PSR Payment Systems Regulator

Market review into the supply of card-acquiring services

Pass-through methodology consultation

February 2019

MR18/1.3

We welcome your views on this working paper. If you would like to provide comments, please send these to us by **5pm on 1 March 2019**.

You can email your comments to **cards@psr.org.uk** or write to us at:

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We will consider your comments when developing the analysis covered in this working paper.

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1 Introduction

1.1 The Payment Systems Regulator (PSR) is conducting a market review into the supply of card-acquiring services. The final Terms of Reference (ToR) were published on 24 January 2019.

1.2 The ToR state that the PSR will examine how the levels of the fees Merchants pay for card-acquiring services have responded to changes in the fees acquirers pay to card scheme operators and card issuers.[1] The ToR further state that we will do such an assessment for card-acquiring services for the Visa and Mastercard card payment systems (the Systems).[2] The Systems are operated by card scheme operators (the Operators).

1.3 The purpose of this working paper is to explain our proposed approach to that analysis. We welcome comments on the methods we propose in this working paper. We would, in particular, welcome comments on the questions set out in Chapter 5 (*Next steps*). In that chapter, we also explain how to respond, and what the time frame for responding is.

1.4 The purpose of the analysis is to assess how the Merchant Service Charge (MSC) – the fees Merchants pay for card-acquiring services for the Systems – has responded to changes in the Systems' Interchange Fees (IF) and Scheme Fees (SF) (collectively, the Fees). Interchange Fees and Scheme Fees are fees acquirers pay to issuers and the Operators, respectively, for Merchants' transactional activity. We have set out our definitions of these terms (MSC, IF, and SF) for the purpose of this working paper in the Glossary. The results of the analysis will be one of several pieces of evidence that will eventually underpin our view of how well the suppy of card-acquiring services is working.

1.5 A data-driven analysis of how the level of MSC has responded to changes in the Fees, such as changes caused by the Interchange Fee Regulation (IFR) caps, is by its nature a relatively technical exercise. The main part of this paper is therefore of a technical nature. The introduction aims to provide a non-technical summary of what we propose to do.

1.6 The approach we set out in this working paper proposes to analyse the pass-through: by how much has the MSC changed for a given change to the Fees? The proposed analysis will in the first instance be concerned with pass-through from large acquirers to Merchants. We may also look at pass-through from acquirers to payment facilitators, and pass-through from payment facilitators to Merchants.

1 Payment Systems Regulator MR18/1.2, *Market review into the supply of card-acquiring services – Final terms of reference* (January 2019), paragraph 3.3.
2 Payment Systems Regulator MR18/1.2, *Market review into the supply of card-acquiring services – Final terms of reference* (January 2019), paragraph 3.16.

1.7 The analysis will explore the following questions:

- **Question 1: What is the long-term pass-through?** (The long-term pass-through is the change to the level of the MSC resulting from a given change to the Fees, once the MSC has fully adjusted to the change.)
- **Question 2: What is the speed of pass-through?** (The speed of pass-through is the time it takes for the MSC to fully adjust to a change in the Fees.)
- **Question 3: Have different broad categories of Merchant seen different degrees of long-term pass-through or different speeds of pass-through?**

1.8 We propose to explore these questions through an econometric analysis based on a comprehensive data set. This econometric analysis will seek to model the MSC as a function of the Fees and other relevant factors.

1.9 In broad terms, we propose to explore three reduced-form econometric approaches:

- **Reduced-form panel estimation:** This analysis seeks to identify the effect of Fee changes on the level of the MSC by modelling the MSC as a function of current and historical Fees, Merchant characteristics, acquirer characteristics, and market-wide characteristics. We would choose the values of a set of parameters that determine the impact of these fees and characteristics in a way that produces as good a possible fit between the modelled MSC and the actual MSC. Pass-through would be determined by the value of the parameter (or parameters) that determine the effect of the Fees in the resulting model.
- **Difference-in-difference estimation with 'interchange plus plus' tariffs as comparator:** This approach seeks to determine how the level of MSC responded to changes to the Interchange Fees by looking at the difference in the level of the MSC between groups of Merchants. We would expect one category (Merchants paying interchange plus plus tariffs) to enjoy full pass-through of the IFR caps. Such a tariff breaks down the MSC into several elements, with the MSC being the sum of these. The Interchange Fees and the Scheme Fees will be two such components of the fee. Under full pass-through, we would expect the difference between the two groups of Merchants to be largely the same before and after the IFR caps.
- **Difference-in-difference estimation with MSC for commercial cards as comparator:** This approach seeks to determine how the level of MSC responded to changes to the Interchange Fees by looking at the difference in the level of the MSC between categories of transaction. We would look at the difference in MSC between the categories before and after the IFR caps. The categories of transaction are such that one category (consumer cards) was affected by the IFR caps, while the other (commercial cards) was not. Under full pass-through, we would expect the difference between the categories of transaction before and after the IFR caps to reflect the reduction in consumer card Fees (less any change to commercial card Fees).

1.10 We do not propose to set out a formal model of competition between acquirers and then estimate the parameters of such a model using market data (a structural model).[3] At this stage, we do not see any benefit in deploying a structural model, for reasons including the considerable complexity of such models.

1.11 This working paper sets out our current thinking on the econometric methodology we propose to follow. It does not make any judgement at this stage on the outcome of that analysis. We anticipate that our approach will be refined and updated as the analysis progresses. As a consequence, the final analysis may depart significantly from what we set out here.

1.12 As we develop our analysis, we will consider whether it is appropriate to provide further information on how our analysis has developed. In any event, we will set out how the analysis has evolved in the interim report of our market review, including how we have taken into account comments on this working paper. The interim report will also set out preliminary results of the analysis.

1.13 The results of the pass-through analysis will be one piece of evidence we will consider when taking a view on whether the supply of card-acquiring services is working well.

1.14 As a general proposition, prices in a competitive market would in the longer term reflect input cost. A reduction in the input costs would therefore result in lower prices. The degree of long-term pass-through depends on several demand and supply factors.[4] Depending on such factors, a competitive market could exhibit different degrees of pass-through. The results of the pass-through analysis will have to be interpreted along with other evidence to be informative. We plan to report on the implications of the pass-through analysis in our interim report.

1.15 This working paper has four main chapters: the first chapter sets out the assumptions we propose to make about the form of the relationship between the MSC, the Fees, and other factors. These assumptions are sufficiently general to represent a wide range of degrees of pass-through, and also capture different potential pass-through dynamics.

1.16 The second chapter sets out the data we propose to use (subject to such data being available in an appropriate form).

1.17 The third chapter sets out our proposed approaches to estimating pass-through – i.e., approaches to answering the questions in paragraph 1.7 using the data we propose to collect. Some of these approaches may be suitable only to some of the questions above.

1.18 The final chapter explains how to provide comments on the methodology we propose in this working paper.

3 RBB Economics (2014) has produced a survey of several different methods for estimating cost pass-through. They identified the following categories: static reduced-form models, difference-in-difference estimation (which they describe as an extension of the reduced-form approach), dynamic reduced-form models, and structural models. See RBB Economics (2014), Annex A. The models we propose in this working paper belong in the first three categories.

4 RBB Economics (2014) provides a wide overview of the economic theory of pass-through.

2 Assumptions about the data-generating process

2.1 We propose to estimate econometrically the extent of pass-through using both a panel data approach (looking at the changes to the MSC over time for individual Merchants on which we collect data) and approaches comparing relevant samples of Merchants before and after the introduction of the IFR.

2.2 Our analysis will view the MSC as the outcome of a random process, with a conditional mean determined by a set of explanatory variables. We call this the data generating process (DGP). This is a conventional approach in econometrics.[5] The values of the parameters of this model are unknown to us. The task before us is to estimate the values of a subset of these parameters using data.

2.3 The DGP is an assumption about the relationship between the MSC, the Fees, and other factors. Our analysis will use as its starting point the DGP set out in Equation 1 below. The DGP models the MSC that a given Merchant (subscript i) would pay for a particular type of transaction (superscript p) at a particular point in time (subscript t) as a linear function of current and historical fees (F), control variables (X), and fixed effects (π, κ, and μ). Boldface symbols denote vectors. Two vectors next to each other (for example, $\boldsymbol{\beta}^T \boldsymbol{X}_t^T$) represents the scalar product of the vectors.

Equation 1

$$m_{it}^p = \sum_{k=0}^{n} \left(\tau_k + \tau_k^G D_{i,t-k}^G\right) F_{i,t-k}^p + \boldsymbol{\beta}^M \boldsymbol{X}_{it}^M + \boldsymbol{\beta}^A \boldsymbol{X}_{A(i)t}^A + \boldsymbol{\beta}^T \boldsymbol{X}_t^T + \pi^p + \kappa_i + \mu_t + \varepsilon_{it}^p$$

2.4 The aim of the analysis we set out in this working paper is to estimate the value(s) of $\tau_0, \ldots, \tau_n$ (the pass-through coefficients) using the data available to us. These coefficients represent the change to the MSC we would over time expect to see due to a change to the Fees, if all other factors were kept constant. As it includes past values of the Fees, the DGP allows a gradual pass-through of changes to the Fees. Therefore, there are several τ with subscripts. Higher values of subscript correspond to Fees further back in history.

5 Greene (2012), page 1055.

2.5 The remainder of this chapter:

- comments on the generality of the DGP set out in Equation 1
- explains the meaning of the variables (m_{it}^{p}, $F_{i,t}$, D_{it}^{G}, $\boldsymbol{X}_{it}^{M}$, $\boldsymbol{X}_{A(i)t}^{A}$, $\boldsymbol{X}_{t}^{T}$) and other components of Equation 1
- comments on testing the appropriateness of the DGP set out in Equation 1

2.6 Equation 1 represents a DGP that can represent a wide range of degrees of pass-through, and can also capture many different pass-through dynamics. The sum of the pass-through coefficients represents long-run pass-through. The values of individual pass-through coefficients determine the pass-through dynamics: the faster the sequence $\{\tau_k\}_{k=0}^{n}$ approaches zero, the quicker pass-through will happen.

2.7 The interaction term D_{it}^{G} also allows the degree and speed of pass-through to vary between categories of Merchant.

2.8 In Equation 1, the superscript p denotes a category of transaction (for example, chip and PIN), i denotes Merchant, and t denotes period (for example, January 2015). The coefficients τ_k, τ_k^{G}, $\boldsymbol{\beta}^{M}$, $\boldsymbol{\beta}^{A}$, and $\boldsymbol{\beta}^{T}$ represent the effects of the variables F_{it}^{p}, D_{it}^{G}, $\boldsymbol{X}_{it}^{M}$, $\boldsymbol{X}_{A(i)t}^{A}$, and $\boldsymbol{X}_{t}^{T}$ respectively. Table 1 sets out the meaning of these variables. The table also sets out the meaning of the constants π^{p}, κ_i, and μ_t (the fixed effects).

Table 1: Meaning of variables and constants in Equation 1

Variable/constant	Meaning
m_{it}^{p}	MSC for transactions in category p, paid by Merchant i to its acquirer, in period t, divided by Merchant i's card turnover for transactions in category p in period t.
F_{it}^{p}	Fees the acquirer pays for Merchant i's transactions, for transactions of type p, in period t, divided by Merchant i's card turnover for transactions in category p in period t.
D_{it}^{G}	Indicator variable. Takes value 1 if Merchant i is a member of group G in period t; 0 otherwise. We plan to define broad categories of Merchant based on data on Merchant characteristics.
$\boldsymbol{X}_{it}^{M}$	A vector of characteristics of Merchant i in period t.
$\boldsymbol{X}_{A(i)t}^{A}$	A vector of characteristics of Merchant i's acquirer ($A(i)$) in period t.
$\boldsymbol{X}_{t}^{T}$	A vector of period-specific effects (demand and cost drivers).
π^{p}	Transaction-type specific component of MSC for transactions of type p. This allows the acquiring margin to vary between categories of transaction.
κ_i	Merchant-specific component of MSC for Merchant i.
μ_t	Period-specific component of MSC for period t.
ε_{it}^{p}	The unexplained component of m_{it}^{p}. Any component of the MSC for transactions of type p, paid by Merchant i to its acquirer, in period t that cannot be explained by Fees, Merchant group, Merchant characteristics, acquirer characteristics, period-specific effects, or the fixed effects. The expected value of the unexplained component is, for each period, zero, conditional on the explanatory variables and the constants.[6]

6 See Wooldridge (2010), page 292. Statistical inference requires a broader set of technical assumptions about the unexplained component. We refer to Wooldridge (2010) or any other comprehensive book on panel data methods.

2.9 We will comment further on what could be the contents of the variables $\boldsymbol{X}_{it}^{M}$, $\boldsymbol{X}_{A(i)t}^{A}$, and $\boldsymbol{X}_{t}^{T}$ in Chapter 3.

2.10 The DGP set out in Equation 1 will be the starting point of our analysis. It could be that this DGP is not a good approximation of a relationship between the MSC, the Fees, and other factors. To test this, we will run appropriate specification tests of our models to assess whether the DGP reflects a causal relationship. If we find it does not, we may have to revise our assumptions about the DGP.

3 Data we propose to use

3.1 In this chapter, we set out the data we propose to use. This will comprise a mix of Merchant-level data (MSC, Fees, and Merchant characteristics), acquirer characteristics, and industry-wide characteristics.

3.2 The chapter has the following structure: we first set out the variables (the data fields) we propose to use in our analysis. We then set out the period for which we propose to collect data. Finally, we explain how we propose to collect the Merchant data (the Merchant sample).

3.3 We propose to request Merchant-level data from the five largest UK acquirers. We may also request data from payment facilitators to complement the analysis of the acquirer data.

3.4 Acquirer characteristics and industry-wide characteristics will likely be based on data we request from acquirers, and statistics derived from the Merchant-level data.

3.5 We explain further below what data we propose to use.

Data fields – Merchant data

3.6 We set out below what type of Merchant data we propose to use for the analysis. This includes our view on the appropriate categories of transaction to consider, based on our current understanding. We also set out our view on the appropriate categories of types of tariff for the purpose of collecting data.

3.7 We propose to collect Merchant data over time for an appropriate sample of Merchants as described further below. The Merchant data we propose to collect falls into three categories:

- MSC – the fee paid by the Merchant to the acquirer for the card-acquiring services (see Glossary) – ideally broken down by category of transaction (see *Categories of transaction* below)
- Fees that the acquirer pays for the Merchant's transactional activity, ideally broken down by category of transaction (see *Categories of transaction* below), comprising:
    1. Interchange Fees paid by the acquirer to the issuer for the Merchant's transactional activity
    2. Scheme Fees paid by the acquirer to the Operators for the Merchant's transactional activity
- Merchant characteristics

3.8 Merchant characteristics will include the following:

- volume of transactions, broken down by category of transaction (see *Categories of transaction* below)
- value of transactions, broken down by category of transaction (see *Categories of transaction* below)
- average transaction value, broken down by category of transaction (see Categories of transaction below)
- Merchant Category Code (MCC) (a four-digit code used to classify the Merchant by the type of goods or services it provides)
- time since the Merchant signed up with current acquirer
- amount acquirer billed the Merchant for card acceptance products – i.e. goods or services to accept card payments that Merchants buy from their acquirers in addition to card-acquiring services
- how the Merchant was signed up (for example, via internal sales team, external sales organisation, or following referral)
- the type of tariff the Merchant is paying (for example, Blended or IF++ – see *Types of tariff* below)
- the type of agreement between the acquirer and the Merchant (for example, standard or bespoke)
- the number of outlets the Merchant is operating

Categories of transaction

3.9 Data on MSCs, Fees, value of transactions, and volume of transactions should ideally be split according to the dimensions that determine the Interchange Fees and Scheme Fees transactions attract. We set out below our view on what appropriate categories may be, based on our current understanding.

3.10 We believe it may be appropriate to define categories based on Card Type, Region, and Transaction Type. Each combination of Card Type, Region and Transaction Type defines a category. We explain below what Card Types, Regions and Transaction Types are:

- Card Type:
  - Visa Consumer Immediate Debit and Prepaid
  - Visa Consumer Credit and Deferred Debit
  - V-PAY
  - Visa Commercial Immediate Debit and Prepaid
  - Visa Commercial Credit and Deferred Debit
  - Mastercard Consumer Debit, Mastercard Consumer Prepaid, and Debit Mastercard Consumer
  - Mastercard Consumer Credit

- Mastercard and Maestro Commercial Cards7
- Maestro Consumer and Maestro Consumer Prepaid

- For each of these Card Types, split by the following Regions:
  - Domestic UK (any transactions that attracted a UK Domestic Interchange Fee)
  - Other Domestic (any transactions that attracted a domestic Interchange Fee oter than the UK Domestic Interchange Fee)
  - Intra-EEA (any transactions that attracted an Intra-EEA Interchange Fee)
  - Other

- For each combination of Card Type and Region, split by the following Transaction Types:
  - Face-to-face, contactless
  - Face-to-face, chip and PIN
  - Face-to-face, magnetic stripe
  - E-commerce, secure (Verified by Visa, Mastercard Secure)
  - E-commerce, other
  - Mail Order/Telephone Order
  - Other

Types of tariff

3.11 Based on our current understanding, we think it would be appropriate to use the following categories when collecting data on types of tariff:

- Blended
- IF+
- IF++
- Other
- Unknown

Blended

3.12 Any tariff where the MSC for a given transaction does not depend directly on the Fees that transaction will attract, and which does not satisfy the criteria for IF+ or IF++ (see below).

7 These comprise Mastercard Corporate, Mastercard Electronic Corporate, Mastercard BusinessCard, Mastercard Electronic BusinessCard, Mastercard Professional Card, Mastercard Prepaid Commercial, Mastercard Fleet Card, Mastercard Purchasing Card, Maestro Prepaid Commercial, and Maestro Small Business.

IF+

3.13 Any tariff where, for any given transaction, the MSC is quoted to the merchant as the sum of the Interchange Fee the transaction attracts, and a margin.

IF++

3.14 Any tariff where, for any given transaction, the MSC is quoted to the merchant as the sum of the Interchange Fee the transaction attracts, the Scheme Fee(s) the transaction attracts, and a margin.

Other

3.15 For instances where the Merchant's tariff is known but does not satisfy the criteria of Blended, IF+ or IF++ tariffs.

Unknown

3.16 For instances where the type of tariff the Merchant pays is unknown.

Acquirer and market characteristics

3.17 It may be appropriate to incorporate data on acquirer and market characteristics in the analysis. The purpose of including these characteristics would be to control for factors that affect the MSC and co-vary with the Fees. Such factors could otherwise result in omitted variables bias.

3.18 Most relevant acquirer characteristics can likely be estimated using the Merchant-level data we propose to collect. Such characteristics would include:

- total volume and value of transactions acquired by the acquirer
- mix of transactions acquired
- mix of Merchant categories (based on, for example, MCC)

3.19 We would have to collect data on other potential acquirer characteristics, including:

- incidence of 'on us' transactions
- fees acquirers pay to the Operators, but are not directly attributable to Merchants' transactional activity

3.20 The following market characteristics may be relevant (to the extent relevant data can be found):

- interest rates
- cost index for cost of processing transactions
- incidence of card fraud
- number of Visa or Mastercard-branded debit and credit cards in issuance

Time

3.21 The IFR caps took effect from 9 December 2015. We propose to collect data covering a period of approximately two years before the IFR caps took effect, and approximately three years after.

3.22 We would ideally use monthly data on MSC, Fees and Merchant characteristics. We recognise that historic data on Merchant characteristics on a monthly basis may not be available. If this is the case, we will consider what approach is most appropriate based on the data available to us.

Merchant sample

3.23 We set out below how we propose to collect Merchant-level data from acquirers.

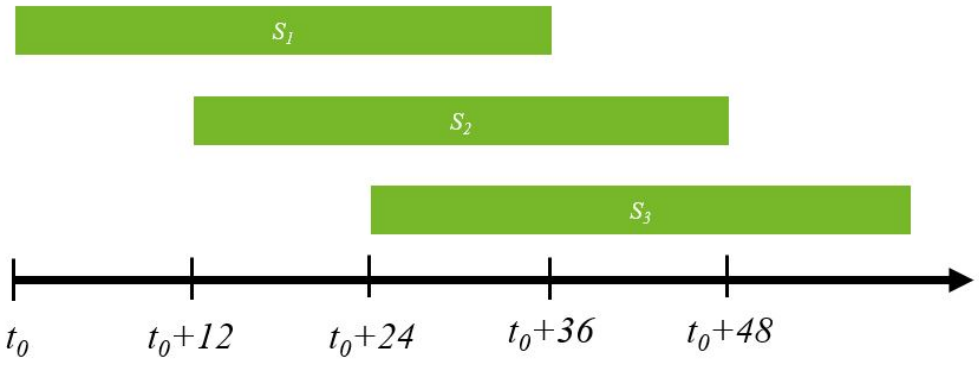
3.24 We intend to rely on a sample of the Merchants served by each of the acquirers in scope of the analysis. The approach to sampling seeks to balance the two following considerations:

- It seems appropriate to draw, for each acquirer, several samples of Merchants over time. Looking only at Merchants who stay with a single acquirer over the entire period would give a skewed picture of pricing dynamics.
- On the other hand, it is useful to follow the same Merchant over a longer period. This allows us to use panel data models for analysing the data.

3.25 We propose to collect three sub-samples for each acquirer. The three sub-samples would cover different, but overlapping, time periods. Each sub-sample would consist of a random selection of the Merchants that buy card-acquiring services from the acquirer in question at a certain point in time (the sub-sample start date), and track those Merchants for up to 36 months. (The sample would stop tracking an individual Merchant earlier if the Merchant ceased being a customer of the acquirer at some point in the 36-month period.) Taken together, the sub-samples would span a period corresponding to the one set out above (see *Time* above).

3.26 The sub-samples would be staggered, with the sub-sample start dates being 12 months apart. Figure 1 illustrates the staggered overlapping sub-samples. The sub-sample start date for the first sample is t_0, the sub-sample start date for the second sample is $t_0 + 12$ months, and the sub-sample start date for the third sample is $t_0 + 24$ months.

Figure 1: Illustration of staggered overlapping sub-samples



3.27 We expect that each of the sub-samples would contain thousands of Merchants.

4 Approaches to estimating pass-through

4.1 We propose to explore several different approaches to estimating pass-through. We set out below three broad approaches to estimating the degree of pass-through. We intend to try multiple variations of each of these approaches. These variations may, for example, involve variances on what control variables we include.

4.2 The three broad approaches are the following:

- **The reduced-form panel estimation approach:** This approach seeks to track individual Merchants over time to determine how changes to Fees affect the MSC.
- **The difference-in-difference approach with IF++ pricing as comparator:** This approach uses the difference in MSC between groups of Merchants before and after the IFR caps to determine how changes to the Interchange Fees affected the MSC. The categories of Merchant are such that we would expect one category (Merchants paying IF++ fees) to enjoy full pass-through of the IFR caps.
- **The difference-in-difference approach with commercial cards as comparator:** This approach uses the difference in MSC between types of transaction before and after the IFR caps to determine how changes to the Interchange Fees affected the MSC. The categories of transaction are such that one category (consumer cards) was affected by the IFR caps, while the other (commercial cards) was not.

4.3 As a practical matter, we plan to implement all analysis in R, a free software environment for statistical computing and graphics.[8]

Reduced-form panel estimation

4.4 This approach seeks to track individual Merchants over time to determine how changes to Fees affect the MSC. It relies on panel data methods to do this.

4.5 This approach builds directly on the DGP set out in Equation 1. An appropriate model could be the following:

Equation 2

$$m_{it} = \sum_{k=0}^{n} \left(\hat{\tau}_k + \hat{\tau}_k^G \tilde{D}_{i,t-k}^G\right) \tilde{F}_{i,t-k} + \sum_{p=1}^{m} n_{it}^p \hat{\pi}^p + \hat{\boldsymbol{\beta}}^M \tilde{\boldsymbol{X}}_{it}^M + \hat{\boldsymbol{\beta}}^A \tilde{\boldsymbol{X}}_{A(i)t}^A + \hat{\boldsymbol{\beta}}^T \tilde{\boldsymbol{X}}_t^T + \hat{\kappa}_i + \hat{\mu}_t + e_{it}$$

4.6 Table 2 sets out the meaning of the variables and constants of this equation.

8 See http://www.r-project.org/

Table 2: Meaning of variables and constants in Equation 2

Variable/constant	Meaning
m_{it}	Average (across all transaction types) MSC per transaction paid by Merchant i to its acquirer, in period t, divided by Merchant i's card turnover in period t.
$\tilde{F}_{it}$	Average (across all transaction types) per-transaction fee the acquirer pays for Merchant i's transactions, in period t, divided by Merchant i's card turnover in period t.[9]
n_{it}^{p}	Proportion of Merchant i's transactions in period t that belong to category p.
$\widetilde{D}_{it}^{G}$	Indicator variable. Takes value 1 if Merchant i is a member of group G in period t; 0 otherwise. We plan to define groups, representing broad categories of Merchants, using the Merchant data fields set out above (see *Data fields – Merchant data)*. Groups could for example represent Merchant size, or line of business, or a combination of such factors.
$\widetilde{\boldsymbol{X}}_{it}^{M}$	Observed characteristics of Merchant i in period t. (This should ideally contain all relevant variables in $\boldsymbol{X}^{M}$ of the DGP.)
$\widetilde{\boldsymbol{X}}_{A(i)t}^{A}$	Observed characteristics of Merchant i's acquirer ($A(i)$) in period t. (This should ideally contain all relevant variables in $\boldsymbol{X}^{A}$ of the DGP.)
$\widetilde{\boldsymbol{X}}_{t}^{T}$	Observed period-specific effects (demand and cost drivers) in period t. (This should ideally contain all relevant variables in $\boldsymbol{X}^{T}$ of the DGP.)
$\hat{\kappa}_{i}$	Merchant-specific component of MSC for Merchant i. Constant over time.
$\hat{\mu}_{t}$	Estimated period-specific component of MSC. Constant across Merchants.
e_{it}	The residual for Merchant i in period t.

9 Strictly speaking, the DGP implies that instead of lagged values of the Fees, the equation should use weighted average of historic Interchange Fees, weighted by current number of transactions in each category of transaction. In practice, that will make little difference if the mix of transactions does not vary too much from one period to the next.

4.7 Equation 2 is similar to the DGP set out in Equation 1, but there are some differences:

- The left-hand side of Equation 2 does not distinguish between categories of transaction. This is because we do not expect to have MSC data broken down by category of transaction for all Merchants. Equation 2 is based on an aggregated version of the DGP (with the DGP being aggregated across categories of transaction).
- The explanatory variables in Equation 2 (denoted with a tilde) need not be the same as the corresponding explanatory variables in the DGP. Any variation in m_{it} that the explanatory variables in Equation 2 leave unexplained, but which would be explained by the explanatory variables in Equation 1, will be absorbed in the residual e_{it}.

4.8 Not all the constants in Equation 2 may explicitly appear in the regression we ultimately run. We propose to use estimation methods that 'strip out' the Merchant-specific and period-specific fixed effects ($\hat{\kappa}_i$ and $\hat{\mu}_t$, respectively). Such methods treat these as unobserved effects.[10] The panel structure of the data makes possible such two-way fixed effects estimation methods.

4.9 We may run regressions with acquirer-specific time effects if data on acquirer characteristics appear insufficient.

4.10 Equation 2 contains lagged variables of the Fees $\tilde{F}_{it}$ and Merchant group $\tilde{D}_{it}^{G}$. It leaves open the question of what the number of lags (*n*) should be. The number of lags is important, as this is a factor that determines the speed of pass-through. We propose to determine this by initially including many lags when running the regression. We would then calculate $\mathrm{T}_h = \sum_{k=0}^{h} \hat{\tau}_k$. The number of lags will be the smallest number *n* that satisfies $\mathrm{T}_n = \mathrm{T}_{n+1} = \mathrm{T}_{n+2} = \cdots$, i.e. the smallest value of *n* such that adding additional lags will not significantly affect the estimate of long-term pass-through.[11]

Difference-in-difference with IF++ pricing as comparator

4.11 This difference-in-difference approach would compare changes to the level of the MSC.

4.12 It could be that Merchants who were paying IF++ tariffs (see *Types of tariff* above) saw full pass-through of Interchange Fee reductions due to the IFR caps. This would be a consequence of the way such tariffs were designed. If it is reasonable to assume that Merchants who were paying IF++ tariffs saw full and immediate pass-through of Interchange Fee reductions due to the IFR caps, we can use them as a comparator.

10 See, for example, Wooldridge (2010), section 10.2
11 This is the same approach as (for example) Nakamura & Zerom (2010).

4.13 We would compare average per-transaction MSC paid by two groups of Merchants: Merchants who pay Blended tariffs, and those who pay IF++ tariffs. It is likely that these two groups pay different average MSCs both before and after the IFR caps came into effect. The difference between the two groups' average MSC before and after the IFR caps came into effect could be a measure of pass-through of Interchange Fees for Merchants who pay Blended tariffs:

- under full pass-through, the difference between the two groups' average MSC would be the same before and after the IFR caps came into effect
- under incomplete pass-through to the group of Merchants on Blended tariffs, the difference would be larger after the IFR caps came into effect than before they came into effect
- under greater than full pass-through to the group of Merchants on Blended tariffs, the difference would be smaller after the IFR caps came into effect than before they came into effect

4.14 This analysis could be run as a 'pooled sample' difference-in-difference analysis comprising the following steps:

1. Identify a subset of our sample, comprising Merchants who are (before the introduction of the IFR caps on Interchange Fees) approximately equally likely to be paying Blended as IF++ tariffs. This assessment could be done based on observable characteristics as set out above (see *Data fields – Merchant data)*. Based on these characteristics, we would calculate a 'propensity score'. This could be based on a regression that determines the probability of a Merchant being on a Blended tariff instead of an IF++ tariff (for example, a logistic regression) and use that score to select a subset of Merchants.
2. From the subset we have identified in the first step, draw two random samples of Merchants. The samples would comprise Merchant characteristics and MSCs paid at two distinct points in time: one before the IFR caps came into effect, and one after the IFR caps came into effect.
3. Run the regression in Equation 3.[12]

Equation 3

$$m_i = \beta_0 + \beta_B \widetilde{D}_i^B + \beta_A \widetilde{D}_i^A + \delta \widetilde{D}_i^A \widetilde{D}_i^B + \boldsymbol{\beta}_C \widetilde{\boldsymbol{X}}_i^M + e_i$$

4.15 Table 3 sets out the meaning of the variables and constants in this equation.

12 See Wooldridge (2010), pages 147-148.

Table 3: Meaning of variables and constants in Equation 3

Variable/constant	Meaning
m_i	Average (across all transaction types) MSC per transaction paid by Merchant i to its acquirer, divided by Merchant's card turnover.
$\widetilde{D}_i^B$	Indicates whether Merchant i is on a Blended tariff ('treatment dummy') – this variable takes value 1 if Merchant is on a Blended tariff, 0 otherwise.
$\widetilde{D}_i^A$	Indicates whether Merchant i belongs to the sample from first or second period – this variable takes value 1 if Merchant belongs to the period post IFR caps coming into effect, 0 otherwise.
$\widetilde{\boldsymbol{X}}_i^M$	Observable factors that could affect pricing. This is to control for any differences between populations in the two periods. (This is analogous to $\widetilde{\boldsymbol{X}}_{it}^M$ in Equation 2.)
e_i	The residual for Merchant i.

4.16 The estimated coefficient on the interaction $\widetilde{D}_i^A \widetilde{D}_i^B$ is a measure of the degree of pass-through:

- If Merchants paying Blended tariffs saw the same degree of pass-through as those paying IF++ fees, we would find $\delta = 0$.
- If the value of δ is close to the value of β_A (the estimated coefficient on $\widetilde{D}_i^A$), Merchants on Blended tariffs would not have seen a price reduction following the IFR caps coming into effect.

4.17 We note that for this approach to be valid, the MSC for the two categories of Merchant prior to the IFR caps would have to follow similar trends.

4.18 We note that this analysis estimates only the pass-through of Interchange Fees (as opposed to the pass-through of Interchange Fees and Scheme Fees jointly).

4.19 We will also consider using as a comparator the MSC paid by Merchants on IF+ tariffs, in addition to MSC paid by Merchants on IF++ tariffs.

Difference-in-difference with commercial card pricing as comparator

4.20 This difference-in-difference approach would compare changes to the MSC charged for payments with consumer cards to the MSC charged for payments made with commercial cards. The bulk of consumer card Interchange Fees were subject to the IFR caps, while commercial cards' Interchange Fees were not subject to the IFR caps.

4.21 This approach seeks to estimate pass-through by comparing the difference in the MSC for these two categories of card before and after the IFR caps taking effect. We would be able to run this analysis only if we have data on the MSC split by commercial and consumer cards.

4.22 The analysis would be based on a group of Merchants for whom we have data both before and after the IFR caps taking effect. Each Merchant would be represented by four data points: Fees for commercial cards prior to the IFR caps taking effect; Fees for consumer cards prior to the IFR caps taking effect; Fees for commercial cards after the IFR caps took effect; and Fees for consumer cards after the IFR caps took effect.

4.23 We would run the regression set out in Equation 4 below.

Equation 4:

$$m_i = \beta_0 + \beta_B \widetilde{D}_i^B + \beta_A \widetilde{D}_i^A + \delta \widetilde{D}_i^A \widetilde{D}_i^B + \boldsymbol{\beta}_C \widetilde{\boldsymbol{X}}_i^M + e_i$$

4.24 Table 4 sets out the meaning of the variables in Equation 4.

Table 4: Meaning of variables and constants in Equation 4

Variable/constant	Meaning
m_i	Average MSC per transaction of relevant transaction type for observation i, divided by Merchant's card turnover for relevant transaction type.
$\widetilde{D}_i^B$	Indicates whether observation i refers to commercial or consumer card transactions – this variable takes value 1 for consumer card transactions, 0 otherwise.
$\widetilde{D}_i^A$	Indicates whether observation i refers to first or second period – this variable takes value 1 if the observation refers to the period after the IFR caps came into effect, 0 otherwise.
$\widetilde{\boldsymbol{X}}_i^M$	Observable factors that could affect pricing. This is to control for any differences in Merchant characteristics between the two periods. (This is analogous to $\widetilde{\boldsymbol{X}}_{it}^M$ in Equation 2.)
e_i	The residual for observation i.

4.25 The interpretation of the result would be analogous with the result of the difference-in-difference analysis with IF++ pricing as comparator. The estimated coefficient on the interaction $\widetilde{D}_i^A \widetilde{D}_i^B$ is a measure of the degree of pass-through.

5 Next steps

5.1 We welcome any comments on the proposed method set out in this working paper. Below are some questions we believe may be particularly important to receive comments on.

5.2 The questions are the following:

- Are there variables you think would have a material influence on the degree or speed of pass-through which are not covered in the chapter *Data we propose to use*?
- Are there variables covered in the chapter *Data we propose to use* that you think would be irrelevant or immaterial to the degree or speed of pass-through?
- Do you have any views on the comparators we are proposing to use in the difference-in-difference approaches?
- Given the contracting arrangements, is three years sufficient for the MSC to reflect the effects of the IFR caps?

5.3 Please send us your comments by 1 March 2019. You can email them to cards@psr.og.uk or write to us at the following address:

Card-acquiring market review team
Payment Systems Regulator
12 Endeavour Square
London
E20 1JN

Disclosure of information

5.4 Generally, we will seek to publish views or submissions in full or in part. This reflects our duty to have regard to our regulatory principles, which include those in relation to:

- publication in appropriate cases and
- exercising our functions as transparently as possible

5.5 We will not accept blanket claims of confidentiality. If you wish to claim confidentiality over specific items in your submission, you must identify those specific items which you claim to be confidential, and explain the basis on which confidentiality is sought. If you include extensive tracts of confidential information in your submissions, we will ask you to submit non-confidential versions.

5.6 We may nonetheless be required to disclose information marked as confidential in order to meet legal obligations.

5.7 This would be the case, for example, if we are asked to disclose confidential information under the Freedom of Information Act 2000. We will endeavour to consult you if we receive such a request under the Freedom of Information Act 2000. Any decision we make not to disclose information can be reviewed by the Information Commissioner and the Information Rights Tribunal.

5.8 In accordance with the legal framework in the Financial Services (Banking Reform) Act 2013 (FSBRA), we will not disclose confidential information that relates to the business or affairs of any person, that we receive for the purposes of our functions under FSBRA, unless:

- we have the consent of the person who provided the information and, if different, the person to whom it relates, or
- there is a 'gateway' permitting such disclosure. One of the gateways is the 'self-help' gateway whereby the PSR will be able to disclose confidential information to third parties to enable or help the PSR to perform its public functions. Where we disclose confidential information to a third party, we may impose restrictions on the further disclosure or use of the information by such parties.

5.9 You should note that information that is already lawfully publicly available or in such a form that it is not possible to ascertain from it information relating to a particular person (for example, if it is summarised, anonymised or aggregated) is not confidential information for the purposes of FSBRA.

5.10 We take our data protection responsibilities seriously and will process any personal data that you provide to us in accordance with the Data Protection Act 2018, the General Data Protection Regulation and our PSR Data Privacy Policy. For more information on how and why we process your personal data, and your rights in respect of the personal data that you provide to us, please see our privacy policy on our website, available here: https://www.psr.org.uk/privacy-notice.

Annex 1
Glossary

Term	Definition for the purpose of this working paper
Merchant	The entity (retailer or service provider) the acquirer bills. Can potentially comprise several outlets. Excludes payment facilitators.
MSC	Merchant Service Charge. The amount the acquirer bills a Merchant for card-acquiring services in a given time period. This includes authorisation charges attributable to the Merchant's transactional activity.
Interchange Fees	Fees acquirers pay to issuers for the Merchant's transactional activity.
Scheme Fee	Fees acquirers pay to card scheme operators (including their processing entities) that are directly attributable to the Merchant's transactional activity. This includes authorisation charges attributable to the Merchant's transactional activity.

Annex 2
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PUB REF: MR18/1.3

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