Proceedings of 5th International Conference of Economic, Business and Government Challenges 2022. Vol. 1 No. 1 August 2022: 319-327

The Strength of the Indonesian Card Market's Reaction to the National Payment Gateway's Implementation

Arianto Muditomo[1*], Yusman Syaukat[2], Trias Andati[3] and Nur Hasanah[4]
School of Business, IPB University, Bogor, Jawa Barat, Indonesia [1,4]
Faculty of Economics & Management, IPB University, Bogor, Jawa Barat, Indonesia [2]
PT. Adhimix Precast Indonesia, Jakarta Selatan, DKI Jakarta, Indonesia [3]
muditomo@perbanas.id[1*]

Abstract. This study aims to examine how the Indonesia's card market reacted to National Payment Gateway (GPN) implementation. The GPN governs the interconnectivity, interoperability, and integration of the Indonesian payment network. Despite being included in the innovation management stage, the effectiveness of this GPN's implementation was not further evaluated due to its gradual implementation and the COVID-19 pandemic. We use data from the Indonesian card market and macroeconomic indicators from 2013 to 2021and employs a modified ARIMA model. This study is unable to prove empirically that GPN implementation has a significant impact on the growth of the card payment market. The past performance of the card payment market has a statistically significant influence on its future growth. The findings of this study will assist regulators and industry participants in implementing policies and strategies to increase the customer base and effectiveness of Indonesia's card payment business.
Keywords: ARIMAX, card payment; GPN; innovation management; time-series analysis.

I. Introduction

Bank Indonesia issued Bank Indonesia Regulation No. 19/8/PBI/2017 regarding the National Payment Gateway (GPN) on June 21, 2021, ushering in a new era of ownership of Indonesia's domestic card payment network. This initiative specifically addresses the challenges of Indonesian payment system conditions prior to the implementation of GPN, such as the still diverse infrastructure, many fragmented payment system platforms, many cards issued, and many transaction processing machines on the market that are not interconnected and cannot process each other. Furthermore, prior to the GPN, transaction costs were higher than in neighboring countries.

Other central banks around the world, as is well known, aim to create a strong economy and stable financial markets. The successful achievement of these objectives is heavily reliant on a well-functioning payment system. This condition explicitly states that the central bank's various objectives, roles, and economic reasons are to formulate and implement payment system policies (Oliver & Weiner, 2009).

The payment system is an essential component for the process of all aspects of the monetary economy, whether in developed, transition, or developing economies. It is critical to understand how the payment system architecture (payment methods, processing, participants, and others) affects the payment industry - microeconomic approach - and how the central bank plays a role in the payment system - macroeconomic / public approach (Gogoski, 2012). It is also stated that the central bank's role in the development of a national payment scheme is to provide settlement services, ensure industry interoperability, provide switching and clearing authorizations between messages, and carry out the payment scheme (Chaplin & Veitch., 2012).

So far, we believe that the GPN is an innovation by Bank Indonesia in ushering in a new era of ownership of the Indonesian domestic debit card payment network, which is managed through the granting of regulations and public policies for the payment system industry. Furthermore, we believe that assessing regulations and public policies is an important step in ensuring their effectiveness in influencing the market. This is necessary to ensure that the steps taken in accordance with policy implementation met the expected goals. Therefore, we conducted this research to contribute to the evaluation process of GPN implementation from the card payment market's perspective as part of sustainable innovation management to determine the effectiveness of an innovation action (Adams et al., 2006).

Based on the background described above, we formulate the following research questions: *Does the implementation of GPN foster the development of Indonesia's two-sided market ecosystem for card payments? Does the implementation of GPN increase card payment acceptance? Has the introduction of GPN increased the use of debit cards as a payment method?* For the 2013-2021 observation period, we chose the main variables to investigate: the number of merchants, the number of POS/EDC, the number of cards issued, and the number of debit card transactions.

II. Literature Review

We use the main theory of a two-sided market model for Payment cards in this study. We adapted the Two-Sided Market Model (Rochet & Tirole, 2003, 2006) to understand the externalities of a two-sided

market economy of supply and demand, particularly in payment ecosystems where payment card operations are considered part of a two-sided market model (Wright, 2012) , as well as an explanation why applying a one-sided business policy to a two-sided market will disrupt the market balance and harm consumers (Gyselen, 2005). Early theoretical studies on the use of non-cash payment instruments focused on understanding the demand for cash (Baumol, 1952; Friedman, 1989; Tobin, 1956; Whitesell, 1989). The following considerations are price, competition, interchange fees, surcharge fees, and two-sided markets (Bolt, 2013; Bolt & Chakravorti, 2008; Humphrey, 2010).

To answer the previously described research questions, we discovered relevant previous research, specifically research (Górka, 2018; Kajdi & Kiss, 2021) that used the ARIMA-X/SARIMA-X time series analysis method, specifically the ARIMA/SARIMA model added with explanatory variables to accommodate the ceteris paribus effect in the economy.

The ARIMA-X/SARIMA-X time series forecasting model was developed for two-sided payment card market variables: on the supply side, the number of merchants accepting card transactions (Górka, 2018; Kajdi & Kiss, 2021), the number of EDC/POS machines (Górka, 2018), and the transaction value of card payments (Górka, 2018; Kajdi & Kiss, 2021) and the transaction value of card payments (Górka, 2018). Tariffs/transaction costs (Górka, 2018; Kajdi & Kiss, 2021) and household consumption are the exogenous variables used (Kajdi & Kiss, 2021).

The forecasting model developed by the two studies is identical, with past performance of the number of merchants receiving card transactions, the number of cards, and the number of card transactions having a significant effect on current and future performance (Górka, 2018; Kajdi & Kiss, 2021). The exogenous variable of household consumption has a significant impact on the number of cards (Kajdi & Kiss, 2021), and the tariff/transaction fee has a significant impact on the number of cards (Górka, 2018; Kajdi & Kiss, 2021) and the value of card transactions (Górka, 2018), but not on the number of merchants who accept card transactions and the number of EDC/POS machines (Kajdi & Kiss, 2021).

We include the COVID-19 variable as an exogenous variable because the COVID-19 pandemic has caused a shift in behavior from cash to non-cash transactions (Huterska et al., 2021; Wisniewski et al., 2021).

Finally, this research is part of innovation management in relation to digital transformation of the Indonesian payment system. In this case, Bank Indonesia's digital transformation of the payment system is consistent with (Appio et al., 2021), developing products and services (in this case GPN) as a result of the development of digitalization of payment instruments (cash to non-cash).

III. Research Method

This is a quantitative study with empirical evidence that uses the ARIMA/SARIMA model, followed by the addition of exogenous variables (explanatory variables) to accommodate the ceteris paribus effect on the model (so that the model becomes ARIMAX/SARIMAX), as found in previous studies (Górka, 2018; Kajdi & Kiss, 2021).

We rely on data sets from the Bank Indonesia statistics website (https://www.bi.go.id/en/statistik/Default.aspx) - Payment System and Financial Market Infrastructure Statistics (PSFMI). The number of merchants (Merchant), the number of POS/EDC (POS EDC), the number of cards issued (Debit Card Issued), and the number of debit card transactions (Debit Card Trans) were obtained from this site, while the Retail Sales Index (RSI) data was obtained from The Global website Economy (https://www.theglobaleconomy.com/). The NSICCS, GPN, and COVID variables are dummy variables denoted by the numbers "0" and "1," with NSICCS having a value of "0" until the implementation of the Indonesian chip card standard in December 2016, and then having a value of "1" thereafter. We denote the value "0" for the GPN variable until the GPN is implemented, which is December 2017, and the value "1" in the future. Furthermore, we denote a value of "0" for the COVID variable until the announcement of the first COVID-19 case in Indonesia, which is March 2020, and a value of "1" in the future. The selection of these variables is a modification of the research (Górka, 2018; Kajdi & Kiss, 2021), by equating the selection of exogenous RSI variables with household consumption, and the implementation period of GPN (NSICCS and GPN dummy variables) with interchange change fees, as well as adding the COVID variable to account for the COVID-19 pandemic in Indonesia.

The research design is based on the rationale that lowering transaction fees should have a positive impact on card payment acceptance and card use, so as an impact of implementing the GPN, we have a hypothesis that the number of merchant growth and card usage growth will be higher than before or will be positively influenced by the implementation of the GPN, which is represented in this case by the variables NSICCS and GPN. We employ the following research framework, which is based on the Box-Jenkins methodology:

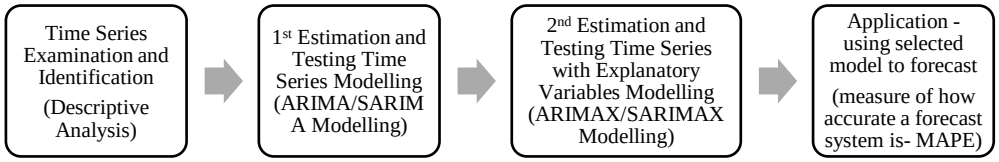


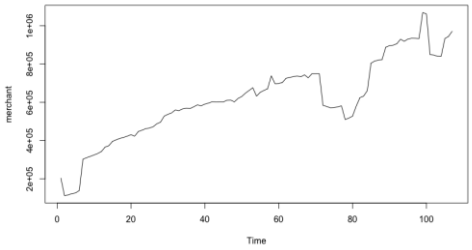
Figure 1. Research Framework

For the entire data processing process in this study, we used the RStudio Version 1.4.1717 application for Mac © 2009-2021 RStudio, PBC.

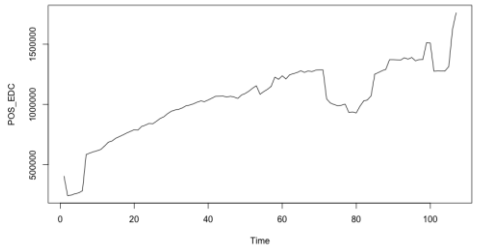
IV. Results and Discussion

Time Series Examination and Identification

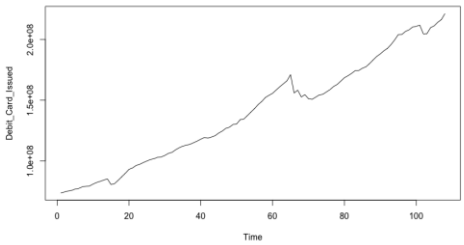
We begin the empirical research in this section by conducting descriptive research on the main variables to be studied in this study. Figure 2 shows the original time series of four variables representing the group acquiring side (card acceptance network): Merchant and POS EDC, as well as the group issuing side (card usage): Debit Card Issued and Debit Card Trans, from the Indonesian card payment market in 2013-2021, with a general upward trend.



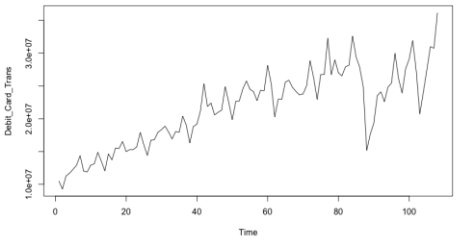
Merchant data



POS/EDC data



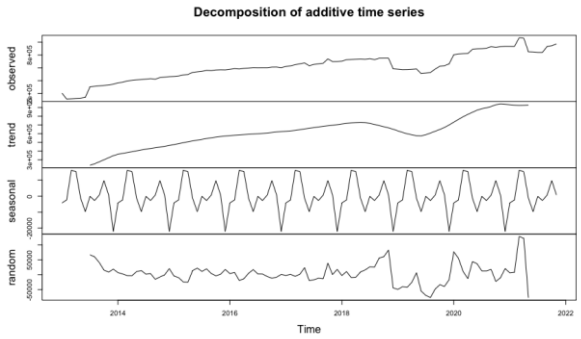
Debit Card Issued data



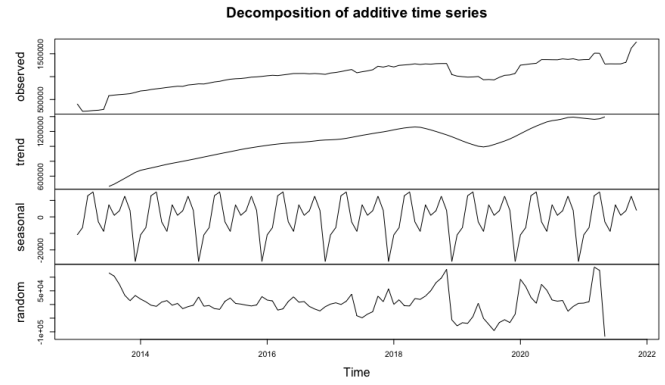
Debit Card Transaction data

Figure 2. Time plots for card acceptance network and card usage from 2013 to 2021 (monthly data)

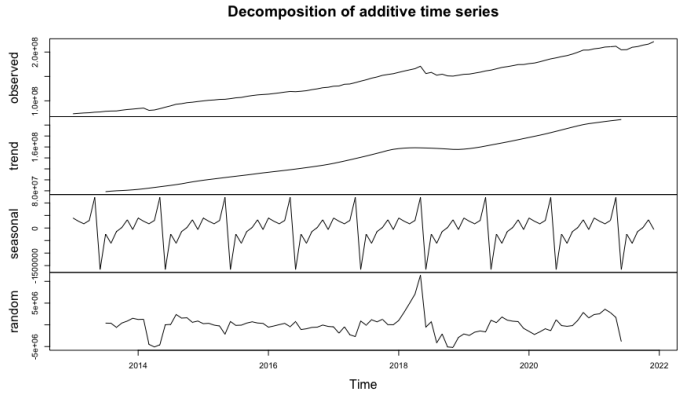
And after that, we decompose all the time series data and discover that, in general, all the data indicates a seasonal pattern (see Figure 3).



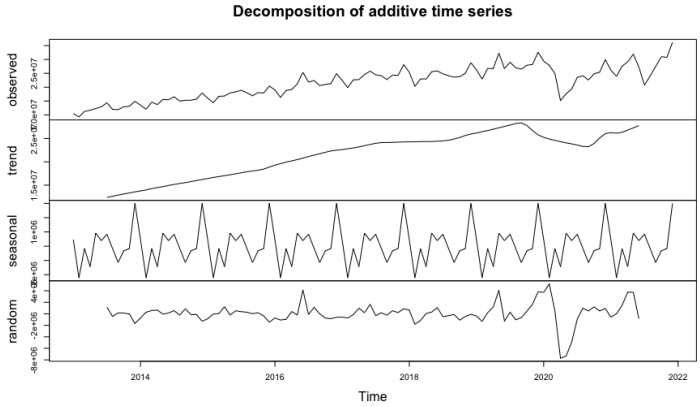
Merchant data



POS/EDC data



Debit Card Issued data



Debit Card Transaction data

Figure 3. Additive decomposition result of card acceptance network and card usage from 2013 to 2021

Figure 3 depicts the phenomenon of a downward swing followed by an increase in the number of merchants, POS/EDC, and debit cards issued in the period surrounding the implementation of GPN, which occurred from the end of 2017 to the middle of 2018. Meanwhile, the number of debit card transactions started to drop in early 2020, coinciding with the start of the COVID-19 pandemic in Indonesia.

Estimation and Testing

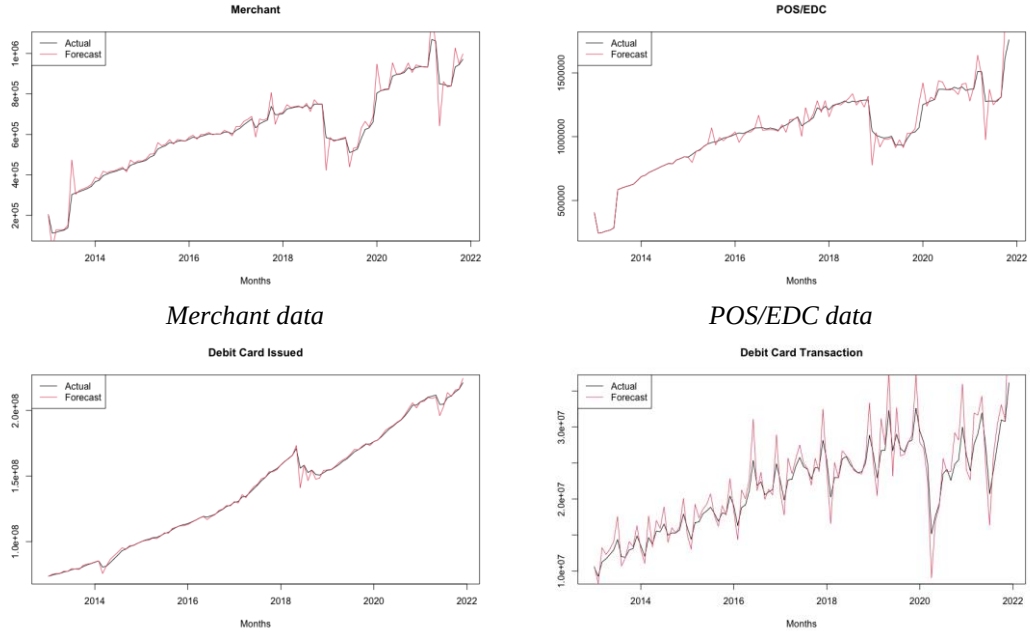
Following the Box-Cox data transformation to fulfill the stationarity test in variance, the stationarity test in the mean to detect seasonal effects, and the plotting of ACF and PACF, the best ARIMA/SARIMA model with the lowest MAPE is as follows:

Table 1. ARIMA/SARIMA modelling and model accuracy

Variable	ARIMA*(p,d,q)* SARIMA*(P,D,Q)S*	MAPE
Number of Merchant	*(1,1,0)*	3,83%
Number of POS/EDC	*(2,1,0) (0,2,2)*	3,87%
Debit Card Issued	*(2,1,2)*	0,64%
Debit Card Transaction	*(4,1,0)*	0,40%

Note: MAPE < 10%: forecast is very accurate; 10% MAPE < 20%: the forecast is good; 20% MAPE < 50%: forecasting is still within reasonable limits; MAPE 50%: forecast is not accurate
Only the number of POS/EDC that meets the stationarity test in the mean indicates a seasonal effect, which can be modeled in SARIMA.

The following is a forecast plot of each of the main variables studied (see Figure 4), with the black line representing the actual value and the red line representing the predicted value.



Merchant data *POS/EDC data*

Debit Card Issued data *Debit Card Transaction data*

Figure 4. Actual Data and Forecasting from the Best Model Comparison

Furthermore, we included exogenous variables (Table 2) for each model from the best ARIMA/SARIMA model found for each model (Table 1). We divide the data into two parts for this modeling: in-sample data and out-of-sample data. In-sample data is used for model estimation from January 2013 to December 2020, with up to 96 observational data, and out-of-sample data is used for forecasting from January 2021 to November 2021, with up to 11 observational data.

Table 2. Variables Definition for ARIMAX/SARIMAX Modelling

Variable	ARIMA*(p,d,q)* SARIMA*(P,D,Q)S*	Explanatory Variable
Number of Merchant	*(1,1,0)*	NSICCS, GPN, COVID, RSI
Number of POS/EDC	*(2,1,0) (0,2,2)*	
Debit Card Issued	*(2,1,2)*	
Debit Card Transaction	*(4,1,0)*	

Using the RStudio application, we obtain the following results for each parameter estimation:

Table 3. Models Estimation

a. Model 1: Number of Merchant

z test of coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
ar1	0.12256	0.10599	1.1563	0.2476	
NSICCS	7164.92224	34306.02301	0.2089	0.8346	
GPN	14226.67104	34479.44352	0.4126	0.6799	
COVID	5270.31622	34361.04278	0.1534	0.8781	
RSI	-291.38392	317.33715	-0.9182	0.3585	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

b. Model 2: Number of POS/EDC

z test of coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
ar1	2.2722e-01	1.2604e-01	1.8027	0.071435	.
ar2	4.8489e-02	1.4922e-01	0.3249	0.745229	
sma1	-1.0345e+00	1.9759e-01	-5.2355	1.645e-07	***
sma2	5.7348e-01	2.1461e-01	2.6723	0.007534	**
NSICCS	7.4094e+04	4.9701e+04	1.4908	0.136015	
GPN	5.9147e+04	5.0810e+04	1.1641	0.244393	
COVID	-5.1809e+03	7.1474e+04	-0.0725	0.942214	
RSI	-2.0733e+03	6.6258e+02	-3.1291	0.001754	**

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

c. Model 3: Debit Card Issued

z test of coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
ar1	2.1476e-01	1.7376e-01	1.2360	0.2164737	
ar2	6.4146e-01	1.7830e-01	3.5976	0.0003211	***
ma1	-1.9592e-01	2.1357e-01	-0.9174	0.3589458	
ma2	-2.3606e-01	2.1688e-01	-1.0884	0.2764084	
NSICCS	-5.7318e+05	2.0078e+06	-0.2855	0.7752758	
GPN	-2.5308e+05	2.0392e+06	-0.1241	0.9012288	
COVID	4.5313e+05	2.0336e+06	0.2228	0.8236723	
RSI	-5.5107e+02	1.7900e+04	-0.0308	0.9754399	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

d. Model 4: Debit Card Transaction

z test of coefficients:

	Estimate	Std. Error	z value	Pr(>|z|)	
ar1	-3.7854e-01	1.1535e-01	-3.2815	0.001032	**
ar2	-7.0398e-02	1.1908e-01	-0.5912	0.554410	
ar3	-1.3593e-01	1.2602e-01	-1.0786	0.280763	
ar4	-1.1204e-01	1.2161e-01	-0.9213	0.356891	
NSICCS	-1.3565e+06	1.5270e+06	-0.8883	0.374358	
GPN	-7.6432e+05	1.5347e+06	-0.4980	0.618468	
COVID	-4.9761e+06	1.8541e+06	-2.6839	0.007277	**
RSI	1.3321e+05	1.6729e+04	7.9626	1.684e-15	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The accuracy of the ARIMAX/SARIMAX model is measured using the results shown in Table 4 below.

Table 4. ARIMAX/SARIMAX modelling and model accuracy

Variable	ARIMA*(p,d,q)* SARIMA*(P,D,Q)S*	Significant Variables	MAPE
Number of Merchant	*(1,1,0)*	-	6,67%
Number of POS/EDC	*(2,1,0) (0,2,2)*	SMA(1), SMA(2), RSI	12,74%
Debit Card Issued	*(2,1,2)*	AR(2)	1,75%

Debit Card Transaction	*(4,1,0)*	AR(1), COVID, RSI	9,05%

Note: MAPE < 10%: forecast is very accurate; 10% MAPE < 20%: the forecast is good; 20% MAPE < 50%: forecasting is still within reasonable limits; MAPE 50%: forecast is not accurate
Only the number of POS/EDC that meets the stationarity test in the mean indicates a seasonal effect, which can be modeled in SARIMA.

According to Tables 1 and 4, the accuracy of the ARIMA/SARIMA model is slightly higher than the ARIMAX/SARIMAX model. However, both ARIMA/SARIMA or ARIMAX/SARIMAX models have a good and accurate forecasting accuracy range (0 < MAPE < 20%).

According to the forecasting model, past performance of the number of merchants, POS/EDC, debit card issued, and debit card transactions has a significant effect on current and future performance. This result is consistent with previous research (Górka, 2018; Kajdi & Kiss, 2021), especially for the ARIMA/SARIMA model but not fully found in the resulting ARIMAX/SARIMAX model, where in the past performance the number of merchants had no significant effect on current performance and future. The exogenous retail sales variable (RSI) has a significant effect on the number of POS/EDC and debit card transactions but not on the number of merchants or debit cards issued. This appears to contradict previous findings (Górka, 2018; Kajdi & Kiss, 2021) that household consumption had a significant effect on the number of cards. The implementation of the NSICCS chip card standard and the GPN were found to have no significant effect on the number of merchants, POS/EDC, debit cards issued, and debit cards. This contradicts previous research (Górka, 2018; Kajdi & Kiss, 2021), which found that setting the tariff/transaction fee had a significant effect on the number of cards and the value of card transactions. Furthermore, our study discovered that the COVID-19 pandemic had a significant effect on reducing debit card transactions, which contradicts previous findings (Huterska et al., 2021; Wisniewski et al., 2021) that the COVID-19 pandemic increased non-cash transactions.

V. Conclusion

GPN is a Bank Indonesia innovation that ushers in a new era of ownership of Indonesia's domestic debit card payment network, which is managed through the issuance of regulations and public policies for the payment system industry. Regulations and public policies are evaluated as part of innovation management to ensure their effectiveness in influencing the market. This is necessary to ensure that the steps taken in accordance with policy implementation met the expected goals. Our research will help to assess the impact of GPN implementation on the Indonesian payment card market. The research's limitation is that it only looks at the impact of regulations and policies on implementing GPN on the overall development of the debit card payment market in Indonesia. Because of the limits imposed of publicly available data sets, this study does not investigate the impact of implementation for each category and merchant size in greater depth (Kajdi & Kiss, 2021; Layne-Farrar, 2013; Shy, 2012).

This study is unable to prove empirically that GPN implementation in Indonesia has a significant impact on the growth of the card payment market. The past performance of the card payment market has a statistically significant influence on its future growth. However, both the ARIMA/SARIMA model and the resulting ARIMAX/SARIMAX model were found to be capable of forecasting out-of-sample data with a good and accurate forecasting accuracy range (0 < MAPE < 20%). The managerial implication of this finding is that Bank Indonesia should pursue additional initiatives to promote the growth of the Indonesian card payment market. Price issues can be minimized, competition fairness issues can be facilitated, interchange fees can be reduced, and surcharge fees can be eliminated (Bolt, 2013; Bolt & Chakravorti, 2008; Humphrey, 2010).

The significant influence of retail sales on the increase in the number of POS/EDC and debit card transactions demonstrates that Bank Indonesia's payment system innovations influences both the payment system architecture (payment instruments, processing, participants, etc.) - microeconomic approach and the payment system architecture - macroeconomic/public approach (Gogoski, 2012). The managerial implication of this finding is that Bank Indonesia must integrate payment system innovation policies with a macroeconomic indicator control strategy, especially those that increase people's purchasing power.

The fact that the COVID-19 pandemic has reduced the number of debit card transactions can also be explained by the fact that the emergence of the COVID 19 virus has changed users' long-term payment habits and reduced the nominal value of card-payment transactions. E-commerce shopping and contactless electronic transactions such as transfers and electronic money are encouraged by social distancing and

physical interactions (CNN Indonesia, 2020; Pink, 2021; Purnama, 2021; Sari, 2021). This finding has managerial implications in that Bank Indonesia and the industry must be able to capitalize on the momentum for changing people's behavior to survive even after the pandemic. The initiatives for the electronic payment of transportation, parking, and port modes, as well as the acceleration of the implementation of the Indonesian Quick Response Standard (QRIS), show that Bank Indonesia is taking the right steps to maintain the momentum for this change in people's behavior (Bank Indonesia, 2019, 2021; Mumtazah et al., 2019; Pitoko, 2022; Putri, 2020; Sihaloho et al., 2020).

The managerial implications of the study's findings can be used to advise Bank Indonesia that although the GPN policy aimed at interconnection, interoperability, and integration of Indonesian electronic retail payments has been able to replace the dominance of foreign principals, it has not been able to significantly boost the growth of the card payment market. The rate of growth is still severely influenced by previous period time series data and the size of consumer demand or purchasing power in the same period. In the future, Bank Indonesia will need to introduce better policies that will encourage an increase in consumer purchasing power, enabling it to ultimately increase the growth of the card market if other factors remain constant (ceteris paribus).

Other explanatory variables, including macroeconomic indicators such as inflation rate, gross domestic product, and money supply, can be included in future research. So that the contribution of this research, which demonstrates that time series analysis can explain market reactions to the implementation of payment system innovation policies, would be enhanced.

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