be negatively correlated with the level of average interchange fees.

These pieces of evidence suggest that interchange fees can be an important factor in explaining changes in payment cards usage. These correlations, however, does not necessarily imply a causal nexus, due to the possible presence of omitted variable problems and other potential sources of bias. In the next Section, we provide an in-depth assessment of the relationship between interchange fees and card payments by relying on panel regressions.

4. Empirical Analysis

In this section, we report and comment the results obtained by the panel analysis and the diff-in-diff approach. As described in the previous sections, we exploit a dataset containing yearly information on the number of card (credit and debit) transactions per inhabitant, the average interchange fee charged on these transactions, and the GDP per capita for a sample of 46 countries over 10 years. The 28 countries in the sample belonging to the European Union witnessed the strong decline in interchange fees following the introduction of IFR in 2015.

4.1 Panel analysis

In the panel analysis we estimate the following relationship:

$$y_{it} = \alpha \times y_{it-1} + \beta_1 \times IF_{it} + \beta_2 \times GDPpc_{it} + \delta_i + \mu_t + \varepsilon_{it} \qquad (2)$$

[8] This is consistent with the seminal literature on demand of electronic payments (Humphrey 1996) and with the fact that per capita GDP also captures effects linked to both education and financial development (so-called financial literacy).

where y_{it}, is the logarithm of the number of debit and credit transactions per capita, or its first difference, measured for country *i* and year *t*, y_{it-1} is an autoregressive term (not included in all specifications), IF_{it} is the average interchange fee on debit and credit card transactions, our variable of interest, $GDPpc_{it}$ is the logarithm of GDP per capita in current US dollars (our main control variable), δ_i is a set of country fixed-effects, μ_t is the set of year fixed-effects, and ε_{it} is an error term. β_1 is the coefficient we are most interested in, because it gives us, on average in the observed period and across the countries included in the sample, the direction and the magnitude of the relationship between the number of card transactions and the interchange fees. The identification of the effect of our variable of interest on the outcome variable relies on the scheme of fixed-effects, able to control for the variables we are not including in the analysis or we cannot observe. Including GDP per capita in current US dollars allows synthetically controlling for many factors such as financial literacy, technological and productivity improvements, factor markets developments, inflation and exchange rate dynamics.[9]

The outcome variable in Table 4 is the logarithm of the number of transactions per capita. A simple random effects estimation (column (i)) confirms the negative and significant correlation between the number of card transactions and the average interchange fee; the coefficient for GDP per capita is positive and significant as expected. In column (ii) we introduce year fixed-effects, to control for unobservable shocks commonly affecting all countries: the coefficient for the average interchange fee reduces by two thirds, but it is still strongly significant, while the one on GDP per capita is virtually unchanged. This specification indicates that the number of card transactions follows some time trend and that, therefore, the initial random effect model suffers from an omitted variable problem and that, consequently, estimated coefficients are likely to be somewhat biased.[10] Once we include also country fixed-effects (column (iii)) the coefficient on average interchange fee is virtually unchanged, while the one on GDP per capita halves. This specification includes a set of double fixed-effects, controlling for all time-varying and country-specific observable and unobservable factors possibly affecting the relationship between the number of card transactions per capita and the

[9] Growth in nominal GDP in US dollars can be decomposed into the sum of the growth in real GDP per capita, inflation and variation in exchange rate.

[10] The coefficients for the year dummies show an increasing and almost linear path (see Fig. A1 in the Appendix); we substituted the year dummies with a linear time trend in all specifications. Results are virtually unchanged for both the average interchange fee and the GDP per capita. Therefore, we decided to keep the complete set of year dummies to remove any restriction on their coefficients, in order to better account for time-varying unobservables. With the inclusion of both a linear time trend and the year fixed effects, the significance of the coefficients of the dummy variables vanishes.

average interchange fee. According to these estimates, on average in the period considered and for all the countries included in the sample, a reduction of 100 basis points in the average interchange fee is associated to an increase of 35.5 per cent in card transactions per capita. To control for the presence of possible autoregressive pattern we then introduce the first lag of the dependent variable (column (iv)). The coefficient on the autoregressive component is significant and close to one, suggesting we should consider also the first difference of the outcome variable (namely the growth rate of number of card transactions): the coefficient capturing the effect of average interchange fee drops to -0.076 but is still strongly significant, while the one on GDP per capita is no longer significant; excluding this variable from the analysis delivers unaffected coefficients for the remaining regressors (column(v)). Finally, we estimate the relationship via an Arellano-Bond dynamic panel GMM estimator, both including GDP per capita and excluding it (column (vi) and (vii), respectively). This robustness check confirms the sign and the significance of the relationship between the number of card transactions and the average interchange fees.

Table 5 reports the results for the growth rate of the number of card transactions per capita (the first difference of the logarithm of the number of transactions per capita). Since in the previous analysis we found that excluding the GDP per capita when it is not significant does not affect other coefficients, we present the results of the analysis on the growth rate of transactions per capita in two panels: in panel a) GDP per capita is included in all specifications, in panel b) it is excluded; all the remaining coefficients but the constant are unaffected, therefore we will comment only on panel b). Here all specifications include a full set of double fixed-effects (country and year). Our benchmark specification confirms a negative and significant relationship between the growth rate of card transactions per capita and average interchange fee (column (v)). Even including the lag of the number of transactions per capita, the lag of its growth rate, or both (columns (vi), (vii) and (viii), respectively), the coefficient for the average interchange fee maintains the same significance and magnitude, suggesting that a reduction of 100 basis points in the average interchange fee is associated to an increase of about 8 per cent in the growth rate of the number of card transactions.

4.2 Diff-in-diff analysis

We now employ a diff-in-diff approach and estimate the following relationship:

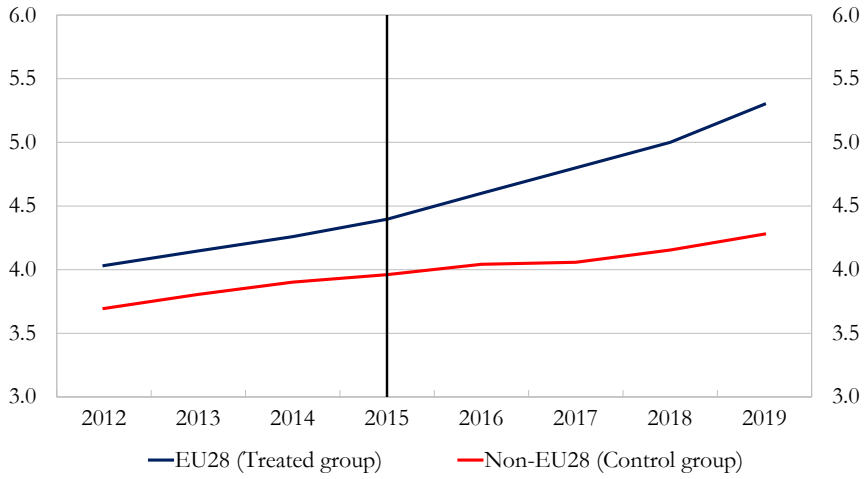
$$y_{it} = \beta_1 \times (TREAT_i * POST2015_t) + \beta_2 \times GDPpc_{it} + \delta_i + \mu_t + \varepsilon_{it} \quad (3)$$

where y_{it}, is again the logarithm of the number of debit and credit transactions per capita, or its first difference, measured for country *i* and year *t*, $TREAT_i$ is a dummy variable equal to one

if the country is part of the EU (therefore subject to the IFR), $POST2015_t$ is a step dummy equal to one for years after 2015 (when the IFR was introduced), $GDPpc_{it}$ is the logarithm of GDP per capita (our main control variable), δ_i is a set of country fixed effects, μ_t is the set of year fixed effects, and ε_{it} is an error term. In this case β_1 represents the *average treatment effect*, measuring the effect of being a country subject to the IFR after 2015, then to belong to the treated group, with respect to what happened in the control group. In this case, the identification relies upon three hypothesis: the treatment is random, the treated and the control group are similar for characteristics not correlated to the treatment, and the dynamics of the outcome variable was similar in both group before the treatment. Treatment was an automatic consequence of being member of the European union, and hence exogenous to country characteristics. As a control group, we selected 14 countries[11] within our sample experiencing no legal[12] or de facto (material) change in interchange fees between 2010 and 2019. One advantage of looking directly at officially published fees is that we are able to exclude countries with significant market developments that may confound the estimation of our treatment effect. Our control group has a good geographical coverage (three non EU Member European countries, five Asian, two North American, two South American, one from Oceania and one African) and shows, on average, comparable levels of economic development and starting level of card transactions per capita to those registered in treated countries (Table 3). In addition, within group variance closely resembles that observed among European countries for both variables. Interestingly treated and untreated countries reported very similar pre-treatment growth rates in card transactions, while trajectories diverged significantly after 2015.[13] One of the most binding identification assumption behind diff-in-diff model is, indeed, the existence of a parallel pre-treatment trend between treated and untreated countries. Intuitively, this assumption requires that in order to estimate a proper causal effect, control units must provide the appropriate counterfactual of the trend that treated units would have followed if they had not been treated (Kahn-Lane and Lang, 2020). Figure 4 shows that treated and untreated countries started with very similar levels of card transactions per capita and reported very similar trends in card payments in the pre-treatment period, hence supporting the view that the control group provides a good counterfactual.

[11] United States, Canada, Brazil, New Zealand, Malaysia, Azerbaijan, Mexico, Russia, Turkey, Iceland, Macedonia, Kyrgiz Republic, Montenegro, South Africa.
[12] Bradford e Hayashi (2008).
[13] A t-test, checking for the difference in means, cannot reject the null hypothesis of equality between the treated and the control groups in terms of average number of transactions and GDP per capita in 2015, and growth rate of transactions per capita between 2012 and 2015. These results confirm the validity of the control group and the parallel trend assumption, and therefore the robustness of the results obtained with the diff-in-diff analysis.

Figure 4: Card transactions: treated and control groups



Source: ECB, BIS, Fed Kansas City and World Bank.

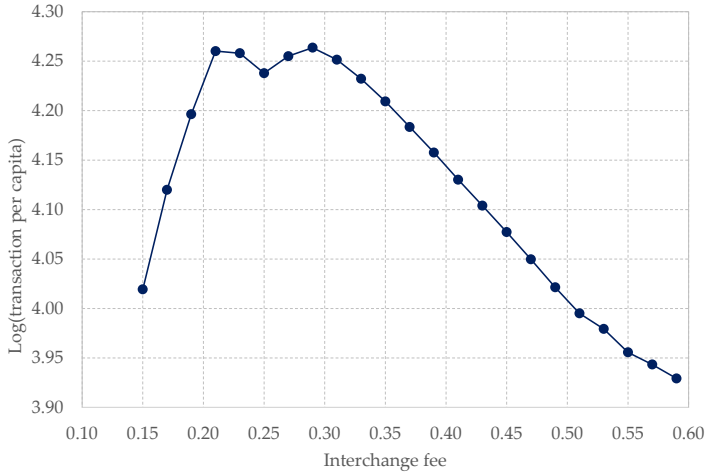
Therefore, a significant coefficient for $TREAT_i * POST2015_t$ captures the effect of the introduction of IFR, and of the consequent drop in average interchange fees in EU countries, on card transactions. Panel a) in Table 7 reports the results for the logarithm of the number of card transactions per capita; all specifications include sets of time and country fixed-effects. Column (i) and (ii) report estimation results of the effect using the whole sample period: in the countries where interchange fees have been capped, the number of card transactions increased by about 30 per cent, indicating that the regulation turned out to be very effective in boosting the use of debit and credit cards. Restricting the sample period to two years before and after the IFR (column (iii) and (iv)) the effect remains strongly significant, even though it reduces to about 20 per cent. This is probably due to the time the regulation may take to fully exert its effects on end-users: since transmission passes through the reduction of merchant fees and a consequent higher acceptance of card payment at POS, this process may take several quarters to complete. Switching to the growth rate of transactions per capita (panel b)) the effect is still sizeable, even with a lower degree of significance. Shrinking the time span to the 2013-17 period, the coefficient for $TREAT_i * POST2015_t$ almost doubles, to about 6.5 per cent, thus signaling a more intense acceleration of card transactions in the period closer to the treatment. The results for the level of card transactions and their growth rate are coherent, describing a strong and relevant one-off impact of the IFR immediately after its introduction together with a considerable propagation of its effects in the following years.

4.3 Sensitivity analysis around the cap

To assess whether the diffusion of card payments can benefit by further reductions of the interchange fees, we employ a local non-parametric estimator around the threshold set by the

IFR. This approach, making no assumptions about the functional form of the relationship between the outcome and the covariates, is robust to misspecification issues and allows for different behaviors in card usage at different levels of interchange fees. Figure 5 reports the estimated marginal effects: under the lower cap set by the IFR (0.2 per cent), at the "near-zero interchange fee" level, further reductions in the fees are associated with a sudden decrease in transactions per capita.[14] These results are likely to be driven by demand factors: with "near-zero interchange fee" the issuing bank may not be adequately remunerated and could shift this loss to the cardholder by applying higher fees on card usage; the cardholder would, in turn, use cards less frequently. Therefore, even in presence of a high level of acceptance by the merchants, we may witness a decrease in card transactions per capita. These results, complementing the ones presented in the previous sections, indicate that containing interchange fees can foster the diffusion of card payments but, at the same time, pushing their level too close to zero (or beyond) may exert unintended and negative effects. It is worth mentioning that such evidences refer to the use of cards as payment instruments in a sort of "constrained" interactions between the payer and the payee at the POS and are not necessarily extendable to other contexts, such as ATM withdrawals: in these cases cardholders can usually choose among a large number of alternatives including the ones provided by their issuing bank, most times not subject to fees.

Figure 5: Marginal effects at "near-zero interchange fee level"



Source: ECB, BIS, Fed Kansas City.

5. Conclusions

In this paper, we have analysed the relationship between interchange fees and card transactions per capita in a large sample of countries. Our work contains some important novelties compared with previous studies on this topic. By assembling a novel dataset, we were

[14] The estimated average marginal effect (-0.33, significant at 99% confidence level) is in line with the results of the panel estimation presented in Section 4.1.

able to perform a panel analysis whose identification strategy relies on the introduction of a set of double fixed-effects, a powerful and synthetic method to control for unobserved country- and time-specific factors. Secondly, we exploited the strong decrease in interchange fees in European countries following the IFR in 2015, to identify more precisely its effects on the number of card payments. Using a diff-in-diff approach, we compared the dynamics of card payments, before and after 2015, in EU member countries, and in a group of comparable countries, which did not witness any material change in interchange fees.

Our results indicate the existence of a negative and significant relationship between interchange fees and both the number of card transactions per capita and their growth rates. In addition, we find that the IFR, after its implementation, significantly boosted card usage in EU member countries, in line with the regulatory intentions.

Our findings are very important from a policy perspective and support the view that low interchange fees contribute to wider usage of electronic payments. Even if the discussion about the optimal level of the interchange fees is beyond the scope of this paper, by using a non-parametric local estimation, we find that further reductions in the fees below the level set by the IFR may lead to an unintended decrease in transactions per capita. This effect is likely to derive from a reduction in card usage due to higher fees charged to the cardholders by those issuers penalized by the "near-zero interchange fee". For these reasons, in the context of payment services, setting interchange fees to zero (or negative values) does not seem to be an optimal choice to encourage card payments. Moreover the pricing and the sustainability of the provision of payment services are strictly connected to competition and innovation issues: with near-zero remuneration only providers able to compensate for their loss of income with other revenues would stay on the market, cutting out the more specialized ones and raising barriers to the entrance of new, and usually more innovative, players. In addition, technological changes may significantly affect the modalities and the costs of interactions at the POS: understanding the link between current fee schemes, innovation and future competition in card payments becomes crucial and is part of future research agenda.[15]

Finally, since we clearly assess the effects that a regulatory intervention exerted on a very important segment of the payment market, our evidence may give reliable indications on the business models and fee schemes to be adopted in less mature payment systems, in order to foster their development and diffusion.

[15] Analyses of the contribution of merchants' adoption and card use to the dynamics of transactions per capita, as well as studies on potentially heterogeneous effects of variations in interchange fees in markets with different levels of competition and different absolute levels of fees, are also part of the research agenda.

Appendix A – Tables and Figures

Table 1 – List of countries in the dataset (according to IMF classification)

European Union	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Moldova, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom
Europe non-EU	Albania, Bosnia, Iceland*, Kosovo, Monaco, Montenegro*, Macedonia*, Switzerland
South America	Argentina, Brazil*, Mexico*
North America	Canada*, United States*
Asia	Azerbaijan*, Belarus, China, Georgia, India, Israel, Japan, Korea, Kyrgyz Republic*, Malaysia*, Russia*, Turkey*
Africa	South Africa*
Oceania	Australia, New Zealand*
* *included in the "control group" in the diff-in-diff analysis.*	

Table 2 – Descriptive statistics

	Mean	Std. Dev.	Min	Max	Obs
Log(transactions per capita)	4.05	1.41	0.22	6.12	458
Log(GDP per capita US$)	0.85	0.51	0.18	2.9	458
Average interchange fee	0.85	0.51	0.18	2.9	458

Table 3 – Correlations

	Log(transactions per capita)	Log(GDP per capita US$)	Average interchange fee
Log(transactions per capita)	1		
Log(GDP per capita US$)	0.81***	1	
Average interchange fee	-0.45***	0.28**	1

Table 4 – Panel estimation: transactions per capita

	dependent variable: Log(transactions per capita)						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
Average Interchange Fee	-0.917***	-0.342***	-0.355***	-0.076***	-0.077***	-0.155***	-0.156***
Log(GDP per capita)	0.758***	0.778***	0.358***	0.037		0.044	
Log(transactions per capita)$_{t-1}$				0.938***	0.943***	0.868***	0.869***
Constant	-2.712***	-3.752***	0.410	0.014	0.364***	0.328	0.761***
Year fixed effects	NO	YES	YES	YES	YES	NO	NO
Country fixed effects	NO	NO	YES	YES	YES	NO	NO
Number of groups	46	46	46	46	46	46	46
Observations	430	430	384	384	384	338	338
Estimation tecnique	Panel Random Effects		Panel Fixed Effects			Arellano-Bond dynamic panel GMM	

Note. For all specifications sample period is 2010-2019.

Table 5 – Panel estimation: growth rate of transactions per capita

	dependent variable: ΔLog(transactions per capita)							
	a) including GDP				b) excluding GDP			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Average Interchange Fee	-0.059**	-0.076***	-0.065**	-0.077***	-0.059**	-0.077***	-0.064**	-0.077***
Log(GDP per capita)	0.014	0.037	-0.058	-0.034				
Log(transactions per capita)$_{t-1}$		-0.062***		-0.060**		-0.060***		-0.062**
ΔLog(transactions per capita)$_{t-1}$			-0.049	-0.014			-0.052	-0.014
Constant	0.000	0.014	0.730	0.727	0.145***	0.378***	0.157***	0.398***
Year & Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Number of groups	46	46	46	46	46	46	46	46
Observations	384	384	338	338	384	384	338	338

Note. For all specifications sample period is 2010-2019 and estimation tecnique is panel fixed effects.

Table 6 – Control group validity

	Treated group	Control group
Log(transactions per capita, 2015)	4.4 [2.4-5.7]	3.9 [1.4-5.9]
Log(GDP per capita US$, 2015)	10.1 [8.9-11.5]	9.6 [8.7-11.1]
Average interchange fee, 2015	0.7 [0.3-1.6]	1.2 [0.6-1.8]
Transactions per capita: var. % 2012-15	22.3	25.0
Transactions per capita: var. % 2015-19	49.8	38.2

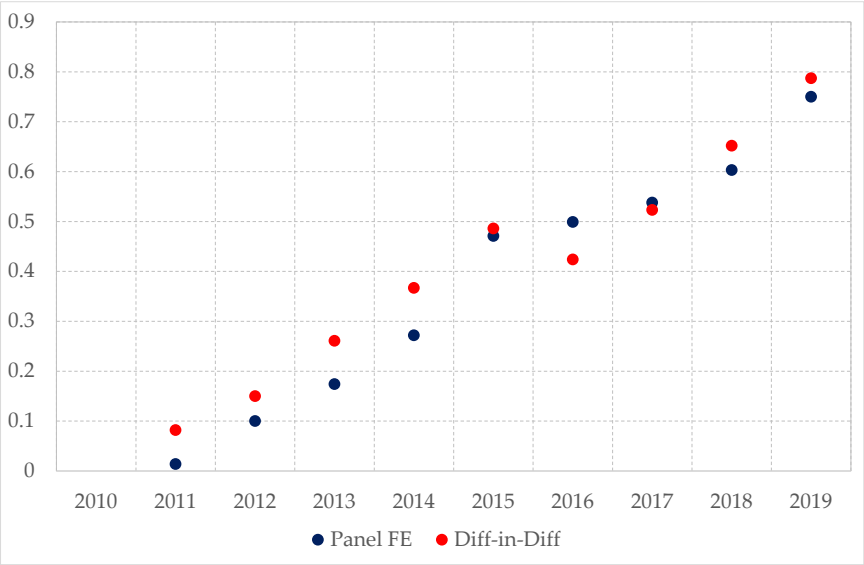
Average values; ranges in brackets.

Table 7 – Diff-in-diff

dependent variable:	a) Log(transactions per capita)				b) ΔLog(transactions per capita)			
	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
TREAT * POST2015	0.305***	0.311***	0.202***	0.193***	0.039*	0.038*	0.05	0.067**
Log(GDP per capita)	0.047		-0.09		-0.011		0.162	
Constant	3.290**	3.765***	4.943***	4.036***	0.200	0.087***	-1.517	0.114***
Year & Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Sample period	2010-2019	2010-2019	2013-2017	2013-2017	2010-2019	2010-2019	2013-2017	2013-2017
Number of groups	42	42	42	42	42	42	42	42
Observations	380	380	200	200	340	340	200	200

Note. For all specifications estimation tecnique is panel fixed effects.

Figure A1: Estimated coefficients for year dummies



Note. The reported coefficients refer to the specification in column (ii) of Table 4 and in column (i) of Table 7, for the panel and the diff-in-diff analysis respectively; all coefficients are statistically significant.

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