Evaluating the Impact of the Payment System Reforms

Submission to the Reserve Bank of Australia's Payment System Board's 2007-08 Review of Payment System Reforms

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1. Introduction

On 11th December, 2006, the RBA announced its review of Payment System Reforms in accordance with its undertakings to do so, 5 years from their inception. At the same time, a call was put out for submissions from interested parties in the reform process.

The deliberations over the reforms and some consulting work for a major Australian bank stimulated research on my part into the workings of the credit card system. This resulted in a stream of peer-reviewed academic publications (co-authored with Stephen King, now an ACCC Commissioner) that dealt with the need for and likely impact of the reforms to both the credit and debit card industries (See Gans and King, 2001, 2003a, 2003b, 2003c). Hence, my interest in the review and the motivation for this submission. However, I will focus exclusively on the credit card reforms and their impact.

The motivation for this submission also comes from my testimony before the House of Representatives Standing Committee on Economics, Finance and Public Administration as part of its Review of the Reserve Bank & Payments System Annual Reports, 2005.[1] This submission draws on and expands my views expressed to that committee.

My conclusions are:

1. (*Impact*): Despite their dramatic nature, econometric analysis reveals that there was no similar dramatic impact of the interchange fee reforms on credit card usage and related behaviour (Hayes, 2007). Indeed, it cannot be established that there was any impact across a broad range of indicators.
2. (*Neutrality*): The econometric analysis is consistent with the neutrality hypothesis that stated that changes to the interchange fee will have an impact on credit card fees and merchant services charges but not on consumer payment instrument choice and usage.
3. (*Regulatory Costs*): Given this, there is no case for continued careful regulation of interchange fees. Either such regulations should be removed or at least be bound by a cap fixed forever rather than cost-based regulation or alternatively, the interchange fee should be set at zero. Regardless of the fee, there will likely be no on-going impact on the card system, but continued regulatory deliberations impose direct costs (compliance and enforcement) as well as indirect costs (uncertainty) on market participants. The goal should be to minimise such costs.

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[1] My submission to that committee is available at http://www.aph.gov.au/house/committee/efpa/rba2005/subs/sub002.pdf.

The outline of this submission is as follows and is structured with the above three conclusions in mind. Section 2 considers the impact of the empirical impact of the reforms. Section 3 considers economic arguments for interchange fee neutrality. Section 4 looks at potential regulatory costs. A final section concludes.

2. The Impact of the Interchange Fee Reforms

The RBA has enacted a dramatic set of reforms impacting upon the credit and card charge industry. On the 1st January, 2003, surcharging was permitted on card transactions. On the 31st October, 2003, the interchange fee was capped based on a calculation of issuer costs resulting in a reduction of approximately 50 percent. On the 23rd February, 2004, the credit card schemes were opened up to more competition.

By any standard these reforms were amongst the most drastic ever to be imposed on a previously unregulated industry. It is normally the case that such large-scale reform takes place in the wake of deregulation rather than regulation. And in regulated industries, when prices are regulated, they are regulated using a 'glide path' towards what the regulator regards as efficient. In contrast, the RBA jumped straight to its desired outcomes in a series of 'big bangs.'

At the time, the expectations in the industry were that these reforms – due to their dramatic nature – would have a big impact on the industry. Normally, this would be the case. The expectations of a large impact came from both sides of the regulatory table. Those in the card industry feared large scale change whereas the regulator wanted it to achieve its policy goals. Either way, it should have had a large impact on credit card usage – something that the RBA wanted to reduce in favour of other instruments.

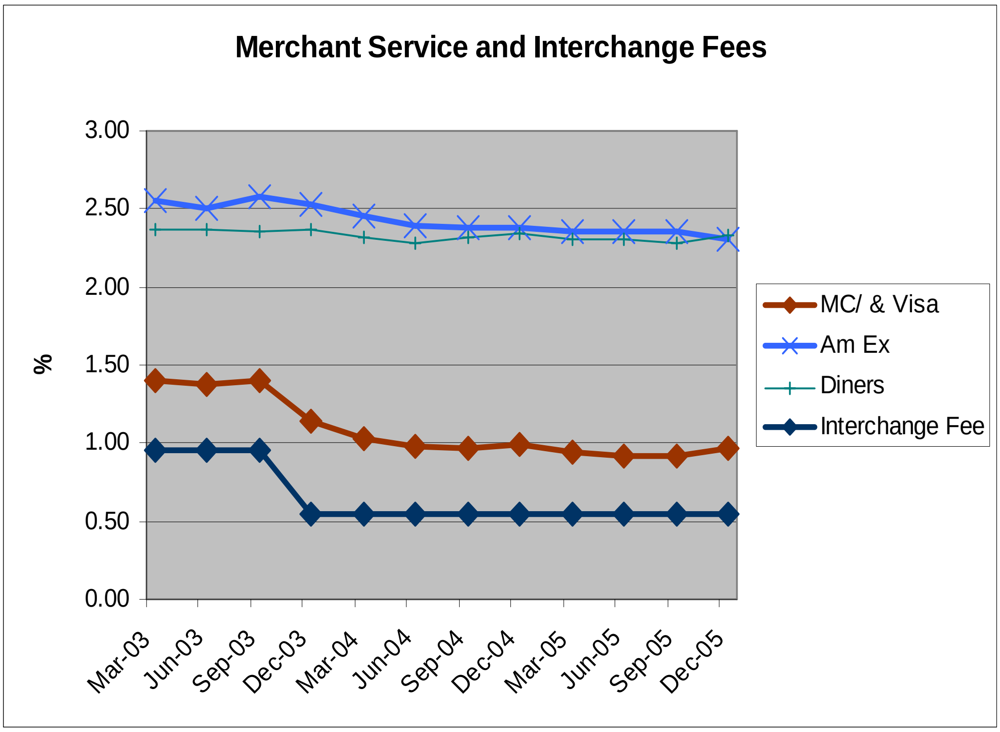
Also, the reforms extracted great interest outside of Australia. Economists around the world did not know what the impact of changing the interchange fee would be and, in many cases, were thankful to Australia for experimenting on its own economy to find out.

As I will note and explain in the next section, there was also reason to believe that, in fact, the impact of these reforms would be more limited. However, my starting point here is to consider, empirically, what the actual impact of the reforms were?

Graphical Analysis

To begin, I will plot a few time series graphs of credit card data. The purpose of this is to see whether there were any discernable breaks or changes in line with the dramatic halving of interchange fees.

First, the interchange fee change does appear to have had an impact on prices. The interchange fee is an input into merchant service charges – that merchants pay for credit card use. The following graph shows that the October 2003 reduction was associated with a corresponding reduction in the merchant service charge.



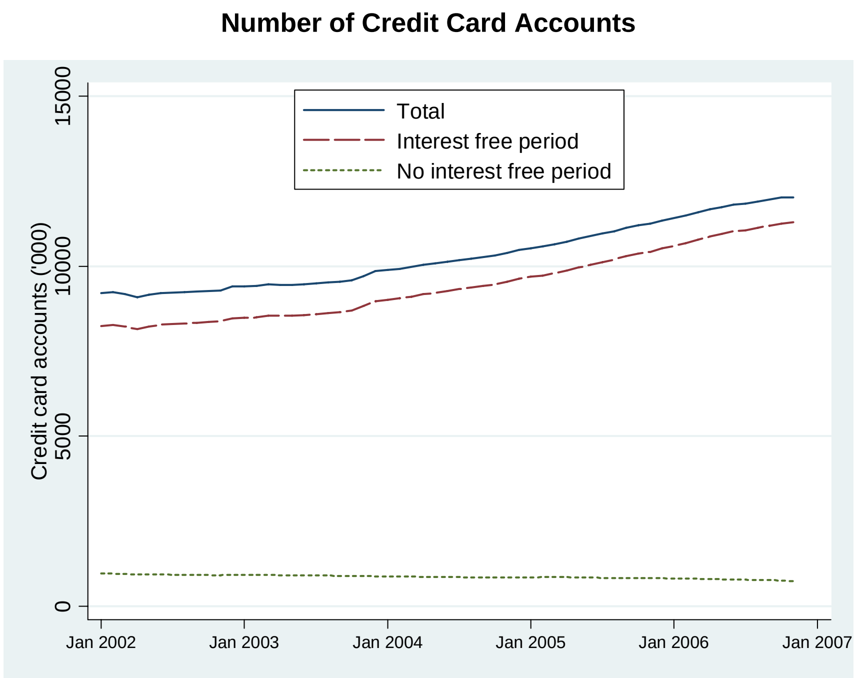
Let a denote the interchange fee and let m be the merchant service charge. The RBA/ACCC Joint Study was concerned that the acquirer margin $m - a$ was too large indicating poor competition. However, notice that there was complete pass through of the reduction in the interchange fee to the merchant service charge. Consequently, prior to and after October 2003, the acquirer margin ($m - a$) equaled about 0.4%.

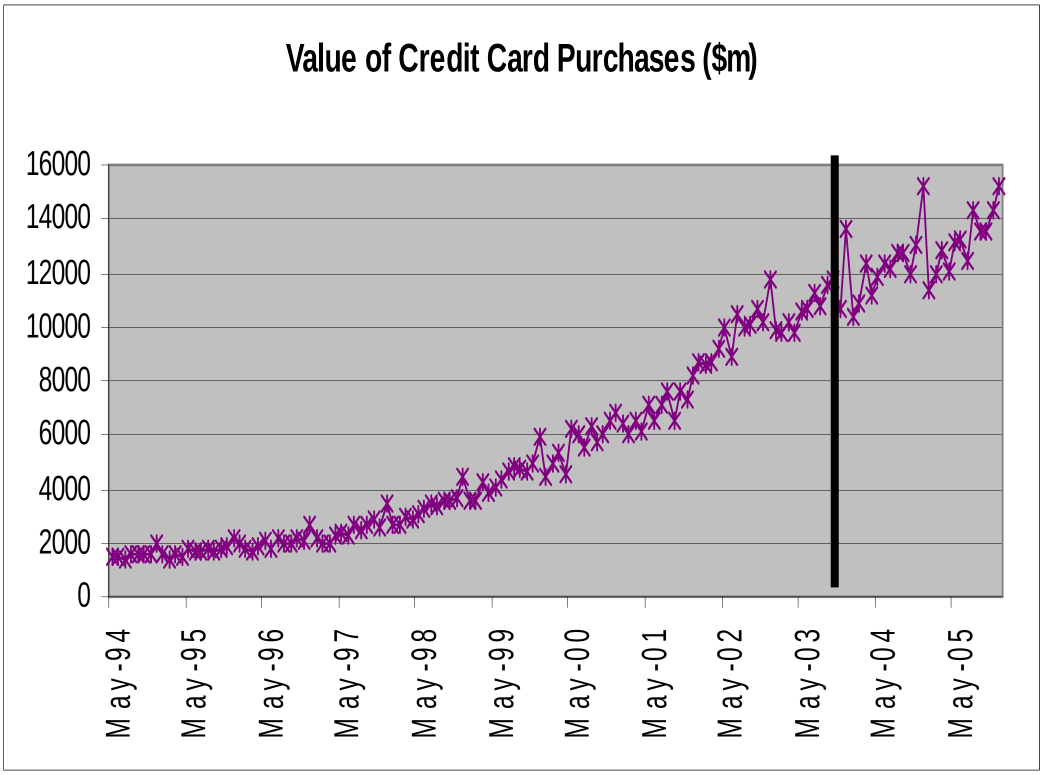
Interestingly, the common measure of the intensity of competition (specifically, the distortion from a lack of competition) – the Lerner Index – for the acquirer market actually went up. If we assume that the marginal cost of acquisition (c_A) is approximately zero, then the interchange fee represents the marginal cost facing acquirers. The Lerner index is $(m\text{-}a)/m$. It has grown from 0.32 in September 2003 to 0.42 in December 2005. Thus, the welfare distortions in acquisition have increased.

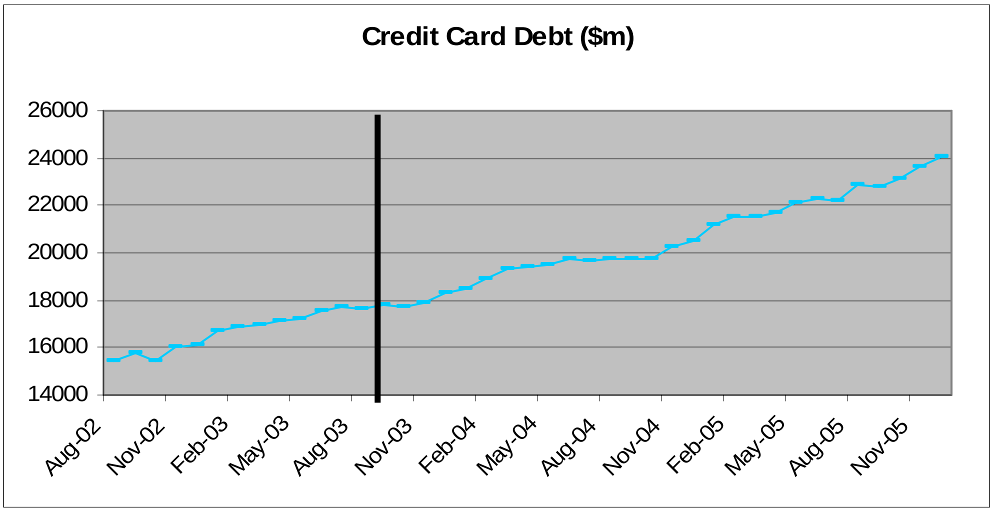
There is no corresponding available data on the issuing side of the market to consider the impacts there.

In terms of quantities, the following graphs show rises in the number of credit card accounts, the value of credit card purchases ($m) and rising credit card debt. In each case, these trends do not appear to have been impacted negatively by the reforms. Indeed, the first graph[2] indicates a jump in the number of credit card accounts. This is surprising as a reduction in the interchange fee would mean that payments to issuers would go down and hence, they would be less likely to want to issue more cards.

[2] The other break was due to a change in definition.

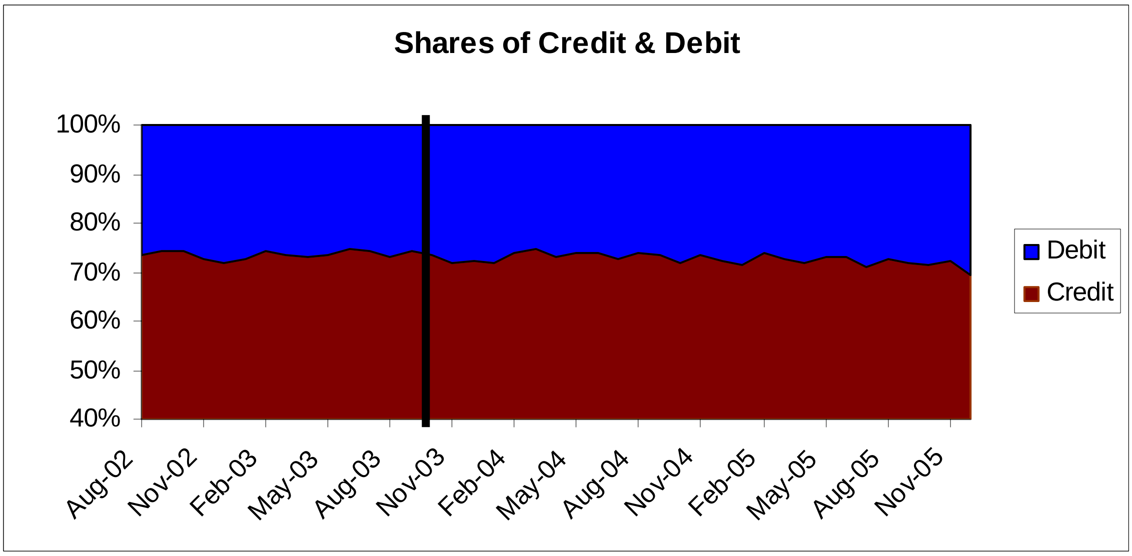

Number of Credit Card Accounts
Total
Interest free period
No interest free period
Credit card accounts ('000)
0
5000
10000
15000
Jan 2002
Jan 2003
Jan 2004
Jan 2005
Jan 2006
Jan 2007


Value of Credit Card Purchases ($m)
0
2000
4000
6000
8000
10000
12000
14000
16000
May-94
May-95
May-96
May-97
May-98
May-99
May-00
May-01
May-02
May-03
May-04
May-05



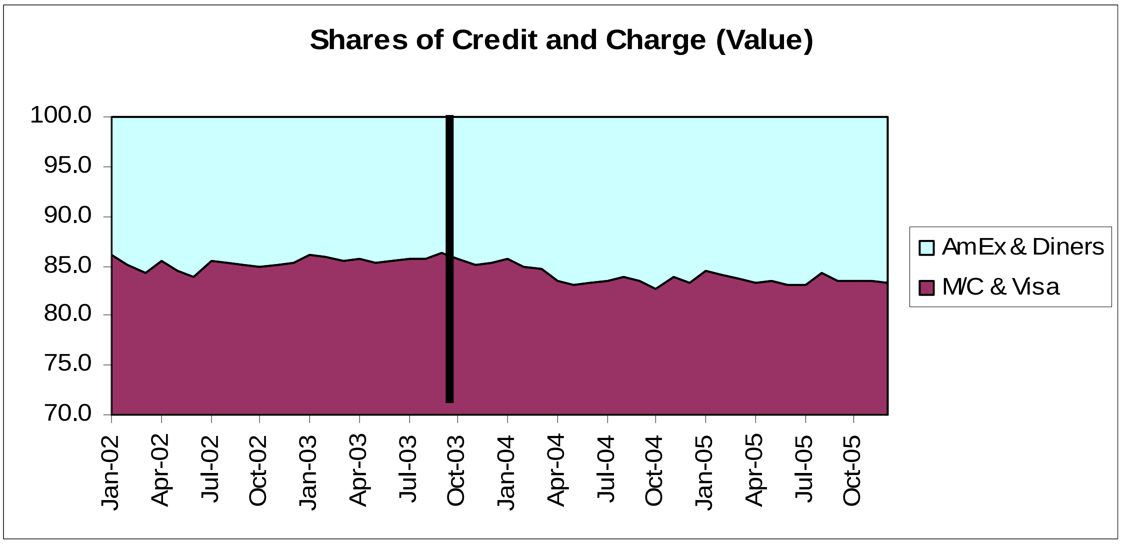
Thus, the dramatic reforms do not appear to have hit the usage of credit cards to any great or at least significant degree. Moreover, as I report on below, this is borne out by a far more sophisticated econometric analysis.

What about the choice of payment instruments? In terms of the shares of credit and debit cards, the reforms have had no significant impact.



There appears to be a recent drop off away from credit cards but that could easily be accounted for by seasonal or other factors. It is hard to imagine that the major impact of the reforms occurred sharply two years after the reforms.

However, when it comes to the choice between credit and charge cards (such as Amex or Diners), there has been a larger shift of a couple of percent towards charge cards. Of course, given that these types of instruments are very similar, the immediate impact of a price change would be expected to be more dramatic.



Econometric Analysis

Graphical analysis can only get you so far in considering the impact of a change. This is because it masks other changes going on as well as time series properties of the data – most significantly, seasonality, and long-term trends that need to be taken into account. The RBA have recognised the value of econometric analysis in their work in all other policy areas. However, to date, I am not aware of any econometric analysis whose results have been disclosed publicly or alluded to in some other way that has been conducted in measuring the impact of its own payment system reforms.

There is one analysis in the literature that does do some econometrics. Chang, Evans and Garcia-Swartz (2005) conduct a similar graphical analysis to that above but also look for differences in quarterly and annual growth rates in quantity data on credit card use. They find no evidence of a significant impact from the reforms and, if anything, some positive impacts. However, their analysis does not consider the full time series properties of the data in particular seasonality issues and they also appear to aggregate credit and charge card data.

Appended to this submission is a paper by Richard Hayes (2007) – "An Econometric Analysis of the Impact of the RBA's Credit Card Reforms" – that, for the first time, conducts a series of sensible econometric tests to consider whether the interchange fee changes had a significant impact on credit transaction values, account numbers and shares amongst payment instruments. The tests provided utilise RBA data that was public as of the writing of this submission and are otherwise the set of tests that a serious econometric analysis would undertake. That said, I caution that time was short on this issue (given the short submission timeframe) and that this analysis has yet to be subject to academic peer review (although that is no different from RBA Working Papers with econometric analysis of other policies).[3]

I will not describe here the precise tests carried out in the appended paper. Instead I will summarise the broad findings:

1. *Seasonality*: credit card transaction value and credit card market shares (in both the payment and card markets) were all strongly seasonal. Credit card account numbers were not seasonal although there appeared to be a December effect.

2. *Stationarity*: the convenience market share data was stationary without a time trend as was the growth of credit card transaction values and accounts.

3. *Breakpoints*: given that the reforms occurred in October 2003 and that we know that there was a price impact at that point, it is natural to test for a break in the data at that date. This includes a levels break and also a growth break. The econometric tests for a break-point show that we are unable to reject the hypothesis that there was no break in October 2003 for the value of credit card transactions. There was, however, some evidence for a break in the credit card accounts series but this was positive – a step change increase in card accounts. This could be the result of an interest rate change at that time. Finally, there is no evidence of a significant break in the credit card share of the convenience payment market. Despite our graphical observation of a shift from credit to charge cards, the statistical analysis of this series indicated non-stationarity so the hypothesis that this was associated with the reforms has not yet been tested.

The 2003 reforms reduced a key price received by card issuers for the promotion of credit cards. This meant that from their perspective it was more costly to service card transactions and less desirable to have card customers. However, there is no evidence of a significant impact of that change and, indeed, where there is some associated change in the trended data, it is in the opposite direction from what was expected by the RBA at the time of the reforms.

[3] For instance, the papers listed here: http://www.rba.gov.au/PublicationsAndResearch/RDP/.

3. Interchange Fee Neutrality

While some economic theory suggested that a reduction in interchange fees would have a negative impact on card use, it was recognised that this would only arise under certain conditions (Rochet and Tirole, 2003). In particular, Gans and King (2003a) showed that when surcharging was permitted and/or the retail economy was sufficiently competitive, changes in the interchange fee would be neutral. That is, interchange fee changes would alter relative prices but not the actual consumer choices over payment instrument usage.

This type of neutrality is *system neutrality*. It says that if there is a reduction in interchange fees by say, Δa, then merchant service fees will fall by the same amount, Δm. As noted in the previous section, this is what happened in Australia. But the price changes would not end there. Competition amongst issuers for card-holders would become less intense. Issuers used to receive Δa more for each card transaction they could encourage. Without that inducement they would have less incentive to promote such transactions. Hence, the marginal fee (which could be negative) which cardholders pay would rise. Say by Δf. Chang et.al. (2005) provide some evidence that that has occurred.

All this has the makings of a reduction in card-usage. However, if merchant service fees drop, then there will be some pressure from retailers to pass those savings on to consumers. This pressure could come from competition or alternatively it could come in the form of lower surcharges on credit card use. Either way, a consumer who opts to use a card may well face lower retail prices in so doing. In this case, while their inducement from banks to use cards has fallen, their inducement from merchants has risen. This is not to mention the fact that lower merchant service charges and permissions to surcharge themselves would mean that more merchants offer card services. In equilibrium, the system balances itself out and consumers end up making the same choices they made before any changes to the interchange fee occurred.

However, even system neutrality, allows for the possibility of temporary disruptions as relative prices adjust. Balanced against this, however, are the habits of consumers. Nonetheless, what it does predict is that once off changes to the interchange fee will have no lasting negative impacts on credit card usage. And that appears consistent with what we have observed in our econometric analysis.

Of course, the data is also consistent with *direct neutrality*. Interchange fees are only one of several types of payments made between issuers and acquirers. There are promotional incentives and the like although these tend to be less or not related to the volume of transactions. It is theoretically possible that as interchange revenue fell, these other payments adjusted accordingly to ensure that issuers continued to attract card-holders. Consequently, there may have been no change in card-holder fees and hence, a similar level of credit card use.

In either case, the implications for policy are very important. First, a constant but unregulated interchange fee will have the same level of credit card use as a constant regulated interchange fee. It is not an instrument for generating more efficient payment instrument choice nor reducing any perceived transaction costs in the payment system.

Second, even an interchange fee of zero, so long as it was constant, would give rise to the same market conditions – profits of issuers and acquirers, incentive for entry, merchant costs and consumer value and usage – as any other. However, it would save any need for accounting or settlement of interchange transactions.

In this sense, if neutrality were established, the RBA would have a free-hand in regulation. There would be no need to justify any particular fee as all fees led to the same real outcome. As I argue next, the alternative – regulating and on-going regulatory decisions – impose other costs. Thus, *treating interchange fees as if they were non-neutral is not, in of itself, neutral in terms of real resource costs*.

4. Regulatory Costs

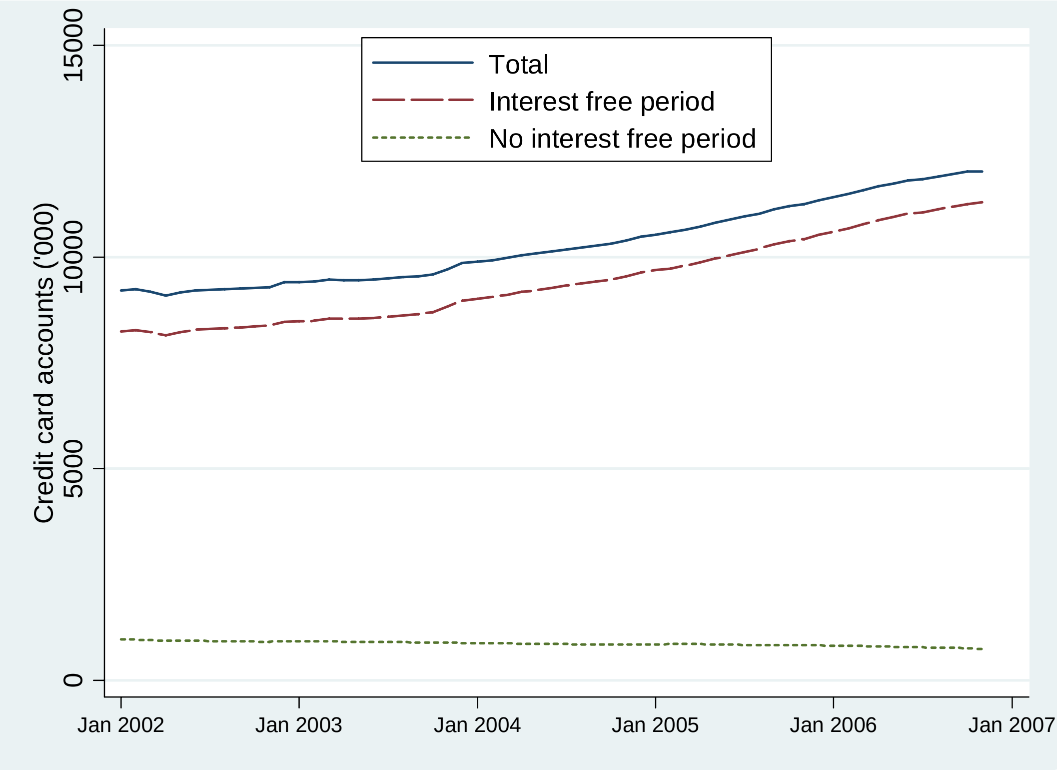
If the interchange fee were neutral, then it might be argued that there were no costs of regulation as regulation itself would have no impact. In this case, the regulator might hedge their bets by regulating the fee regardless, just in case it turned out that it was effective and non-neutral.

However, regulation has its costs and these must be balanced against its effectiveness. In particular, I am not so concerned here with capping interchange fees and moving on. I am instead concerned with on-going re-calculations of those fees, auditing, enforcing, data collection, debating and reviewing. All of these activities are costly and also lead to uncertainty over what future interchange fees will be. There may be constant adjustment in an industry that did not see changes in interchange fees for over twenty years prior to regulation.

As an example of such costs, consider the inclusion of the costs of funding interest-free periods in determining the interchange fee. I argued in a previous submission that such a cost inclusion seemed appropriate given that payment functionality seemed to imply at least some interest free period to be of value to consumers.[4] However, I was concerned about the potential ability of banks to manipulate these costs by changing the length of that period and so argued for some averaging.

In hindsight, I am concerned that the assumptions upon which that conclusion was based may have been incorrect. According to the RBA's own data, there exist credit card accounts without an interest free period. Moreover, since October 2003, all of the new growth in credit card accounts has come from those with an interest-free period. This is shown in the following graph.

[4] Gans, J.S. and S.P. King (2002), "Regulating Credit Cards in Australia: A Submission to the Reserve Bank of Australia" http://www.rba.gov.au/PaymentsSystem/Reforms/CCSchemes/ResponsesConsultDoc/core_120302_1.pdf



It is possible that it was the very fact that interest-free period costs were included in the interchange fee that caused issuers to ramp up marketing of those accounts to customers. Hence, the rapid growth in those accounts immediately following the reforms.

Recall that the reforms were supposed to create a disincentive to issue new credit cards compared with other payment instruments. However, the econometric analysis verified that an increase in the growth rate of accounts (specifically, interest free period accounts) was associated with the reforms introduction. Indeed, it remains the most visible impact of the reforms.

My suggestion here is that the unintended consequence of the way the interchange fee was calculated was to create a growth in interest free period accounts; the opposite of the direction the RBA was hoping for.

To be sure, this is a potential example of the costs of regulatory intervention in an on-going sense. If the interchange fee were fixed, there may have been no distortion created.

In this respect it is very important to assess and form a view on neutrality. If the outcome is that the interchange fee is neutral, then it should be capped once and for all and no further reviews undertaken; certainly not annually. Indeed, there may be an argument for setting it at zero.

5. Conclusion

In this submission, I have argued that regulation of interchange fees has been ineffective. A typical response to this conclusion has been the following:

> It had been argued that, in the face of Reserve Bank actions on surcharging and access, regulation of interchange fees was unnecessary. The problem with this position is that, as argued above, card payment systems, left to their own devices, do not tend towards efficient operation. While in normal markets increased access could be expected to cure many anticompetitive ills, this was not the case in the credit card market. The structural features of the market are such that increased access to issuing or acquiring would not, of itself, overcome the problems with the inefficient setting of interchange fees: large subsidies to consumers that distort payment systems choice; relatively high costs to merchants who, in turn, pass those costs on to all consumers; and no effective resistance from merchants to inefficiently high charges. (Simon, 2005, p.376)

This response fails to distinguish between the efficiency of the system and the use of the interchange fee as an instrument for generating more efficient outcomes.

Put simply, it is hard to find any economic analysis that says that interchange fees set in an unregulated market will lead to efficient choices by consumers of payment instruments. Either the interchange fee is set arbitrarily (because it is neutral) or alternatively, it is set too high (Rochet and Tirole, 2002). If it is non-neutral and set to high, then capping is appropriate (Gans and King, 2003b) and indeed it can be argued that the RBA has been conservative in the fee that it has set (Gans and King, 2003c).

However, if it is neutral – as reforms such as surcharging would drive – then even if the system is not operating efficiently, the interchange fee cannot be used to generate that efficiency. It is an ineffective instrument. Payment systems are different because they are two-sided markets. That means regulation of one price only leads to the adjustment of others. If simultaneously the RBA could regulate all prices – interchange fees, card issuing fees and merchant service charges – then price regulation would be effective. The question would be: how to regulate these to generate improvements in efficiency?

6. References

Chang, H., D.S. Evans and D.D. Garcia Swartz (2005), "The Effect of Regulatory Intervention in Two-Sided Markets: An Assessment of Interchange-Fee Capping in Australia," *Review of Network Economics*, 4 (4), pp.328-358.

Gans, J.S. and S.P. King (2001), "The Role of Interchange Fees in Credit Card Associations: Competitive Analysis and Regulatory Options," *Australian Business Law Review*, Vol.29, No.2, April, pp.94-122.

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An Econometric Analysis of the Impact of the RBA's Credit Card Reforms: Preliminary Results

by

Richard Hayes*

19th January, 2007

On 31 October 2003 the interchange fee for credit card transactions was lowered in a dramatic way – from 1% of transaction value to 0.46% of transaction value. This appendix provides details of tests to determine if this change was associated with a structural break in the use of credit cards. In other words, *can the change in interchange fee be linked in a statistical sense with structural breaks in the time series data for credit card transaction values, credit card account numbers and credit card market shares?*

The market share figures are more directly indicative of the effect of the change in the interchange fee on the relative preference for credit cards. The credit card transaction value and credit card account numbers are still indicative of whether or not the interchange fee change had an absolute effect.

The tests were done using credit card and other payment data from January 2002 to November 2006, extracted from the RBA website. The series tested are described in Table 1, including the construction of various credit card market share measures. The data series tested extends back to January 2002, when separate credit card and charge card statistics first become available.

* Melbourne Business School, University of Melbourne. The author is also a casual employee of the Australian Competition and Consumer Commission. The views expressed in this appendix represent those of the author and should in no way be construed as representative of the above organisations. Responsibility for all errors and omissions lies with the author.

TABLE 1
VARIABLES & DEFINITIONS

VARIABLE	FULL VARIABLE NAME	DERIVATION	RBA SOURCE As at 18 January 2007
Credval	Credit card transaction value ($ million)	This is the total value of transactions involving credit cards. It is the sum of transaction value for cards with an interest free period and those with no interest free period. Transaction value includes both cash advances and purchases made during the month	Bulletin table C1 - Credit and Charge Card Statistics: Additional Credit Card Statistics
Credaccts	Number of credit card accounts ('000)	This is the total number of credit card accounts. It is the sum of credit card account numbers for cards with an interest free period and those with no interest free period, as at the last day of the month.	Bulletin table C1 - Credit and Charge Card Statistics: Additional Credit Card Statistics
Credsharetotal	Credit cards share of total "convenience payment" market	Total credit card transaction value divided by the total value of transactions for credit, charge and debit cards, customer cheques and direct entry debit transfers. It doesn't include financial institutions cheques, direct credit or cash	Bulletin table C1 - Credit and Charge Card Statistics: Additional Credit Card Statistics Bulletin table C4 - Debit Card Statistics Bulletin table C5 – Cheques and Direct Entry Payments
Credsharecards	Credit cards share of total card market	Total credit card transaction value divided by the total value of transactions for credit, charge and debit cards.	Bulletin table C1 - Credit and Charge Card Statistics Bulletin table C4 - Debit Card Statistics

1. Time series plots

The series examined are plotted in Figures 1, 2, 3 and 4 below. The credit card transaction value series appears to be subject to seasonality, with December standing out as a peak and January appearing to be a low point. The peak retail season in December would explain this. Credit card account numbers generally increase over the time period examined. All of the increase is from credit cards that have an interest free period. In fact there was a decline in the number of credit cards held without an interest free period. There is some visual evidence of a break after October 2003, the time of the introduction of the interchange fee decrease, with credit card account numbers having a marked **increase** from October 2003 to November 2003.

For the remaining tests we use the log of credval and credaccts and initially assume they have a trend for the purposes of testing seasonality and testing for unit roots.

Visual inspection of the market shares graphs suggests a number of things. There appears to be an increase in the credit card market share for both markets over time.

No structural break is readily discernible from these graphs. The credit card share of the total card market has a noticeable “sawtooth” pattern, for reasons that are not clear to us. This could be an artefact of the data collection method.

The underlying data used in constructing these market shares has not been seasonally adjusted. The graphs do not suggest strong seasonality although there does appear to be some “peaking” in December. Separate inspection of correlograms for these two series suggests potential seasonality with a 12 month lag. The market share series are assumed likely to have some deterministic trend, until tests indicate otherwise.

Figure 1 – Credit card transaction value

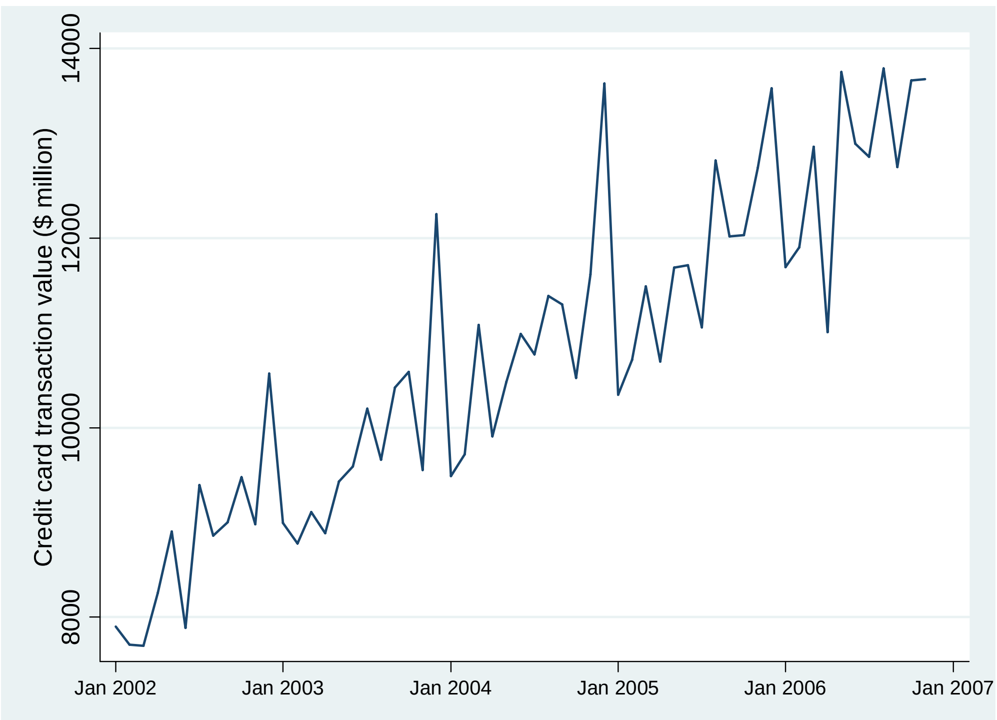


Figure 2 – Credit card account numbers

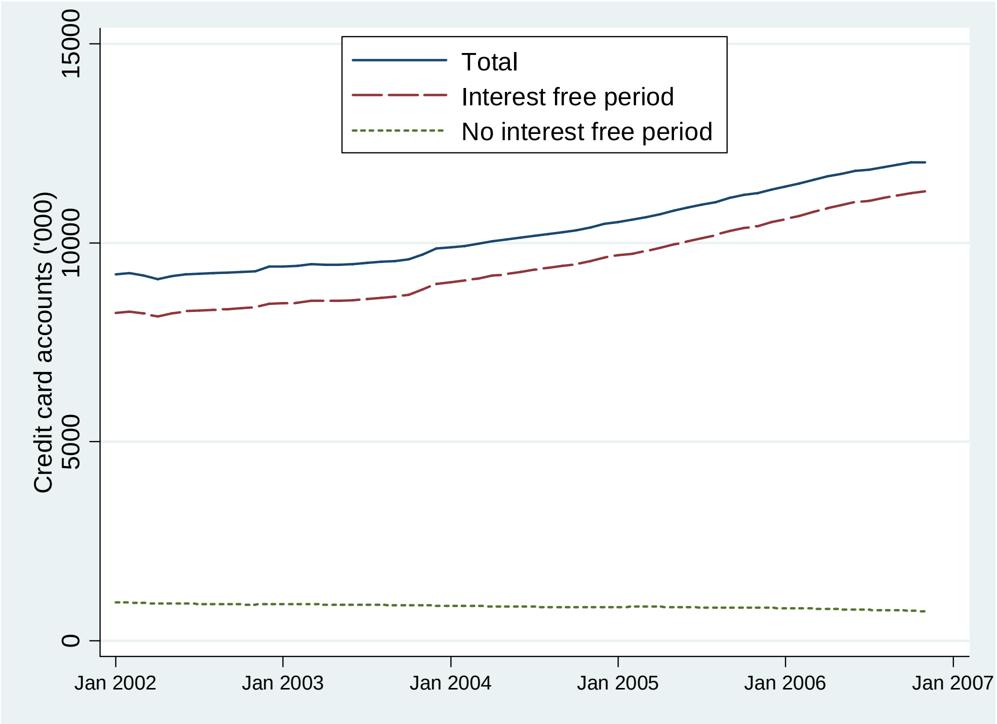


Figure 3 – Credit card share of total convenience payment market

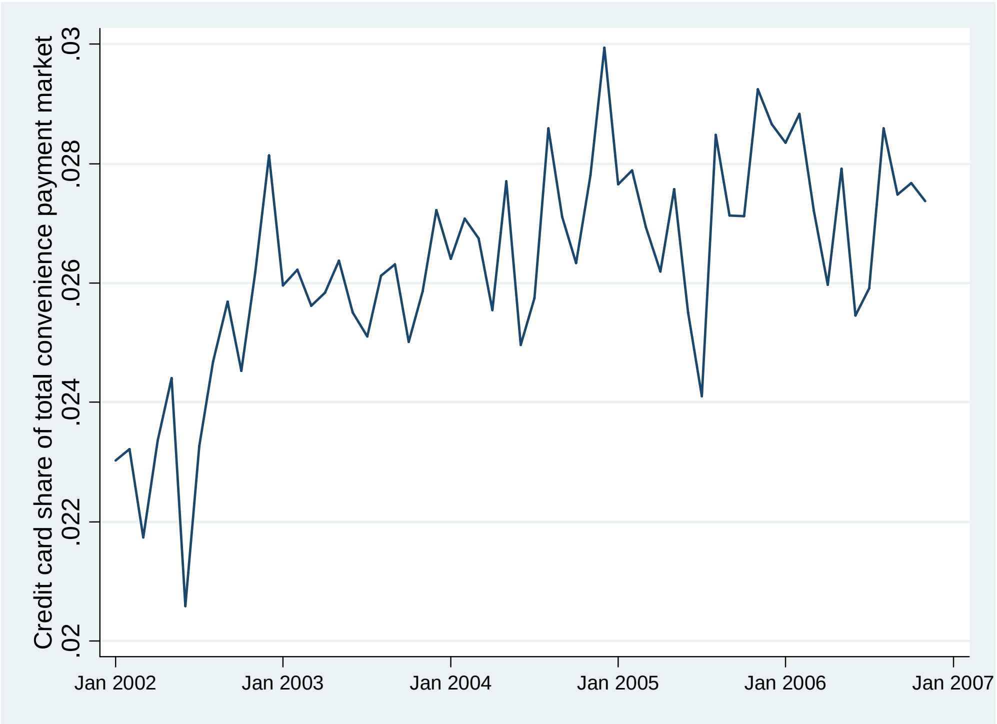
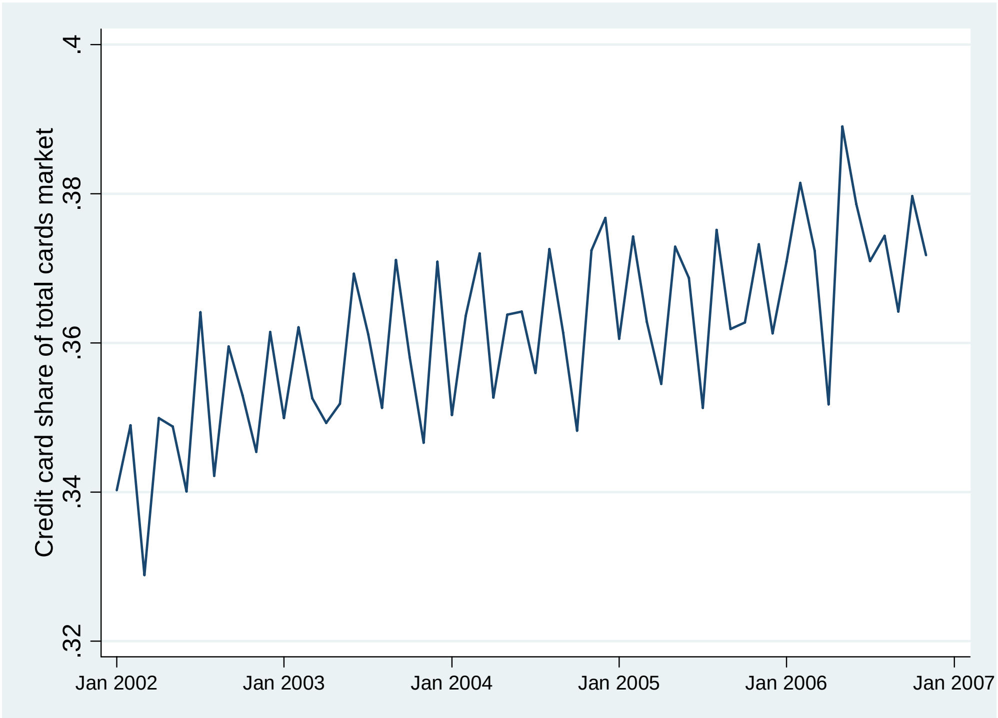


Figure 4 – Credit card share of cards market



2. Seasonality tests

The RBA data is not seasonally adjusted. We deal with potential seasonality by using seasonal dummy variables. This relies on an assumption of deterministic seasonality. Although tests exist for seasonal unit roots (e.g. Hylleberg, et al 1990) we are somewhat restricted in having only 4-5 data points for each month. In particular, there are only 1-2 data points for each month prior to the break date of 31 October 2003.

In any event, we consider this deterministic seasonality assumption reasonable, following the arguments of Miron (1996). The seasonal dummy model is likely to be a good approximation for credit card markets, where much of the seasonal variation would be anticipated to be associated with relatively unchanging underlying events – the timing of certain holidays and changes in the weather producing regular increases and decreases in retail sales and resulting credit card usage. The fluctuations caused by these underlying factors will not be identical in all years. However a good first approximation will be that the seasonal effects, associated with say December, will still be apparent independent of the state of the business cycle.

We initially tested for seasonality by regressing each series on a constant and a set of 11 monthly dummies. Table 2 highlights the results. We included a time trend based on the potential for underlying trends observed from the time series plots of the variables. An F-test of joint significance of the dummies was used to test seasonality.

Table 2 Seasonality tests

Series[1]	Joint F-test on seasonal dummies (p value)	Individual t-test on December dummy, p value	Seasonal dummies used in regressions?
Log credval	13.37 (0.0000)	0.000	✓
Δ Log credval	7.57 (0.0000)	0.000	✓
Log credaccts	0.22 (0.9956)	0.485	×
Δ Log credaccts	1.62 (0.1250)	0.001	✓
Credsharetotal	5.82 (0.0000)	0.009	✓
Credsharecards	3.05 (0.0038)	0.042	✓

1 All series include time trends

Credit card transaction value and its various market shares were all strongly seasonal. For credit card account numbers, the joint test of significance did not indicate seasonality in the presence of a time trend. The joint test of seasonality for the 1st difference only barely rejected seasonality. However, there was a very strong individual December result. We have chosen to assume seasonality for the differenced series due to a reasonable belief that opening new credit card accounts could easily be seasonal, the strong seasonality apparent for the series in December and the strong seasonality in the other series.

We considered the use of more complex seasonal adjustment involving moving averages. We chose not to do this, partly due to the relatively small number of data points available prior to the interchange change. In addition most such prefilters (Tramo/Seats, X-12-ARIMA etc) can distort the underlying properties of the data, adding a degree of autoregressive character that is not actually present.

3. Exogenous testing of breakpoint

The date of change of the interchange fee is well known. A potential dilemma is choosing between the known exogenous date of the actual interchange fee change and using a break point date endogenously determined by the actions of agents in the credit card market. Econometric techniques that test for endogenous structural breaks have been developed (see Maddala and Kim, 1998 for a summary) and techniques are also available for confirming the existence of known or assumed breaks (Chow 1960, Perron 1989). For our primary tests, we follow Maddala and Kim's suggestion (p398) that where there is prior information about the timing of drastic policy change tests for breaks should be around those events. We supplement this with some preliminary test results for endogenously determined break points.

These exogenous breakpoint tests generally require stationarity. We perform unit root tests to help determine the form of the break point tests.

4. Unit root tests

We initially use an augmented Dickey Fuller test (Dickey and Fuller 1979) for unit roots on the time series. Following the assumption of deterministic seasonality, we include seasonal dummy variables where applicable:

$$\Delta y_t = \alpha_1 + \sum_{i=2}^{12} \alpha_i M_{ti} + \delta t + \beta y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t, t = 1,...,T$$

M_{it} are centered seasonal dummies, used to avoid shifting the magnitude of the intercept. M_{it} = 11/12 if the month corresponds to the month *i* and -1/12 otherwise, with January as the base month.

The null hypothesis of these unit root tests is that the variable has a unit root against the alternative of no unit root. The ADF tests are done with a deterministic trend and constant and with a constant alone. The null hypothesis of a unit root can be tested using the standard Dickey-Fuller statistics as Dickey, Bell and Miller (1986, page 25) show that the limiting distribution for β is not affected by the removal of the deterministic seasonal components.

If the null of a unit root is rejected we assume the series is stationary and proceed to use a Chow type test to determine if there is a break in the series after October 2003.

Perron (1989) shows that standard unit root tests that don't allow for a structural break can have low power against the alternative of no unit root, when the underlying series has a structural break and no unit root. Accordingly if the null of a unit root is not rejected in the ADF tests we use Perron's (1989) procedure to test for unit roots in the presence of structural change.

We use Perron Model C to test for trend stationarity with a structural break at time τ, ie after October 2003. The null hypothesis is a change in both the level and drift of a unit root process:

$$H_0 : y_t = a_0 + y_{t-1} + \mu_1 D_P + \mu_2 D_L + \varepsilon_t$$

The alternative hypothesis is a trend stationary series with a change in the intercept and the slope of the trend:

$$H_1 : y_t = a_0 + a_2 t + \mu_2 D_L + \mu_3 D_T + \varepsilon_t$$

Where:
D_P is a pulse dummy variable such that $D_P = 1$ if $t = \tau + 1$ and zero otherwise;
D_L is a level dummy variable such that $D_L = 1$ if $t > \tau$ and zero otherwise;
$D_T = t$ if $t > \tau$ and zero otherwise.

Where seasonality is indicated, seasonal dummy variables are included. The procedure is to estimate the regression H_1. Then use the residuals $\hat{y}_t$ to estimate the regression:

$$\hat{y}_t = a_1 \hat{y}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \hat{y}_{t-i} + e_t$$

The t-statistic for the null hypothesis $a_1 = 1$ can be compared with the critical values for Model C calculated by Perron (1989). The critical values vary with the proportion of the breakpoint to the entire sample, λ. Here the break point is exogenously given as October 2003, which approximately gives λ = 0.4.

5. Unit root test results

Table 3 shows the unit root test results. The null hypothesis of a unit root in each of the log series is rejected using differenced data, implying there is not a second unit root. The market shares are bound by construction and so would be expected to be stationary in the long run. The results indicate the share of total market to be stationary without trend.[1]

However the tests of share of the total card market fail to reject the null hypothesis of a unit root. Indeed similar tests on credit cards as a share of credit and debit cards and as a share of credit and charge cards also failed to reject the null of a unit root.[2] Furthermore, testing of the residuals from the structural break regressions for all 3 of these credit card market shares failed to reject the null of no cointegrating relationship. Accordingly OLS regression results on these series are unreliable and are not reported here.

This apparent lack of stationarity and of cointegration in these credit card market shares may be a result of the noticeable "sawtooth" pattern in each of these series. This is an area for future development.

These results suggest we should treat log credval and log credaccts as difference stationary with deterministic trends. We treat credsharetotal as stationary with no deterministic trend. Credsharecards is not tested for an exogenous structural break due to stationarity concerns.

[1] Testing for significance of the trend using the ADF φ_3 statistic indicated the trend is not significant at the 5% level..

[2] Differencing the series removed the unit root but the interpretation of the resulting series is problematic - we would be looking for breaks in the marginal effects of variables causing a change in credit card share.

Table 3 Unit root test results

	ADF tests			Perron test	
	Lags[a]	**ADF stat**	**5%CV**	**Lags[b]**	**t-stat[c]**
Log credval				8	-2.14
Trend & constant	8	-1.683	-3.500		
Constant	8	-1.363	-2.930		
Δ Log credval				7	-3.70
Trend & constant	7	-4.238***	-3.500		
Constant	7	-4.015***	-2.930		
Log credaccts				8	-2.32
Trend & constant	10	-2.825	-3.508		
Constant	8	0.906	-2.930		
Δ Log credaccts				7	-2.94
Trend & constant	0	-4.630***	-3.493		
Constant	0	-4.022***	-2.924		
Credsharetotal				1	-3.74
Trend & constant	2	-2.896	-3.494		
Constant	2	-3.262**	-2.925		
Credsharecards				8	-2.55
Trend & constant	8	-2.173	-3.500		
Constant	8	-0.919	-2.930		

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

a ADF maximum lag length of 10 is selected by the method of Schwert (1989) ie $k_{\max} = \text{int}\left[12\{(T+1)/100\}^{0.25}\right]$. The final lag length is selected using Ng and Perron's (1995) sequential t-test method, removing successive lags until a significant lag is found (using a significance level of 10%).

b Perron lag lengths are determined using t-tests on the coefficients. Following Lumsdaine and Papell (1997) a maximum lag length of 8 was chosen. The final value of k was selected if the t-statistic on β_k was greater than 1.60 in absolute value and the t statistic on β_i for i>k was less than 1.60 (Perron, 1989)

c Significance levels based on Perron Model C with $\lambda = 0.4$

6. Testing for structural break

For stationary series, we use a Chow type test with dummy variables to test for a structural break in the time series data. Our primary tests assume the date of structural break is exogenously given as 31 October 2003, when the interchange fee was cut. We test for a statistically significant structural break at this time using:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_0 X_t + \gamma_0 D_L + \gamma_1 [D_L * Y_{t-1}] + \gamma_2 [D_L * X_t]$$
$$+ \theta_2 M_{2t} + \cdots + \theta_{12} M_{12t} + u_t$$

We test the null hypothesis of no structural break using a binary variable interaction regression. The full model consists of an intercept, the independent variable X and a single lag of the dependent Y variable. M_{it} are centered dummy variables for each month. The base month is January, $M_{2t} = 1$ for February and 0 for all other months, $M_{3t} = 1$ for March and 0 for all other months etc. D_L is a dummy variable that equals 0 before the interchange fee was changed on 31 Oct 2003 and equals 1 after that date.

Under the null hypothesis of no break:

$$H_0 : \gamma_0 = \gamma_1 = \gamma_2 = 0 .$$

Under the alternative there is a break and at least one of the γ's is non zero.

The change in the general interest rate level is included as an independent variable via the proxy of changes to the RBA cash rate. Merchant fee levels and changes in merchant fee levels are not included in the regressions despite being of interest. Merchant fee levels are only available on the RBA website from March 2003 so there are not enough data points available prior to November 2003 to include this variable.

We test both with and without a deterministic time trend for Δ Log credval and Δ Log credaccts series. For the credsharetotal series, the unit root testing suggested no deterministic trend.

7. Exogenous structural break test results

Results from the structural break tests are given in Table 4. It is possible that alternative modelling strategies could uncover different processes. However, *the results here provide no support for an October 2003 break point negatively affecting the credit card series tested*.

We found no structural break in the Δ Log credval series. The interpretation of this is there was no structural break in the growth rate of the underlying credval series. The tests give no evidence consistent with the claim that lowering the interchange fee would negatively affect the growth in the value of credit card transactions. The regression excluding a time trend is slightly preferred due to its higher adjusted R^2 and significant negative coefficient for interest rate changes.

We did find evidence of a structural break in the Δ Log credaccts series. Looking at the results including a deterministic time trend we found a strongly significant **positive** change to the intercept term, indicating an increase in the average credit card account growth rate, all other variables held constant. The results on the time trend itself suggest that prior to the break point the growth rate itself was increasing slowly over time. However after the break point the trend change in the growth rate itself has essentially become zero.

Increases in interest rates spur statistically significant increases in credit card account growth rates. One could speculate that this indicates a proportion of consumers use a new credit card account to ease cash flow concerns in the aftermath of interest rate rises. The negative coefficient on the interaction term for this indicates a reduction in this effect since the break point. We could speculate that banks have increased the fees associated with cards to offset the decline in interchange revenue. If so then the fixed costs of having an account have increased so it now costs more to obtain credit simply by opening a new account. This may have led to the decrease in the interest rate effect.

We found no evidence of a step change in the credit card share of the "convenience payment" market as the interchange intercept was insignificant. The results also indicate that increases in interest rates tend to decrease the market share of credit cards. This may indicate that when interest rate rises occur a proportion of consumers switch where possible to other lower cost payment methods – methods whose cost of use is unaffected by interest rates. After the break point this interest rate effect reduces. This may be due to the proliferation of competing credit cards following the loosening of the credit card access conditions.

Table 4 Exogenous break point test results

	Dependent variable Y_t				
Coefficient (p value)[1]	**Δ Log credval**	**Δ Log credval**	**Δ Log credaccts**	**Δ Log credaccts**	**Credsharetotal**
Newey West lags	12	12	0	12	12
Intercept dummy (D_L)	-0.0292 (0.234)	-0.0142 (0.089)	0.0102 (0.006)	0.0042 (0.003)	0.000039 (0.932)
Lag (Y_{t-1})	-0.560 (0.000)	-0.564 (0.000)	0.161 (0.428)	0.234 (0.076)	0.496 (0.000)
Lag interaction ($D_L * Y_{t-1}$)	0.0108 (0.946)	-0.0056 (0.972)	-0.0382 (0.886)	-0.104 (0.627)	0.0304 (0.098)
Time (T)	-0.00022 (0.905)		0.00035 (0.018)		
Time interaction (D_T)	0.00053 (0.754)		-0.00040 (0.010)		
ΔInterest	-0.203 (0.124)	-0.194 (0.034)	0.0366 (0.004)	0.0247 (0.000)	-0.0076 (0.000)
ΔInterest * D_T	0.273 (0.185)	0.267 (0.079)	-0.0332 (0.019)	-0.0214 (0.028)	0.0064 (0.001)
Joint seasonal dummies significant?	✓	✓	✗[2]	✓	✓
F test of break dummies	2.01 (0.1128)	2.22 (0.1003)	4.27 (0.0060)	5.47 (0.0030)	11.98 (0.0000)
R^2	0.7677	0.7670	0.6659	0.5845	0.8368
Adj R^2	0.6576	0.6738	0.5077	0.4183	0.7731
N	57	57	57	57	58

1 OLS regression with Newey West (1987) standard errors. The stata bgodfrey test of serial correlation was used to suggest a lag order of 0 (equivalent to White errors), 1 or 12, depending on the extent of serial correlation in the errors.

2 Individual Decmber dummy remained significant, p value 0.002

8. Tests with an endogenously determined break

The previous sections assumed that the date of the structural break was exogenous and known to be October 2003. In this section we present preliminary tests using the sequential test of Zivot and Andrews (1992) (ZA) to endogenise the break point.

The null hypothesis of the ZA unit root test is a unit root process with drift that excludes structural change. The alternative hypothesis is a trend stationary process that allows for a one time break in the level, the trend or both. The assumption is that the break point is unknown before testing. The test estimates the break point to be where the ADF unit root t-test statistic is minimised (i.e., the most negative).

Where seasonality was indicated this test was done on deseasonalised data, using the residuals $\hat{y}_t$ from the regression:

$$y_t = \alpha_1 + \sum_{i=2}^{12} \theta_i M_{it} + \varepsilon_t$$

Where M_{it} are centered dummy variables for each month, January is the base.

These residuals are used in the underlying ADF unit root tests. Typically the ends of the series are trimmed anywhere from 0 to 15%, we tested both 5% and 15% trims.

We present results in Table 5 below. For the series Log credval, Log credaccts, credsharetotal and credsharecards, the test fails to reject the null of a unit root process with drift that excludes structural change. This is evidence against a structural break for these series.

The results for Δ Logcredval and Δ.Log credaccts both suggest trend stationary processes with one time breaks in the trend, intercept or both. However, there is little consistency to the estimated endogenous timing of the breaks. There is some support for a break from October 2003 in the Δ.Log credaccts series, highlighted in bold in Table 5. As explained in the previous section, this appears to be associated with a strong **positive** change to the intercept term, indicating an increase in the credit card account growth rate.

These preliminary endogenous break point tests do not provide support for an October 2003 break point negatively affecting the credit card series tested. They are suggestive of multiple break points. The plots of the ZA results, not reproduced here, also indicate the potential for multiple break points in the series. Further work using tests for multiple break points could be useful.

Table 5 Zivot Andrews unit root tests

	t-statistic, estimated break point (5% trim)			**t-statistic, estimated break point (15% trim)**		
	Both	**Intercept**	**Trend**	**Both**	**Intercept**	**Trend**
Logcredval	-3.430 Jan 2003	-3.349 Jan 2003	-3.242 Jul 2006	-3.430 Jan 2003	-3.349 Jan 2003	-3.147 Apr 2004
Δ Logcredval	-8.394*** May 2003	-8.459*** Jul 2005	-8.445*** Jun 2002	-8.394*** May 2003	-8.459*** Jul 2005	-8.315*** Dec 2002
Log credaccts	-4.616 Apr 2003	-4.464 Jan 2003	-3.967 Sep 2003	-4.616 Apr 2003	-4.464 Jan 2003	-3.967 Sep 2003
Δ.Log credaccts	-6.536*** Apr 2002	-6.796*** Apr 2002	-6.267*** Jun 2002	**-6.280***** **Oct 2003**	-5.995*** Sep 2003	-6.111*** Jul 2005
Credsharetotal	-4.088 Jul 2003	-3.899 Sep 2002	-4.055 Feb 2003	-4.088 Jul 2003	-3.571 Nov 2002	-4.055 Feb 2003
Credsharecards	-4.565 Jul 2005	-4.525 Apr 2005	-4.234 Mar 2003	-4.565 Jul 2005	-4.525 Apr 2005	-4.234 Mar 2003

*** significant at 1% level, ** significant at 5% level

Stata module zandrews used

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