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An application of the tourist test to Colombian merchants

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ABSTRACT

As in many developing economies, cash is still widely used in Colombia, even among merchants who accept payment cards. Indeed, 60% of these merchants use dissuasive strategies to make their clients pay with cash. This paper presents estimates of merchant card fees that are optimal according to the Tourist Test, so that merchants are indifferent between being paid with cash or cards. We find the estimates are far below the rates that the industry charges because of the low marginal costs of cash and the incentives that sales-tax evasion—a common practice in many developing economies—adds to its promotion. Moreover, we find that reductions in cash usage may lead to an increase in optimal merchant card fees due to scale effects. The results show that the Tourist Test should be used as a guideline for regulators but ought to be complemented with a broader analysis of the industry.

1. Introduction

The use of electronic payments is growing rapidly in developing countries, but to achieve its consolidation, merchants' acceptance must increase. One of the reasons merchants are reluctant to adopt electronic payments is the associated high costs. This is the case with payment cards because merchants are sensitive to their processing costs compared to cash. In fact, the last two decades have witnessed pivotal litigation processes filed by merchants² and regulatory interventions or voluntary agreements to reduce card fees.³

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² <https://www.nbcnews.com/business/visa-mastercard-7-3-billion-settlement-over-credit-card-fees-881386>; <https://www.pymnts.com/news/payment-methods/2016/visa-mastercard-merchant-antitrust-settlement/>

³ In countries such as Canada, the United States, New Zealand, Australia, and the European Union.

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Several studies have investigated the costs of various retail payment methods; some estimate the social costs (e.g., Australia, Belgium, Netherlands, Portugal, and Norway) and others focus on the costs incurred by merchants.⁴ Studies have found the costs of payments are non-negligible and that cash payments often carry the lowest cost for small transactions. They have also found credit cards are the costliest payment method for merchants. Hayashi (2021) found that debit cards are more expensive than cash for merchants in the United States; however, cash was found to be costlier to accept than debit cards in Australia, Canada, the Netherlands, Norway, and Sweden. Other studies have found that debit and credit cards are the costliest means of payment for merchants mainly because of the fees that banks charge them for card payment transactions (i.e., merchants service charge; MSC), which account for more than 80% of the costs (Carbó-Valverde and Rodríguez-Fernández, 2019; Kosse et al., 2017).

Merchant interchange fees (MIFs), the fees that issuing banks charge to acquiring banks, have been at the center of the discussion because they constitute a price floor on the final MSC that acquiring banks charge to merchants (Baxter, 1983; Rochet and Tirole, 2002, 2003). As such, MIFs have come under antitrust scrutiny in several countries, and empirical evidence shows a positive effect of MIF reductions on the growth of payment card transactions at the point-of-sale (POS; Ardizzi, 2013; Ardizzi et al., 2021; Chakravorti et al., 2009;).

The Reserve Bank of Australia began regulating the MIF for credit cards in 2003 and debit cards in 2006 and the country now has a relatively low-cost payments system (Hayashi and Nimmo, 2021). In the European Union, caps on interchange fees came into force as of December 2015 (0.2% for debit cards and 0.3% for credit cards). As a result, in some countries of the Union (e.g., Hungary, Romania and Slovenia), card fees were reduced by more than half. In the United States, since the Durbin Amendment (DA) to the Dodd-Frank Act in 2010, the Board of Governors of the Federal Reserve (Fed) began to regulate the MIFs on debit cards with caps that are currently set at USD 21 cents, plus 0.05% of the transaction value.

Developing countries, including South Africa, Malaysia, China, and Serbia, have introduced MIF regulations. In Latin America, the Central Bank of Argentina committed to reducing the MIFs for debit and credit cards to 0.6% and 1.3%, respectively, by 2021. In Costa Rica, the central bank established caps on the MSC. Brazil capped debit card MIFs at 0.8% per transaction in 2018. In Colombia, MIFs have been subjected to various interventions since 2004, and the MIF for Visa debit fell from 1.4% to 1.1% (the MIF for MasterCard debit remained at 1.1%), while the MIF for Visa credit fell from 2.8% to 1.5% (Bardey et al., 2012).⁵ Yet, the MIFs are currently set by the card networks with no restrictions.

The MIF cap levels that some regulators such as the European Commission (ECDGC, 2015) have applied are based on a methodology introduced by Rochet and Tirole (2007 and 2011) named the “Tourist Test.” The Tourist Test or Merchant Indifference Test (MIT) measures the mismatch between market and optimal card fees that maximize both merchants and consumers’ welfare.⁶ The methodology is based on the idea that merchants should be charged card fees that make them indifferent to being paid in cash or via cards, in the context of a sporadic consumer (e.g., a tourist).

Research in various countries has found that estimates of card fees based on the Tourist Test are lower than the fees the card industry charges.⁷ Results for Canada and Europe show that MIT cards fees could even be negative at average retail transaction values. Layne-Farrar (2013) found that the MIF set by the Fed for debit cards did not pass the MIT. Similarly, for the Netherlands, Poland, and Peru, results show negative or low MIT values, far below the fees charged by the card industry.

For Colombia, there is evidence that the current MSCs may not be optimal in terms of the Tourist Test, given that 60% of merchants that accept cash and cards use cash discounts, minimum transaction values, or card surcharges to dissuade customers from using cards at the POS (Arango-Arango et al., 2021). Currently, the MIF for debit cards is between 0.34% and 2.46%, with an average of 1.28%, and between 0.35% and 2.25% for credit cards, with an average of 1.44%. These fees are greater than the caps introduced in the European Union (EY-EC, 2020), but close to the unregulated fees charged in other developing countries such as Turkey, Ukraine, Moldova, Bosnia and Herzegovina, and Albania.⁸

This study applies the MIT methodology to Colombia, using data from a survey of merchants’ costs conducted by the Central Bank in 2018, which collected information about the costs of accepting cash, debit cards, and credit cards (Arango-Arango and Betancourt-García, 2020). As Arango-Arango et al. (2020) show, the relatively high costs of operating with electronic payments vis-à-vis cash are still a significant barrier for small businesses to accept debit and credit cards in Colombia. This has led to low levels of acceptance and use of these instruments, which contrasts with the relatively high number of consumers who have cards.

Our contribution to the literature is twofold. First, this study is one of the few that applies the MIT methodology in a developing country. Aurazo and Vazquez (2019) showed that for such economies, this method should account for sales-tax evasion because it adds to the incentives that merchants may have to operate with cash instead of cards. Second, we assess the validity of the two methodologies proposed in the literature (Fung et al., 2018; ECDGC, 2015). The first is an arithmetic estimation of the marginal costs of accepting cash and card payments, which relies on linear assumptions of the cost functions. The second is based on econometric estimations of the cost functions. We extend previous attempts by allowing for economies of scale and scope in our specifications. Because cash is predominant in developing economies, our econometric approach enables us to simulate changes in card fees compatible with the MIT as the economy becomes less cash dependent.

⁴ See Schmiedel et al. (2012) and The World Bank (2016) and the references therein.

⁵ Resolution 40478, June 2012, issued by the Colombian competition authority.

⁶ The Tourist Test may lead to false positives if the criterion is total social welfare (consumers, merchants, and card firms), depending on the underlying assumptions (Rochet and Tirole, 2011; Wright, 2012; Zenger, 2011).

⁷ Bolt, Jonker, and Plooij (2013) in the Netherlands; ECDGC (2015) in Europe; Fung et al. (2018) in Canada; Górká (2014) in Poland; Aurazo and Vasquez (2019) in Peru; and Layne-Farrar (2013) in the United States.

⁸ Hayashi and Nimmo (2021).

We find that for the average retail transaction (USD 12.27), the marginal cost of cash is lower than it is for debit or credit cards, implying negative card rates under the Tourist Test. Hence, merchants would prefer to be paid in cash rather than with cards at any positive MSC. For the average card receipt of USD 42.49, we find that from the short-term perspective of a sporadic consumer, the MSC would be up to 0.74% (0.44% adjusted for sales-tax evasion). These figures are considerably below the average MSC charged by the card industry in Colombia. These findings are in line with studies in other jurisdictions, and, in particular, with the results found by [Aurazo and Vasquez \(2019\)](#) for Peru and the recent cap regulation imposed in Argentina for debit cards ([Morales et al., 2021](#)). Our estimates for medium-term scenarios yield an even lower optimal MSC.

The Tourist Test is an intuitive guide for regulators to measure the degree to which market card fees may be misaligned. However, the estimations presented should only be taken as guidance given that they are sensitive to underlying assumptions about costs, have wide variance across merchants, and do not consider the implications that cap regulation may have on the sustainability of the card networks or on fees to card holders because it centers only on the merchants' side. In addition, the fact that sales tax evasion tightens the Tourist Test criterion to evaluate market fees reveals that price regulation of card fees should be accompanied by fiscal measures with the purpose of leveling the playing field between cash and cards. Finally, our simulations show that economies of scale and the mixture of card and cash payments may imply increasing card fees based on the Tourist Test, as commerce moves to a less-cash intensive scenario. Increasing card fees may not be compatible with a policy intended to reduce cash and make electronic payment systems widely accessible and could be misleading, because higher card fees may induce entry.

The paper is organized as follows. [Section 2](#) describes the survey used in the estimations of card fees compatible with the Tourist Test. [Section 3](#) provides the methodological approach. [Section 4](#) presents the results of applying the Tourist Test to Colombian merchants. [Section 5](#) presents econometric simulations to explore the ways economies of scale and scope may affect the Tourist Test results as the economy becomes less dependent on cash. The last section presents a discussion of the results, derives policy implications, and concludes.

2. Survey of merchant costs of various payment instruments

The estimations of card fees compatible with the MIT criterion for Colombia presented in this document use information about the merchants' costs of accepting different payment methods at the POS from the Survey on Merchant Costs of Processing Payments carried out by the Central Bank of Colombia in 2018 ([Arango-Arango et al., 2020](#)).

The survey collected information about private costs that merchants incur for accepting each payment method, considering the volume and value of payments and different types of front and back-office costs. It included questions about labor costs associated with payment processing, third-party services by payment instrument (e.g., cash handling services, EFTPOS, and card-processing fees), fraud, sales' surcharges, and discounts, as well as information on cash balances. Because front-office costs include the cost of the time it takes to process and finalize a transaction at the cash register, a subsample of merchants' POSs was directly monitored.

Finally, the survey asked for merchants' perceptions of the nature of each cost category between fixed and variable costs in a 2- to 3-year horizon, where cash transaction volumes would fall by 20%, being substituted by cards. Merchants stated whether a cost category associated with labor or capital inputs would be fixed, variable, or mixed under such a scenario, including labor costs associated with back- and front-office activities, fees paid to third-party service providers, and equipment such as cash registers or EFTPOS terminals.⁹

The sample is made up of 867 merchants located in urban areas of 15 municipalities in Colombia and was divided by merchants' size and economic activity. Fifty percent of the merchants are located in the four main cities of Colombia, and about half are micro-merchants.¹⁰ In terms of economic activities, 64.5% of the sample is concentrated in four sectors: clothing and footwear; bars, restaurants, and hotels; vehicles and auto-parts; and household appliances.

According to the survey, fixed costs account for almost half of the total costs for all merchants in the sample, regardless of the payment instrument. However, for medium and large merchants, these costs account for a third of total costs of debit and credit cards. Almost all variable costs for cash for all merchants are associated with processing costs, which comprise front- and back-office activities (accounting, reconciliation, auditing, bundling, depositing, and withdrawing at a financial institution). For cards, acquiring fees are the most important variable costs followed by processing costs. For medium and large merchants, these fees are the most important cost, representing more than half of total costs ([Table 1](#)).

In terms of variable costs, the survey indicates that the cost of cash is 2.7 times lower than that of cards ([Arango-Arango et al., 2020](#)). As has been found in many countries, cash is less costly than cards are mainly due to the high MSC that merchants face ([Carbó-Valverde and Rodríguez Fernández, 2019](#)).

According to the survey, the cost of cash and cards increases with merchant size (in terms of number of employees), which can be related to the fact that medium and large merchants tend to have lower transaction volumes and larger receipt sizes than the micro and small counterparts. The costs of cards are slightly lower for larger merchants, probably because they can negotiate lower acquiring rates (MSC) with the card networks.

⁹ For more details about the sampling framework, questionnaire, and the survey responses, see [Arango-Arango and Betancourt-García \(2020\)](#).

¹⁰ Merchant size is defined in terms of number of employees where micro-merchants are those with fewer than 10 employees, small merchants are those with 10 to 50 employees, and medium and large merchants are those with more than 50 employees.

Table 1
Distribution of fixed and variable costs per payment instrument.

| | Fixed costs | Acquiring fees | Processing costs | Opportunity costs | Fraud/counterfeiting/robbery losses |
|----------------------------|-------------|----------------|------------------|-------------------|-------------------------------------|
| All merchants | | | | | |
| Cash | 43.60% | 0.00% | 55.67% | 0.08% | 0.65% |
| Debit card | 50.43% | 30.70% | 18.87% | 0.00% | 0.00% |
| Credit card | 49.55% | 34.92% | 15.53% | 0.00% | 0.00% |
| Micro merchants | | | | | |
| Cash | 43.49% | 0.00% | 55.71% | 0.09% | 0.71% |
| Debit card | 51.57% | 28.48% | 19.95% | 0.00% | 0.00% |
| Credit card | 53.73% | 29.54% | 16.73% | 0.00% | 0.00% |
| Small merchants | | | | | |
| Cash | 44.63% | 0.00% | 54.99% | 0.05% | 0.34% |
| Debit card | 46.83% | 39.74% | 13.43% | 0.00% | 0.00% |
| Credit card | 34.96% | 54.18% | 10.86% | 0.00% | 0.00% |
| Medium and large merchants | | | | | |
| Cash | 42.56% | 0.00% | 57.14% | 0.14% | 0.17% |
| Debit card | 35.93% | 50.06% | 14.01% | 0.00% | 0.00% |
| Credit card | 31.31% | 55.89% | 12.80% | 0.00% | 0.00% |

Note: Percentage with respect to total payment processing costs.

Source: Authors' calculations based on the Survey on Merchant Costs of Processing Payments.

3. The tourist test: methodological approach

Authorities and regulators assert that the interchange fees are set too high because merchants cannot reasonably reject cards for fear of losing customers, even though accepting them represents an incremental cost: This is the “must-take cards” argument. Yet, some countries such as the United States have regulated interchange fees based on issuing banks' processing costs. [Rochet and Tirole \(2011\)](#) sustained that in such cases, there is no connection between the rationale and the criterion for regulation. They formalized the must-take cards rationale by showing that merchants internalize the surplus that cardholders enjoy from accepting cards. Therefore, merchants may accept card payments they do not want. Hence, they introduced the Tourist Test or the MIT. According to this criterion, an MSC passes the tourist test if and only if accepting a card does not increase the merchants' operating costs.

The MIT criterion is compatible with the optimal pricing derived from the maximization of total user surplus (consumers and merchants) under the assumption that acquirers are perfectly competitive, merchants are homogeneous, and issuers may have constant market power. In the case of heterogeneous merchants, an interchange fee compatible with the MIT may be implemented by setting it as an average interchange fee; however, it implies that the merchants who benefit least from accepting cards are likely to fail the MIT.

As [Aurazo and Vasquez \(2019\)](#) pointed out, the Tourist Test was initially conceived for developed countries where merchants' main benefits from accepting cards would be their lower marginal costs (net of the MSC) compared with cash. In developing countries, these benefits may be undermined by lower compliance with sales taxes that merchants, especially those in the informal sector, may exert on cash sales. Hence, sales-tax evasion brings an additional incentive for merchants to promote cash usage, and this needs to be accounted for in the estimation of card fees compatible with the Tourist Test.

Following [Rochet and Tirole \(2011\)](#) and [Aurazo and Vasquez \(2019\)](#), calculations of the MIF under the Tourist Test criterion focus on the comparison of the marginal costs of card and cash payments, net of the value-added tax (VAT) evasion benefits derived from differentials in the level of VAT compliance in cards and cash transactions. The marginal costs of cash and cards are mainly driven by the processing time at the POS and the costs associated with reconciliation, auditing, and fraud prevention processes. In addition, there are costs related to deposits and withdrawals in cash and those associated with the MSC in the case of cards. The MSC can be associated with the different parties involved in a card transaction. It contains the acquirer margin (AM) set by the acquirer, the MIFs paid by acquirers to issuers, and the network access fees (NAFs) paid by issuers and acquirers to the networks.

As shown in [Fig. 1](#), there are two measures of interest: the MSC (or merchant discount rate) and the MIF compatible with the MIT criterion, the MIT MSC, and the MIT MIF, respectively. The MIT MSC would be the difference between the marginal cost of cash, including the effective VAT contribution per transaction (the bar on the left), and the marginal costs of cards, net of the MSC, including the effective VAT contribution (as shown in the bar on the right). The MIT MIF would result from subtracting the AM fees and NAFs from the MIT MSC. The difference between the bar at the center and the bar on the right would be the level of market overpricing. Both the MIT MSC and the MIT MIF are calculated as a percentage of the average transaction value.

The literature presents two methodologies to calculate the MIT MSC ([Fung et al., 2018](#); [ECDGC, 2015](#); [Aurazo and Vega, 2020](#)). The first is an arithmetic (or accounting) estimation of the marginal costs of accepting cash and card payments.

The arithmetic approach assumes that part of the total costs of processing a payment instrument j is associated with transaction volumes and another part with sales values (Q_j multiplied by the average transaction value [ATV]), including the effective VAT

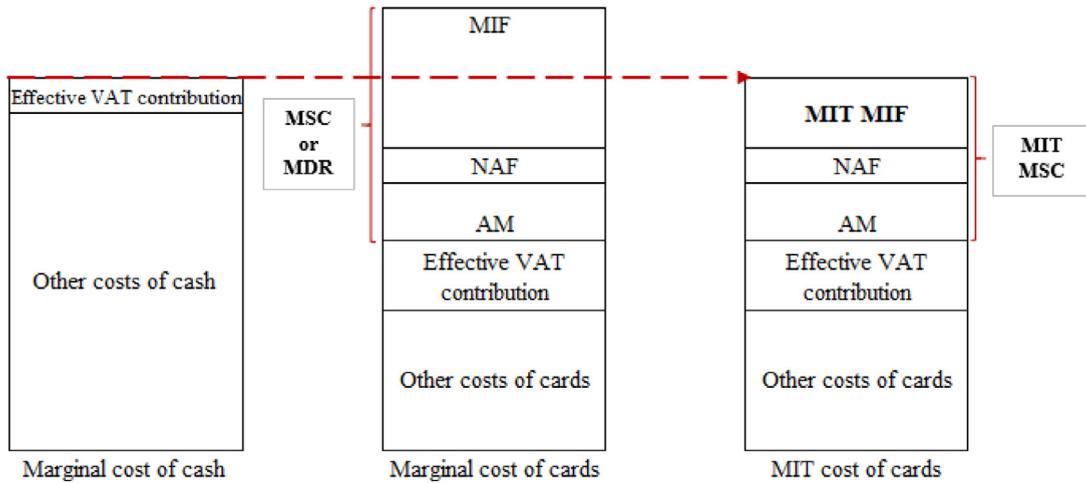


Fig. 1. Definitions of the merchant indifference test

Note: MIF: merchant interchange fee; NAF: network access fee; AM: acquirer margin; MSC: merchant service charge or merchant discount rate (MDR); MIT: merchant indifference test; VAT: value-added tax. The red arrow indicates the level of the marginal cost of cards, and hence the MIT MSC that is compatible with the MIT criterion.

Source: Adapted from Fung et al. (2018) and ECDGC (2015).

contribution. The approach assumes a linear total cost function of the form¹¹:

$$C_j = \gamma_j + \alpha_j Q_j + (\beta_j + \theta_j \tau) Q_j ATV_j, \tag{1}$$

where γ_j is the fixed cost, α_j is the variable cost per one additional cash/card transaction, β_j is the variable cost per one additional dollar of cash/card sales, and θ_j is the level of VAT compliance associated with payment instrument j and τ is the VAT rate.

In this case, the MIT MSC is calculated as the difference between the marginal cost of cash and the marginal cost of cards (net of the MSC) relative to the ATV_j , where the marginal cost of the payment instrument j is $mgc_j = \alpha_j + (\beta_j + \theta_j \tau) ATV_j$. Hence,

$$MIT\ MSC = \frac{\alpha_{cash} - \alpha_{card}}{ATV} + \beta_{cash} - \beta_{card} + (\theta_{cash} - \theta_{card}) \tau. \tag{2}$$

The second approach is based on econometric estimations of the cost functions for processing payments. We center our analysis on the econometric approach and provide arithmetic estimates for comparison purposes. The econometric approach has the advantage of avoiding the accounting and the linearity assumptions of the cost structure made in the arithmetic approach (Fung et al., 2018; ECDGC, 2015).

We extend the econometric approach in ECDGC (2015) by introducing quadratic specifications (scale effects) not only on sales volumes (Q_j), but also on sales values ($SALES_j$). In addition, we allow the relative combination of payment instruments to affect marginal costs. This is done by interacting the proportion of transactions made in cash, P_e , with transaction volumes and sales values in the cost function for each payment instrument j (scope effects). We also include merchants' specific payment processing characteristics, X_j . We include the number of outlets because chain operation may bring economies (e.g., in cash-handling services). We include the number of equipment items such as the number of safety boxes merchants might have for cash custody (or number of EFTPOS for cards), as a proxy for differences in risk-mitigating actions (better acquiring deals). We include commerce sector and city size dummies as proxies of differences in input costs such as wages. Moreover, we include payroll size dummies as proxies of informal (fewer than 10 employees) and formal payment-processing arrangements:

$$C_j = \alpha_0 + \alpha_1 Q_j + \alpha_2 Q_j^2 + \alpha_3 SALES_j + \alpha_4 SALES_j^2 + \alpha_5 Q_j P_e + \alpha_6 SALES_j P_e + X_j' \beta_j + \epsilon_j. \tag{3}$$

In this case, the marginal cost for each payment instrument j before VAT contributions is (assuming $SALES_j = Q_j ATV_j$):¹²

$$Cmg_j = \alpha_1 + 2Q_j(\alpha_2 + \alpha_4 ATV_j^2) + \left[\frac{\partial P_e}{\partial Q_j} Q_j + P_e \right] (\alpha_5 + \alpha_6 ATV_j) + \alpha_3 ATV_j, \tag{4}$$

where the proportion of cash transactions, P_e , changes with cash and card volumes as follows:

$$\frac{\partial P_e}{\partial Q_{cash}} = (T_q - Q_e) / T_q^2, \tag{5}$$

¹¹ See Fung et al. (2018) for a detailed account of this methodology.

¹² By decomposing total sales into the product $Q_j ATV_j$, we are implicitly assuming that merchants' sales receipt values do not depend on transaction volumes. This may be a strong assumption for merchants that offer volume discounts to their clients, but for the majority of merchants in the survey, which are micro-merchants, volume discounts are less likely to occur.

$$\frac{\partial P_e}{\partial Q_{card}} = \frac{-Q_e}{T_q^2}, \quad (6)$$

where Q_e is the volume of cash transactions and T_q is the total volume of transactions made in cash, debit cards, and credit cards.

Regressions are performed using robust regression due to the strong kurtosis and skewness observed in the key variables used in the estimations compared with a normal distribution. We use the Cook's distance algorithm to weight the observations depending on their influence and their error size in estimation.¹³ Because the MIT criterion refers to the analysis of card fees among merchants that already accept cards and do not consider extensive margin aspects of card fees, we focus on cost estimations for merchants that already accept both cash and payment cards (the universe of merchants targeted in the survey).

Our econometric approach is semi-structural, because we estimate cost functions separately for each payment instrument rather than a multiproduct cost function, given the strong departure from normality. However, our specifications borrow from the literature on the estimation of multiproduct cost functions¹⁴ by allowing for economies of scale (squared terms) and scope (interaction of cash and card sales with P_e).

Using the econometric estimations of the marginal costs of cash and debit and credit cards, together with our estimates of the VAT evasion incentive, we estimate the MIT MSC.

Finally, we use public information on MSC and MIF currently charged by the industry to estimate the MIT MIF, because the sum of the AM fee and the NAF is equal to the difference between the MSC and the MIF (Fig. 1). We adjust our estimates of the MIT MSC by discounting the AM and the NAF to arrive at the MIT MIF.

4. Application of the tourist test to Colombian merchants

In this section, we present the MIT calculations based on the econometric approach and compare them with the arithmetic approach. Second, we adjust the MIT to account for sales-tax evasion and present estimates of the MIT MIF. Finally, we relate our results to the international literature. Because the MIT MSC varies with the transaction value, we follow ECDGC (2015) and present the MIT estimations for the average retail receipt value (USD 12.27) and the average card receipt value (USD 42.49) in Colombia.¹⁵

4.1. Medium-Term MIT MSC based on econometric cost models

This section presents the results of the econometric model (Eq. (3)).¹⁶ As Table 2 shows, non-linear effects in transaction volumes and sales values as well as the interaction variables with P_e are significant for all payment instruments. However, some differences are worth mentioning. For cash, higher levels of P_e reduce the slope associated with transaction volumes, whereas for debit and credit cards, it increases the slope associated with transaction volumes (for debit cards) and sales values (for credit cards). These results mean that the marginal cost of processing cash increases as the merchant becomes less cash intensive in its total sales, and the marginal cost of cards decreases accordingly. The estimates also imply that there is no evidence of economies of scope in processing cash and card payments as the marginal cost of cash (cards) increases with card (cash) processing volumes.

For debit cards, we find that the MIT MSC that follows from the econometric estimations of the cost functions is negative at the retail receipt value (median of -0.05%) and positive at the card receipt value (median of 0.04%), whereas for credit cards, the MIT MSC estimates are centered on negative values for low and high transaction values (median of -0.07% at the retail receipt value and -0.04% at the average card receipt value, respectively; Table 3). Fig. 2 presents the MIT MSC for the full range of average receipt values.

4.2. Arithmetic MIT MSC

Under the arithmetic approach, we consider a short-term and a medium-term scenario. For the short-term scenario, we assume that all the costs of the equipment required to process cash and cards is fixed. For the medium-term scenario, we consider as variable costs not only the labor costs (as in the short-term scenario) but also the costs associated with capital inputs that each survey participant declared to be variable when they confronted a hypothetical 2- to 3-year cash-sales reduction scenario. Based on this information, we calculate average estimates across merchants for α and β in Eq. (1) for each payment instrument to calculate an average MIT MSC.

¹³ The algorithm iterates to convergency by recalculating the Cook's distance in each iteration until their variation is less than a tolerance level. Once the weights are calculated, robust estimation methods are used to obtain efficient standard errors. We trimmed observations with extreme values for total costs (the dependent variable) by dropping the top 5% of the distribution of total costs and dropped salient outliers for transaction values and volumes.

¹⁴ See Caves, Christensen, and Trethewey (1980) for a thorough discussion of multiproduct cost functions.

¹⁵ The average retail receipt value is taken from a payments survey performed by the Colombian central bank in 2016 and the average card receipt value from the annual statistics of card networks in 2020.

¹⁶ Several other specifications were considered before selecting the one used in our calculations based on its statistical performance. Of interest is the comparison between the linear case and the non-linear case. We found that non-linearities associated with economies of scale and payment composition effects were statistically significant, and hence, we discharged the linear specifications. In addition, some specifications with higher fitness statistics such as R^2 were discharged because they were affected by strong influential observations. Finally, we explored log-log versions of Eq. 4 and found they do not outperform the quadratic specifications and have the disadvantage of assuming that all costs are variable.

Table 2
Econometric estimates of cost functions by payment instrument.

| VARIABLES | Cash | Debit Card | Credit Card |
|--|---------------------|-------------------------|-------------------------|
| Number of transactions by payment instrument | 0.3271 (0.7328) | *** 0.4994 (0.0664) | *** 0.4613 (0.0818) |
| Number of transactions by payment instrument squared | -0.0063 (0.0125) | -0.0232 (0.0042) | *** -0.0182 (0.0059) |
| Sales value by payment instrument | 0.2916 (0.0721) | *** 1.6606 (0.2057) | *** 0.4401 (0.0746) |
| Sales value by payment instrument squared | -0.1323 (0.0212) | *** -0.0472 (0.0066) | *** -0.0344 (0.0084) |
| Number of outlets | -0.2009 (0.0442) | *** -0.0378 (0.0503) | -0.0857 (0.0520) |
| Equipment related with each payment instrument | 0.2548 (0.0578) | *** -0.0053 (0.0496) | 0.0254 (0.0495) |
| Number of transactions by payment instrument* Cash payment share | -0.2165 (0.0511) | *** 0.2594 (0.0643) | *** 0.0334 (0.0578) |
| Sales value by payment instrument* Cash payment share | 0.0663 (0.0469) | -0.3206 (0.1560) | ** 0.0996 (0.0272) |
| Economic activity (8 sectors dummies) | | *** | * |
| Merchant size (2 scale dummies) | | *** | *** |
| City size (2 dummies) | | | *** |
| Constant | 0.4639 (0.0935) | *** 0.2399 (0.0743) | *** 0.2548 (0.0764) |
| Observations | 612 | 687 | 668 |
| R-squared | 0.489 | 0.463 | 0.461 |

Robust standard errors in parentheses.

Note: Parameter estimates are presented as standardized betas for comparison purposes. They measure the change in the total costs of a payment instrument in standard deviations because of a change of one standard deviation in an independent variable (see Table A.1 in Appendix A for standard deviations). Significances of merchants' commerce activity, merchant size, and city size are calculated using a global significance test. Merchant size is defined in terms of number of employees where micro-merchants are those with fewer than 10 employees, small merchants are those with 10 to 50 employees, and medium and large merchants are those with more than 50 employees. City size has three categories: small cities with fewer than 200,000 inhabitants, medium cities between 200,000 and 500,000 inhabitants, and large cities with more than 500,000 inhabitants.

* $p < 0.01$.

** $p < 0.05$.

*** $p < 0.1$.

Table 3
MIT MSC statistics from the econometric model by average transaction value.

| | | Midmean | p25 | Median | p75 |
|--------------|-------------|---------|-------|--------|------|
| At USD 12.27 | Debit card | -0.03 | -0.12 | -0.05 | 0.10 |
| | Credit card | -0.05 | -0.11 | -0.07 | 0.05 |
| At USD 42.49 | Debit card | 0.05 | -0.03 | 0.04 | 0.19 |
| | Credit card | -0.02 | -0.11 | -0.04 | 0.12 |

Note: Percentage of Average Transaction Value. The midmean refers to the interquartile mean. The average retail transaction value is USD 12.27, and the average card transaction value in 2020 is USD 42.49. Statistics are based on the distribution of MIT MSC estimates based on the predicted marginal costs for each survey participant from the econometric cost functions.

When estimating the short-term MIT MSC for different transaction values, the MIT MSC for debit cards is positive from USD 18.1 onwards (USD 20.3 for credit cards). In addition, it is -0.46% at the retail receipt (-0.57% for credit cards) and 0.74% at card receipt (0.59% for credit cards) transaction values. This scenario is the closest to the Tourist Test because it addresses the question: "Would the merchant want to refuse a card payment when a non-repeated customer with enough cash in her pocket is about to pay at the cash register?" (Rochet and Tirole, 2011).

The medium-term scenario is the closest to the econometric estimations presented above. We find that the MIT MSC for debit cards is positive from USD 42.4 onwards (USD 47.6 for credit cards). In addition, it is -2.0% at the retail receipt value and 0.06% at the card receipt value for debit cards (-2.0% and -0.03 for credit cards). These results are consistent with our econometric results.

The medium-term scenario looks for MIT MSCs that are compatible with the notion of MSCs that do not imply incremental costs in a situation where merchants use dissuasive strategies on their clientele to use cash on a regular basis and not only on sporadic shoppers, which is the case in the Colombian context. In fact, 60% of merchants in Colombia provide cash discounts or impose minimum transaction values and surcharges on cards regularly to drive their clients to pay in cash (Arango-Arango and Betancourt-García, 2020). Hence, merchants would consider the medium-term marginal efficiency of cash versus cards in deciding upon these strategies.

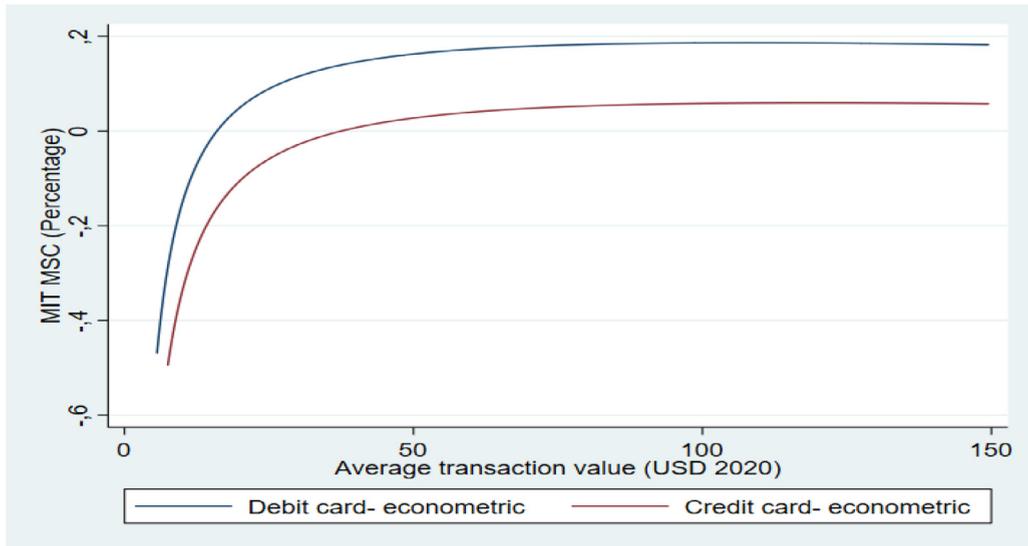


Fig. 2. Medium-term econometric MIT MSC by average transaction value
 Note: MIT MSC measured as a percentage of average transaction value. The figure shows that the MIT MSC for both debit and credit cards behaves according to the average transaction value based on econometric estimates.

4.3. Sales-Tax evasion and the merchant indifference test

We have presented the MIT MSC based purely on the relative efficiency of the marginal costs of cash and cards. Following [Aurazo and Vasquez \(2019\)](#), we estimate a scenario that considers the incentives for VAT evasion on cash transactions. In Colombia, the VAT is set at 19%, and businesses can deduct the VAT paid for inputs of goods and services used in their economic activities. For 2019, the level of sales-tax evasion was 23.2% ([DIAN-OCDE, 2021](#)).

We estimate the tax evasion benefits of cash sales as follows. First, we estimate the level of sale-tax evasion that would apply to merchants who accept payment cards. Using the results of a survey on merchants performed by the Central Bank in 2020 ([Arango-Arango et al., 2021](#)), we find that the degree of fiscal compliance (i.e., whether a merchant has a fiscal identification number) among merchants who accept cards is 2.1 times the compliance among merchants who do not accept cards. Therefore, we estimate that the evasion rate in card-accepting stores that would be consistent with a weighted average of 23.2% would be 15.8%.¹⁷

Second, assuming that card-accepting merchants would only evade taxes on their cash sales, the net benefit of VAT evasion from cash payments relative to card payments would be 15.8% times the merchants’ annual markup,¹⁸ times the 19% VAT rate. We estimated the median markup at 10.1% based on the survey described in Section 2.¹⁹ Hence, all MIT MSC estimates should be reduced by 0.30% to accommodate the evasion incentives associated with cash.

[Table 4](#) summarizes the empirical results. Accounting for sales-tax evasion brings most of the MIT MSC estimates to negative figures. Only the weighted short-term arithmetic estimates would be positive for debit cards (credit cards), at 0.44% (0.29%). The econometric estimates (as well as the arithmetic medium-term estimates) of the MIT MSC remain in the negative domain at both the retail and the card receipt values.

Both the short-term and the medium-term MIT MSC estimates are far below the rates currently charged in the Colombian market—1.54% for debit cards and 1.69% for credit cards.²⁰ This clearly evidences that these rates are not optimal according to the Tourist Test.

¹⁷ Considering that we have no access to desegregated levels of VAT evasion, we assume that the overall evasion rate γ (23.2%) is a weighted average of the evasion rate in the no-cards sectors γ_{nc} and the evasion rate in the card-accepting sectors γ_c : $\gamma = w_{nc}\gamma_{nc} + w_c\gamma_c$. We estimate the weights w_{nc} and w_c as the sales shares of each sector in total sales using the Central Bank’s 2020 Merchant Survey ([Arango-Arango et al., 2021](#)). Assuming γ_{nc}/γ_c is proportional to the relative levels of fiscal compliance in the cards and no-cards sectors, as recorded in the same survey, we estimate this ratio as 2.1 and solve for γ_c (15.8%).

¹⁸ The markup rate proxies for the fiscal base upon which the VAT is applied and it corresponds roughly to the value added in the merchants’ operation.

¹⁹ We took the median markup rate before taxes (12%) and divided it by 1.19 to subtract the effect of sales taxes.

²⁰ Estimates based on public reports by Redeban and Credibanco for the third quarter of 2020. These means exclude minimum values posted as zero in some sectors. Debit card MSC vary between a minimum of 0.09% and a maximum of 1.54%, whereas credit card MSC vary between 0.15% and 1.69%.

Table 4
Summary of MIT MSC results for short-term, medium-term, and long-term estimations.

| | At USD 12.27 | | At USD 42.49 | |
|--------------------------|--------------|-------------|--------------|-------------|
| | Debit card | Credit card | Debit card | Credit card |
| Short-term arithmetic | -0.46 | -0.57 | 0.74 | 0.59 |
| Adjusted for VAT evasion | -0.76 | -0.87 | 0.44 | 0.29 |
| Medium-term arithmetic | -2.00 | -2.00 | 0.06 | -0.03 |
| Adjusted for VAT evasion | -2.30 | -2.30 | -0.24 | -0.33 |
| Medium-term econometric | -0.13 | -0.21 | 0.05 | -0.02 |
| Adjusted for VAT evasion | -0.43 | -0.51 | -0.25 | -0.32 |

Note: Percentage of Average Transaction Value. The average retail transaction value is USD 12.27, and the average card transaction value in 2020 is USD 42.49. For the short-term and the medium-term arithmetic approach, the weighted average MIT MSC is reported. For the medium-term econometric MIT MSC, the interquartile mean is reported.

4.4. Interchange fees compatible with the Tourist Test (MIT MIF)

So far, the calculations have focused on the MIT MSC. Although in some countries such as Costa Rica the regulator is entitled to rule over the MSC, in other jurisdictions, the regulation on card fees has focused on the MIF. To calculate the MIT MIF, we need estimates of the AM and the processing fees charged by the card networks (NAF), as shown in Fig. 1. As was noted before, the sum of the AM and the NAF can be calculated from the difference between the MSC and the MIF charged by the industry.

We use the information on MSC and MIF published by the two switches, Redeban and Credibanco, on their websites for the third quarter of 2020. The difference between the MSC and the MIF represents 16.9% of the MSC for debit cards and 14.8% for credit cards. Applying these percentages to the MIT MSC estimated previously, we have estimates of the MIT MIF for the different methodologies summarized in Table 4. In particular, the short-term weighted MIT MIF would be 0.62% for debit cards and 0.48% for credit cards at the card receipt value (0.32% and 0.18% adjusted for VAT evasion). The arithmetic and the econometric medium-term MIT MIF would be negative for both debit and credit cards if adjusted for VAT evasion.

4.5. International comparisons

Our results are consistent with findings in the international literature. The studies in Europe, Canada, and the United States show that MIT estimates crucially depend on the receipt value at which they are assessed. These studies found that the MSC and MIF, consistent with the MIT, are much lower than the market fees charged by the card industry are. They also found that in most cases, the MIT MSC and the MIT MIF were negative at low receipt values (Table 5).

For instance, the Canadian study found that cash was less costly than cards at transactions below CAD 43, hence the MIT MSC would be negative (e.g. -0.38% at CAD 20). In the case of Europe, the MIT MIF was close to zero for debit cards (0.06%) and negative for credit cards (-0.3%) at retail receipt values. In Poland, it was also negative at the retail receipt value of EUR 13.57 (-0.39%). In the United States, it was 0.86% at USD 7, and in the Netherlands, it was between -0.1% and -2.3% at transactions below EUR 30 (with 2002 data).

These findings are in line with our negative estimates of the MIT MSC and MIT MIF at retail receipt values, although in the Colombian case the gap between the marginal costs of cash and cards is wider. Our short-term estimates at the card receipt value are comparable with those of Aurazo et al. (2020), who found for the Peruvian case a positive MIT MSC for debit card transactions of 0.59%, which is reduced to 0.30% when considering VAT evasion.

5. Economies of scale and less dependence on cash

The Colombian case reflects significant differences in the way payments are processed across merchants; hence, MIT MSC estimates have high dispersion. One of the reasons for such dispersion is the differences in marginal costs arising from the economies of scale in terms of transaction volumes and sales values for each payment instrument, as shown by our econometric estimations.

However, economies of scale are not only relevant for the estimation of current MIT MSC but also for future estimates as merchants grow in scale and become less dependent on cash. For instance, our estimations imply increasing MIT MSC as debit card transaction volumes increase, which is more pronounced at the retail receipt value (Fig. 3).

Based on the econometric cost models, we run simulations where merchants' sales shift towards a higher share of card payments. We decreased cash payment volumes and increased debit card payment volumes by the same amount to keep merchants' total sales constant. By doing so, the marginal cost of cash would increase and the one for debit cards would decrease.

Fig. 4 presents the MIT MSC for different scenarios with less dependence on cash. For instance, at 30% lower volume of cash transactions (dotted line) merchants would reach an average cash share of 50.3% (currently at 71.7%). In this less-cash dependent scenario, cash would have higher marginal costs than cards, leading to positive MIT MSC (0.28%) for debit cards at the retail receipt value (0.07% for credit cards) and at the card receipt value (0.16% for debit and 0.09% for credit cards). The MIT MIF consistent with these MIT MSCs would be 0.23% at the retail receipt value and 0.13% at the card receipt value for debit cards (0.06% and 0.08%

Table 5
International measures of the merchant indifference test.

| Country | Data | Methodology /Assumptions/Model | Main Results of MIT |
|---|---|--|---|
| Canada (Ben, F. et al., 2018) | Data on merchants’ acceptance, perceptions and costs of accepting cash, debit and credit cards. Retailer Survey on the Cost of Payment Methods (2015). | Estimations of MIT MSC using the arithmetic approach for transaction values of CAD 20, CAD 50 and CAD 100, using different scenarios for fixed and variable costs. | CAD 20: MIT MSC -0.38%. CAD 50: MIT MSC 0.05% CAD 100: MIT MSC 0.19% Negative for transactions less than CAD 43. |
| European Union (ECDGC, 2015) | Data from two surveys carried out in 10 countries. A cost survey of processing cash and card payments (500 large merchants) and an auxiliary survey that collects the number and value of transactions with different payment instruments (2000 merchants). | Arithmetic and Econometric approaches. Uses non-linear econometric cost functions to capture economies of scale. Calculates the MIT MSC and the MIT MIF for average retail and card ticket values, splitting the sample according to merchants’ sizes and countries. | Medium-term retail ticket value EUR 25: Debit card: MIT MIF 0.06% MIT MSC 0.12% Dcredit card: MIT MIF -0.03% MIT MSC 0.03% Short-term retail ticket value EUR 25: Debit card: MIT MIF 0.06% MIT MSC 0.12% Credit card: MIT MIF -0.03% MIT MSC 0.03% |
| Netherlands (Bolt et al., 2013) | Merchant cost surveys on cash and debit cards for 2002 and 2009 commissioned by the Dutch Central Bank. | Comparison of arithmetic estimations of the MIT MIF in 2002 and 2009 for different transaction values. | MIT MIF: Trans. Value < EUR 10: 2002: -2.3%, 2009: 0.6% Trans. Value EUR 10–20: 2002: -0.5%, 2009: 0.3% Trans. Value EUR 50–100: 2002: 0.3%, 2009: 0.6% Trans. Value >= EUR 100: 2002 0.4%, 2009 0.7% |
| United States (Layne-Farrar, 2013) | Data taken from Garcia-Swartz et al., 2006, the Food Marketing Institute (1998), wages from BLS (2009) and from banks and commerce industry reports. | Arithmetic estimations of the MIT MIF by commerce sectors and transaction values. | MIT MIF: Ticket value USD 7: 0.86% Ticket value USD 50: 0.46% overall ticket value USD 27.7: 0.50% |
| Poland (Górka, 2012) | Merchant cost survey 2011–2012 of more than 1000 merchants of all sizes from different branches of economy activity in retail trade. | Arithmetic estimations of the MIT MIF and the MIT MSC based on three scenarios of fixed costs: short, medium and long-term. | MIT MIF: Mean card ticket value EUR 20.24: 0.16% Mean of cash and cards ticket value EUR 13.57: -0.39% |
| Perú (Aurazo et al. 2020) | Data from a merchant cost survey on cash, debit cards and credit cards commissioned by the central bank (2019). Sample size of 1063 small merchants with at least one POS terminal. | Arithmetic estimations of the MIT MSC and the MIT MIF for debit cards, for small merchants using an extended framework that includes tax evasion (Aurazo and Vasquez, 2020). | Standard approach (card ticket value PEN 58): MIT MSC without tax benefit: 0.59% MIT MSC with tax evasion: 0.30% MIT MIF: 0.24% |

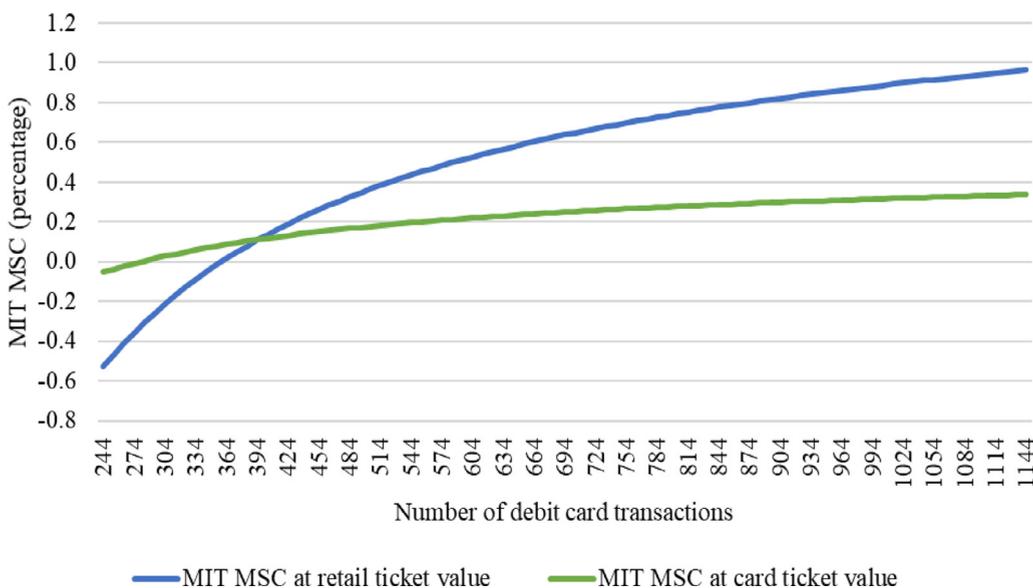


Fig. 3. Scale effects on the MIT-MSc
Note: MIT MSC measured as a percentage of average transaction value. The figure illustrates the way the MIT MSC may change with an increase in debit card payment volumes, keeping cash volumes constant.

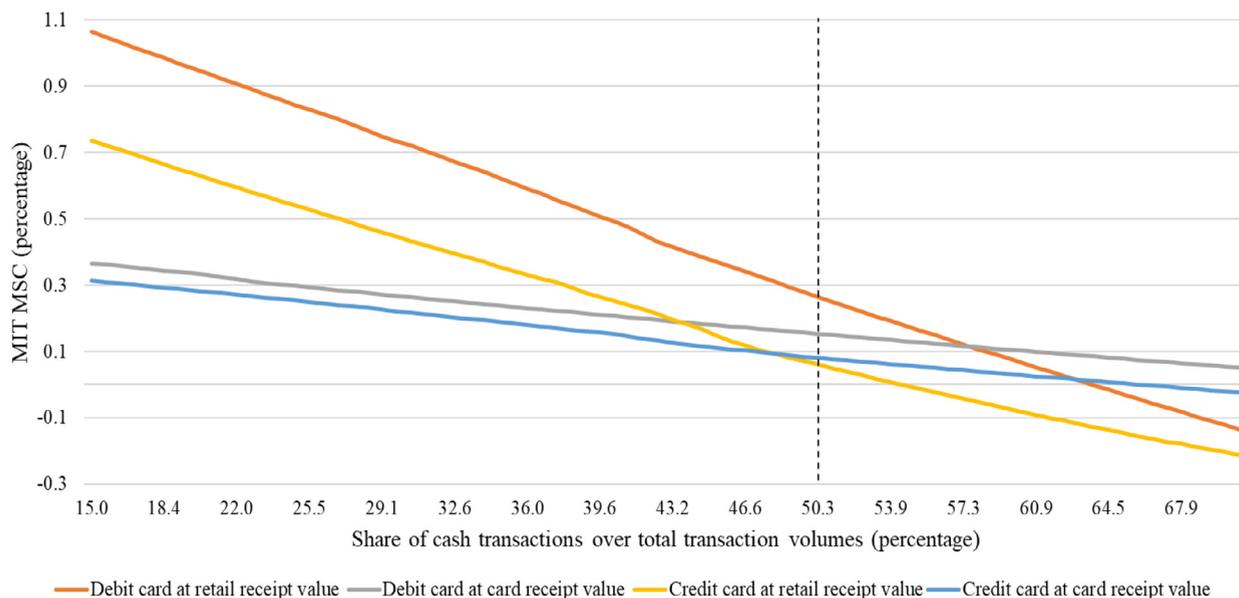


Fig. 4. MIT MSC by share of cash transactions

Note: MIT MSC measured as a percentage of average transaction value. The figure shows the way the MIT MSC for both debit and credit cards for the retail receipt value and card receipt value behaves as a change in the share of cash occurs over the total transaction volumes. At each point, the graph plots the interquartile mean statistics of the MIT MSC calculated for each merchant in the survey.

for credit cards). However, some of these figures would remain negative if adjusted for VAT evasion. It is worth noting that as cash payment shares decrease, the MIT MSCs become higher at the retail receipt value than do those assessed at the card receipt value.

These simulations beg the question of whether shifting to a retail sales environment that uses less cash would reduce the merchants' overall transaction costs (net of the MSC). We calculate the aggregated costs of running the current volumes and sales values at the current marginal costs for cash and debit and credit cards and do so for processing the new levels under the 30% cash reduction scenario. We find that total variable costs would increase 25.2%. This shows how sensitive cash marginal costs are to scale. It is only when cash shares drop below 10.7% that merchants would experience a reduction in total variable costs.

6. Final remarks

Our results imply that under the current cost structure, merchants would find the cost proposition for paying an MSC acceptable at high receipt values or high card payment volumes. They also state that the rates currently charged are much higher than those implied by the MIT. To accommodate the levels suggested by the MIT MSC estimates, the industry should move towards the lower bounds of the current fees.

The reasons why all merchants in the survey accept cards despite such a high merchant discount rate is beyond the scope of this paper. However, the "must-take cards" argument is compelling because merchants may internalize the surplus that cardholders enjoy by, for example, increasing final prices (Vickers, 2005; Rochet and Tirole, 2011; Jonker, 2011), and in particular, because consumers tend to prefer cards to cash at higher transaction values (Arango-Arango et al., 2015, 2018).

VAT evasion brings an extra burden to the levels of MIF and MSC compatible with the MIT that are based on pure relative marginal costs of cash and cards. Indeed, it could represent a 0.3% reduction in the MIT calculations.

Evasion on sales taxes is common across emerging economies. In Latin America, Colombia has among the lowest rates with 1.7% of the GDP but it could go up to 3.8%, as in Bolivia (CEPAL, 2021). The benefit that merchants perceive from VAT evasion is a strong deterrent to the adoption of card payments. Therefore, regulation on card fees ought to seek a middle ground and to be complemented with sales-tax reforms that curtail tax evasion, so that card fees are set closer to the relative efficiencies of cash and cards in terms of marginal costs.

Our MIT estimates show that the current fees in Colombia are far above any MIT MSC or MIT MIF, even before discounting for VAT evasion. An average cap regulation in Colombia could begin with the short-term MIT MSC estimates of 0.74% (0.64% for the MIT MIF) as an upper bound for both cards. Because these are significant reductions in current card fees, regulators should monitor merchants' use of strategies that dissuade consumers from using cards and assess possible effects on other parties in the market. These findings are in line with the MIT MIF results found by Aurazo and Vasquez (2019) for Peru (0.56%) and the recent cap regulation imposed in Argentina for debit card interchange fees at 0.6% (Morales et al., 2021). Yet, our results suggest that caps on card fees could move lower, as suggested by our medium-term MIT estimates.

Our results also confirm the insights of Bolt et al. (2013) in the sense that the MIT methodology may lead to increasing costs for merchants due to economies of scale. We found that a 30% reduction in cash payments would yield a twofold increase in the MIT

estimations. These findings are in line with Bolt et al. (2013), who found that between 2002 and 2009, their MIT MIF estimates raised from 0.2% to 0.5%, as the Dutch economy experienced a 35.2% reduction in cash payments and an 82% increase in the use of debit cards.

We also show that the difference between the marginal costs of cash and cards would be higher the lower the receipt value is, as cash payment shares drop. These results are consistent with Hayashi and Keeton (2012) and Layne-Farrar (2013), who found that the introduction of a uniform MIF cap for debit cards in the United States increased the fees for merchants with small average transaction values and decreased them for those with large average transaction values.

The MIT criterion should be used as a yardstick by which regulators may assess the degree to which the MSC (and the MIF) on cards is misaligned with respect to cash when it is widely used. However, MIT regulation imposes a challenge, as policymakers try to move the retail payment ecosystem towards more efficient electronic payment alternatives. We estimate that overall transaction costs may be lower as the market moves towards lower cash shares. However, increasing merchant card fees as well as higher fees for low receipt value stores, according to the MIT criterion, may work against these policy objectives.

The potential for higher card margins due to increasing MIT caps may also induce entry in the market. As Rochet and Tirole (2011) have argued, entry may bring lower prices and/or payment innovations that limit market power. In such cases, the MIT could be too high, compared to the level that maximizes the users' welfare. Entry also could imply that the benchmark for MIT estimates may not be cash, but other low-cost electronic payment instruments as they become mainstream.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests

Appendix A

Table A.1

Table A.1

Descriptive statistics of the variables used in the econometric models of Section 4.1.

| | Cash | | | Debit card | | | Credit card | | |
|--|--------|--------|--------------------|------------|--------|--------------------|-------------|--------|--------------------|
| | Mean | Median | Standard deviation | Mean | Median | Standard deviation | Mean | Median | Standard deviation |
| Total costs | 107.2 | 79.2 | 96.8 | 48.9 | 37.1 | 41.4 | 48.3 | 37.6 | 40.4 |
| Number of transactions by payment instrument | 410.1 | 100 | 854.3 | 104.5 | 15 | 418.3 | 99.7 | 11.7 | 366.6 |
| Sales value by payment instrument | 8494.3 | 3034.3 | 14,006.6 | 7001.6 | 568.9 | 79,371.6 | 4375.9 | 474.1 | 13,593.8 |
| Number of outlets | 4.3 | 1 | 17.2 | 4.1 | 1 | 15,7 | 4.29 | 1 | 15.9 |
| Equipment related with each payment instrument | 8.4 | 2 | 37.3 | 9.8 | 2 | 43,0 | 9.9 | 2 | 43.1 |
| Number of transactions by payment instrument* Cash payment share | 333.2 | 50.4 | 759.1 | 60.7j | 6.7 | 288.9 | 53.3 | 6.1 | 238.8 |
| Sales value by payment instrument* Cash payment share | 5439.5 | 1724 | 9973.9 | 5163.4 | 269.0 | 75,613.4 | 1937.8 | 238.5 | 6740.5 |

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