PAYMENTS CANADA

# Payment Stream Volume Migration: Target State Volume Projections

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# Payment Stream Volume Migration: Target State Volume Projections

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**Abstract**

In order to account for potential risks and implement relevant policies, this paper aims to estimate the directions of migrations between current and new payment systems under management by Payments Canada as well as each system's market share for the next 5 years. Seasonal Auto-Regressive Integrated Moving Average (SARIMAX) modeling is used to predict the total volume of transactions for each payment stream. The Vector Autoregressive (VAR) model and the Ordinary Least Squares (OLS) models are selected to find the relationship between the calculated net migration volume and the total volume for different streams.

With economic and work-life adjustments resulting from the COVID-19 global pandemic, the analysis aims to account for potential structural changes to the economy that have resulted from the pandemic and affected payment ecosystem.

**Keywords:**

## 1. Executive Summary

Economic fluctuations raise a lot of uncertainties when it comes to launching new products. As part of the ongoing modernization initiative, Payments Canada is looking to implement new ISO standard-based payments systems: RTR, SOE, and Lynx. To account for potential risks and implement relevant policies, it is important to estimate the directions of migrations between current and new systems as well as the payments market share for the next 5 years. An important factor that needs to be taken into account when predicting migration is the impact of COVID-19. The pandemic has fundamentally changed consumer behavior which makes forecasting future volumes challenging. The following research paper aims to improve volume projections from existing, taking into consideration the impact of COVID-19; project how much volume will move to the newly created systems and verify the directions for migrations, and detail the significance of relevant attributes to provide insights on what end-users are incentivized by. The information that is created from the models presented in this paper will be used to advise decision-making around strategic and regulatory challenges including but not limited to corporate funding, value caps, risk and settlement models, etc.

The proposed methodology consists of three steps (1) forecast model that is used to model the impact of the COVID-19; (2) customer choice model that is used to find relevant attributes; and (3) migration model that is constructed to predict volume migration. The primary findings of each of the steps described above are:

1. In terms of forecast model implications, some payments systems tend to be more resilient to shocks than others (POS Debit vs. Bill payments). Additionally, it is concluded that payments volume has already returned to pre-COVID levels.
2. The customer choice model concludes that (1) cost-based attributes matter the most when it comes to migration; (2) increasing weights of speed or cross-border reach may not be the most relevant assumption; and (3) adoption for new payments rail is cost-based, not value-driven.
3. Lastly, implications of the migration model can be summarized as (1) payments migration trends can be reversed if certain attributes are deemed more important to end-users, however, this requires extreme changes and is unlikely to occur; (2) RTR is shown to be the preferred payments rail for end-users; (3) modernization seems to have reduced the utility that LVTS provides compared to RTR; and (4) to induce migration, some payments channels need to be incentivized more than others.

## 2. Introduction and Context

Global digitalization has changed consumer demands, increased international competition, and accelerated economic growth, which created the need for fast, digital, and secure transactions. For Canada's economy to engage in this digital landscape, its payments systems need to be renovated to adapt to rapidly changing technologies. In partnership with financial institutions and other stakeholders, Payments Canada is leading Canada's payments modernization project.

This modernization initiative includes the introduction of new payments systems: Lynx, SOE (Settlement Optimization Engine), and RTR (Real-Time Rail). Lynx is a new high-value payments system that is going to replace the current Large Value Transfer System (LVTS). SOE is a new retail batch system created for lower value and less time-sensitive transactions, which will outplace the existing Automated Clearing Settlement System (ACSS). The third system is RTR. It is a brand-new capability for smaller-value payments, which will enable users to make payments instantly and provide a more open access regime. It is essential to make sure that all newly created systems follow modern rules and standards. One of the fundamentals of the modernization project in Canada is the launch of the ISO 20022 global messaging standard, which will allow data-rich information to flow with electronic payments.

To prepare the financial institutions, policymakers, and stakeholders for the modernization of payments systems, accurate forecasts of payments volume migration to new systems are required. However, in the last two years, the implementation process of modernization has been disrupted by COVID-19. The pandemic has fundamentally changed consumer behavior which makes forecasting future payments migration volumes difficult. COVID-19 has led to an increased usage of digital and contactless ways of payment and has led to a significant drop in the usage of cash. Therefore, the COVID-19 pandemic has become an important factor that needs to be accounted for when predicting migration.

The research presented in this paper aims to predict the payments volume migration to new systems, investigate the impact of COVID-19 on payments, and determine policies for the new payments systems. Data that is being used in this project are INTERAC annual data, monthly transactions for ACSS and LVTS payment systems, financial institutions data, and macroeconomic indexes for the period between 2006 and 2020. The analysis implementation includes four main steps. First, model the impact of COVID-19 on transaction volume and value. Second, identify factors affecting financial institutions to decide whether to migrate or not, generate a model to predict migration volume based on the identified factors, and fourth, determine the impact of potential policies. We review these steps in Sections 3-6. Specifically, Section 3 describes the economic underpinnings related to the problem and how Covid-19 impacted the economy. Further on, Sections 4-5 talk about assumptions and attributes used in the model. Section 6 finalizes the description of our methodology by presenting a 3-step model implementation approach that is being used. Lastly, Section 7 provides results as well as sensitivity analysis.

## 3. Economic Underpinnings

The COVID-19 crisis has caused a devastating impact on all aspects of people's lives including physical, mental, and emotional health, social stability, and financial activity. Canadians are experiencing significant changes in economic behavior and spending habits. People are uncomfortable handling cash, as well as touching debit/credit payment machines, and using ATMs (Payments Canada, 2020). According to the latest payment trends, 58 percent of people spend less overall, and 42 percent report the preference of digital payments for the long term. Concerning the safety and social distancing, businesses and Canadians are shifting to e-payments and searching for new ways to exchange money smoothly.

To account for the COVID-19 impact as well as other potential future fluctuations in the economic behavior, it is important to choose relevant macroeconomic factors while constructing the time-series forecasting model (see Section 6). However, during economically stressed periods macroeconomic nowcasting becomes challenging (Bank of Canada, 2021). Mostly because of two reasons: delay and uncertainty. A significant amount of economic indicators are released with a substantial time gap. Additionally, these indexes undergo multiple revisions, which sometimes take years after their first release.

| Macroeconomic Index | Published by | Frequency | Last Updated (as of June 2021) |
|---|---|---|---|
| Consumer Price Index (CPI) | Statistics Canada | Monthly | May 2021 |
| Gross Domestic Product (GDP) | Statistics Canada | Quarterly | June 2021 |
| Volatility Index (VIX) | Chicago Board Options Exchange (CBOE) | Real-time | June 2021 |
| Unemployment Rate (UNEMPLOY) | Statistics Canada | Monthly | May 2021 |

| | | | |
|---|---|---|---|
| Canadian Financial Stress Index (CFSI) | Bank of Canada | Monthly | June 2021 |
| Treasury Bills (TBILL) | Federal and provincial governments | Twice a week | June 2021 |

**Table 1 – The Overview of Macroeconomic Indexes**

Since 2014, the total payments market has increased by an average of one percent per year in volume and an average of five percent per year in value. In 2019, the total number of consumer and business transactions reached 22 billion, worth around $9.9 trillion (Payments Canada, 2020). Figure 1 depicts trends in the macroeconomic indexes of factors presented in Table 1, such as CPI, GDP, VIX, Unemployment rate, CFSI, and Treasury Bills.

As seen from Figure 1, all macroeconomic indicators reflected the occurrence of COVID-19, represented in Figure 1. CPI follows very closely to the total volume trend, it fell during the first two months of the 2020 recession, has since recovered to near its pre-recession level, and is forecasted to gradually rise. With the start of the COVID-19, there was a massive drop in GDP and Treasury Bills, whereas unemployment, VIX, and CFSI rapidly increased.

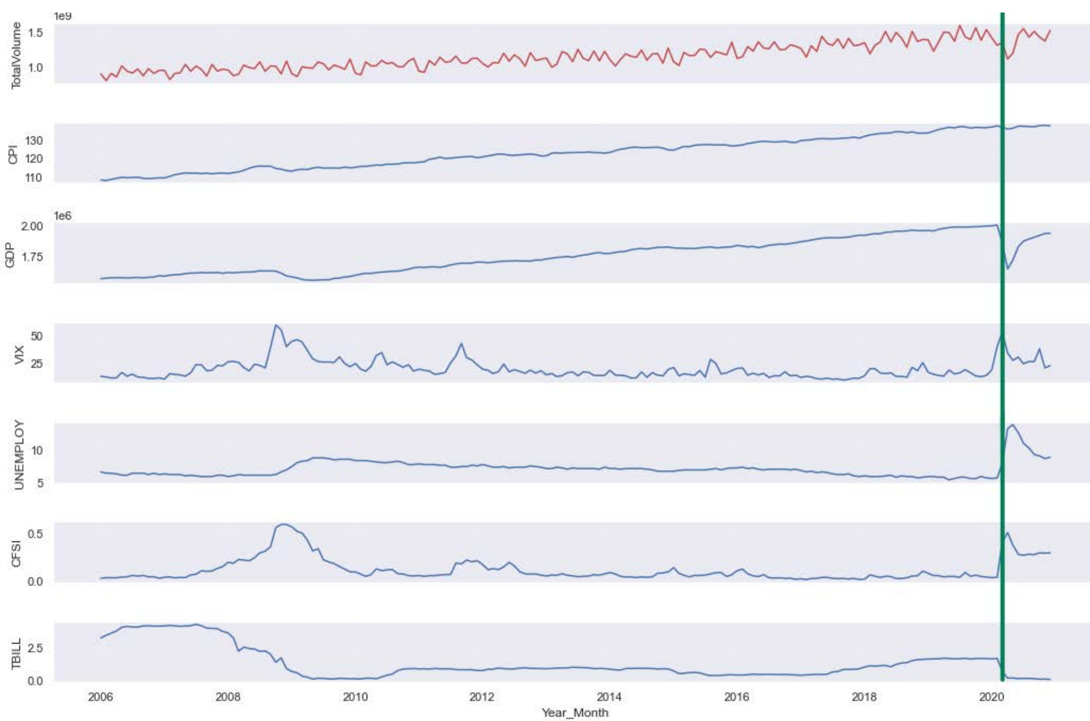

**FIGURE 1 – Trends in Macroeconomic Indexes, 2006-2020**

In order to examine whether certain macroeconomic factors explain trends in transaction total volume, we perform a correlation analysis (see Figure 2) among the total volume of transaction streams, such as Paper, Bill Pay, AFT Credit and Debit, POS Debit, RTR, and other streams, and macroeconomic indices presented in Figure 1. Among all the factors that were used, GDP and CPI have the highest correlation with the total volume of the various payment channels based on the pre-COVID situation. Other economic indicators seem to demonstrate low correlation. The remaining problem is that correlation is not guaranteed to be the same since consumers have changed their spending patterns.

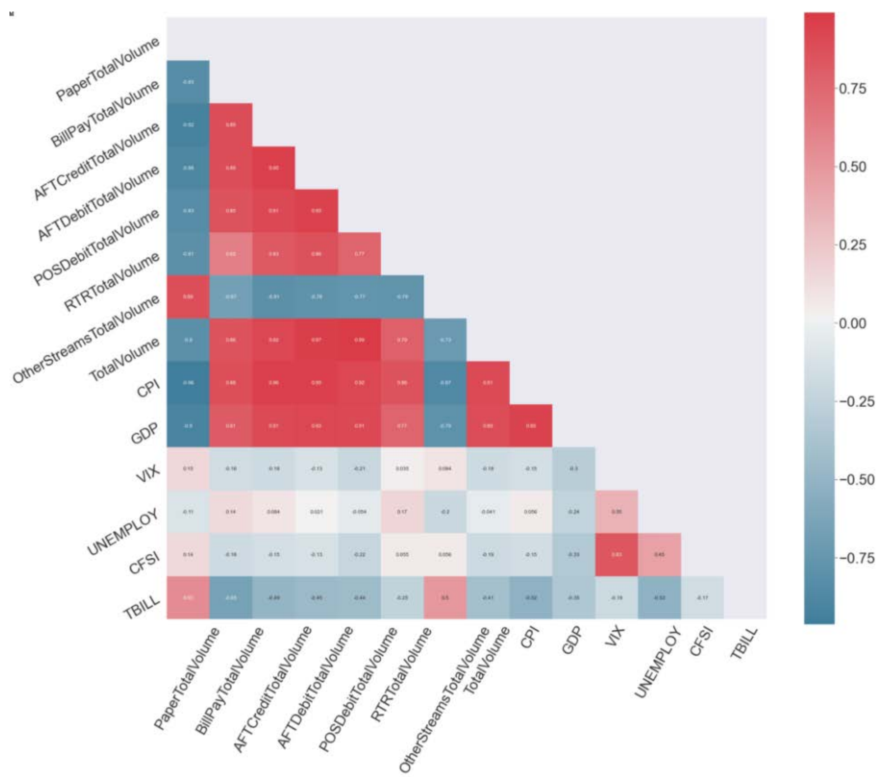


**Figure 2 – Correlation Matrix**

The consumer price index (CPI) uses a fixed basket of goods and services, based on expenditures reported by Canadians. Quantifying the cost of a fixed basket over time allows for consistent measurement of pure price change. The fixed-basket approach has worked relatively well under normal economic conditions. However, consumers have changed their spending patterns because of COVID-19 whereas the CPI basket was last updated in January 2019 using data from

2017. According to Statistics Canada, the next basket update is expected to be released only in July 2021.

Since GDP is the most commonly recognized measure of economic activity, a significant correlation of it to the total volume of transactions could be expected. However, as mentioned earlier, the problem of nowcasting during a crisis is that indicators have a substantial delay. For instance, GDP in Canada is released with a delay of eight weeks. Recessions cannot be fully captured by GDP – it understates costs on health, the environment, society, community, and trust. As a result, GDP tends to systematically underestimate decreases in wealth.

Although some indicators are insignificant and have their limitations we still can extract valuable insights on the impact of COVID-19, which are shown in the further analysis in Sections 6-7. For the unemployment rate, although there was a large increase due to COVID-19 as seen in the graph, the increase is not representative of consumer spending as CERB payments were provided for financial support, reducing the decrease in payments volume. The Canadian Financial Stress Index (CFSI) was developed by the Bank of Canada. It uses data from 1981 onward and considers financial stress that spans seven market segments, namely the equity market, the Government of Canada bonds market, the foreign exchange market, the money market, the bank loans market, the corporate bonds market, and the housing market. CFSI can be useful for at least two purposes. First, it is a useful metric for benchmarking the intensity of financial stress against historical episodes. For instance, the stress associated with the COVID-19 pandemic reached levels comparable only with the 2008 global financial crisis. Second, financial market stress is often associated with non-linear macro-financial dynamics that can amplify negative shocks.

One of our goals is to create a function that can reflect payments trends in different economic scenarios. As observed earlier, some of the macroeconomic indicators are not significant in terms of COVID-19. However, due to their historical performance, we allow for the possibility of indexes to become significant in other potential types of future economic fluctuations. Therefore, we use the above-mentioned macroeconomic indicators in the forecasting model to capture the future impact of COVID-19 and changing spending patterns of consumers at an aggregate level.

## 4. Assumptions

Several assumptions are required to support the proposed payment migration with two main areas: End Users and Payments Systems. We first note the modeling approach for predicting total transaction volume greatly depends on the lag economic factors mentioned in Section 3. We predict results for 5 years into the future using forecasts of different macroeconomic factors.

Forecasting these factors is very challenging and outside the scope of our work. Therefore, the result of the model serves as a directional projection rather than specifying the actual magnitude of changes (as this can diverge greatly depending on the future economic situation). The main value from the model is the correlation between these economic factors and the total migration volume, which can be updated as more data becomes available.

## 4.1 Assumptions for Users

The first set of assumptions are conceptual in the sense that they relate to judgments on the behavior and information available to financial institutions. Payments Canada as an institute maintaining the payments rails has no interactions with the end consumers. Financial Institutions ultimately decide what products will be introduced to their client (end consumers). Several offer discounts or preferences for clients to choose one payment rail over the other and Payments Canada does not have control over this aspect.

The Financial Institutions are rail agnostic and do not have brand loyalty to one stream over another. Therefore, we assume Financial Institutions would choose the payment stream that provides the most value for a given transaction. However, some payment rails such as LVTS are only available to Financial Institutions and are limited to where they can migrate towards. For example, LVTS tranche 1 payments cannot migrate towards SOE or RTR as they are all wire payments involving the Bank of Canada.

In terms of the end consumer, we assume they are rail agnostic when making payments. An average consumer is less likely to understand the structure and function of each rail and develop any deep preferences beyond cost. Therefore, they are likely to choose the rail that provides the maximum utility or the most functional benefit rail for their purpose. Once again, end consumers cannot use the Lynx payment rails outside of consumer/client wires, but their transactions can go through RTR or SOE.

As an average consumer, the analysis is focused on the total value transferred (value market share). On the other hand, the financial institutions handle all the transfers from the end-users that allows them to focus more on the total volume market share.

## 4.2 Assumptions for Payments Systems

To simplify the migration modeling approach, a few assumptions need to be made to ensure the forecast is accurate and reflects the insights from the prediction. One major assumption is that all new payment systems are implemented at once and no staggering effect is observed. This assumption is made to simplify the modeling process and is also because of the uncertainty of when all the new systems are active. Therefore we assume that SOE, Lynx, and RTR, will all be operational by 2022. Furthermore, payments going through INTERAC, PayPal, or any other e-transfer service are assumed to automatically go through RTR once implemented.

The attribute difference is what differentiates one payment system from the other. The attributes that define a payment system are speed, security, and cost as explained in Section 5. The weights for different attributes are assumed to be equal in the base model for the forecast. The additional customer choice model will explore the preference for different financial institutions with the changes in weights. The weight changes will be reflected in the sensitivity analysis in Section 7. Since the payment systems consist of different payment streams, the streams under the same payment systems have the same attributes except for AFT under ACSS (or SOE as the new system).

We remind that RTR transactions are also value capped at $100,000 and the base model has all the attributes equally weighted. Finally, other payments systems such as cryptocurrencies are assumed to only migrate towards RTR or themselves. Figure 3 demonstrates the allowable migrations in our model.

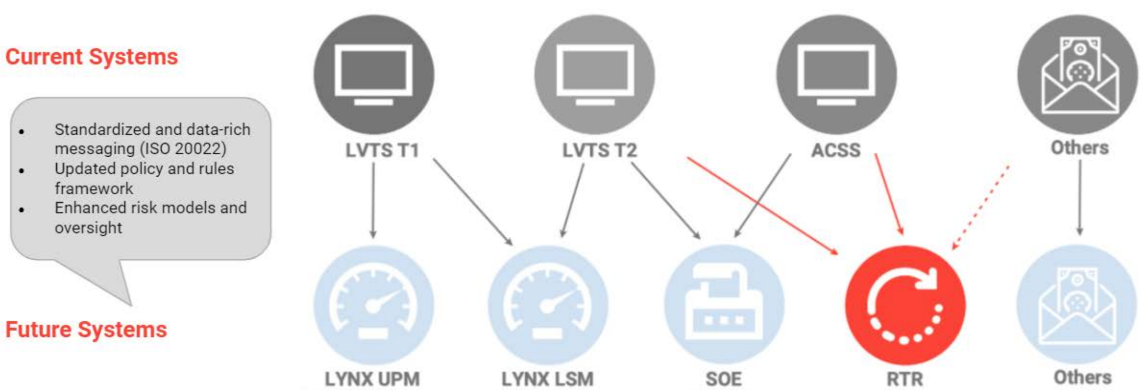


**Figure 3 – Possible migration between current and existing systems**

## 5. Attributes

Attributes play an important role for end-users when it comes to the adoption of new systems. Each payment rail RTR, Lynx, and SOE has a unique set of attributes. Within these payments, rails are payment systems that share the same attributes with some exceptions that will be discussed in later sections.

## 5.1. The Choice of Attributes

In order to rank and compare the payment instruments that end-users will have available to them, we use these nine attributes as shown in Table 2: average transaction value, settlement speed, hours of speed, irrevocability, transaction fees, acceptance level, safety & privacy, cross border availability, and collateral savings level. Based on the various pillar leads, the core stream attributes can be described in the following way:

- Average transaction value corresponds to a typical value of a transaction that is processed under each core stream. It is defined as a numeric variable and calculated by dividing one stream's total value by its total volume;
- Settlement speed is an expected transmission speed of a transaction under the core stream. Additionally, the maximum duration between payment transmission time and when it must be processed reflects fund availability. Settlement speed has a numeric value in the model;
- Hours of operation represent the number of hours during a single day in which payments transmission occurs through a core stream and is processed by the associated payments platform. The following variable has a numeric value in the model;
- Irrevocability corresponds to the maximum duration defined by the rules of a core stream for a sender to recall a transaction. In the model it is used as a dummy, where 1 refers to a transaction being irrevocable and 0 otherwise;
- Transaction fees account for expected fees paid by the end-user or charged by the financial institution for certain payment transmission. Transaction fees variable has a numeric value in the model;
- Acceptance describes what entities are allowed to participate in a payment system, starting as narrow as banks and ending up with non-financial institutions (Bank of Canada, 2020). The following variable corresponds to a numeric value;
- Safety & Privacy represents a technique that is being used in order to perform credit risk management, usually referring to whether or not collateral is applied to back up a transaction. The most commonly used techniques are collateral pools and full collateralization. Safety & Privacy is a dummy variable where 1 corresponds to the collateral being applied to back up a transaction and 0 otherwise;

- Cross-border reach represents the ability of a certain core stream to process cross-border payments. As well as previously, this is a dummy variable where 1 corresponds to the possibility of a transaction being sent abroad and 0 otherwise;
- Collateral savings are the costs associated with the collateral defined by the clearer participating in the core stream and other operational costs faced by financial institutions of a certain payment platform handling the core stream transactions. The collateral savings variable has a numeric value.

| Payment Rails | SOE (excl. AFT) | SOE (AFT) | Lynx | RTR |
|---|---|---|---|---|
| Average Transaction Value | Derived from the Data | Derived from the Data | Derived from the Data | Derived from the Data |
| Settlement Speed | 18 h | 2 h | 15-60 min | 1 min |
| Hours of Operation | 23 h | 23 h | 18 h | 24 h |
| Irrevocability | Cheque and Debit | Cheque and Debit | No | No |
| Transaction Fees | 1% of wire | 1.5% of wire | $52 per wire | 2% of wire |
| Acceptance | Less restrictive compared to ACSS | Less restrictive compared to ACSS | Open access regime | Open access regime |
| Safety & Privacy | Collateral pool | Collateral pool | Fully backed with liquidity; LSM and UPM mechanisms | Fully backed with liquidity |
| Cross-border | No | No | Yes | No |
| Collateral Saving | Derived from the Data | Derived from the Data | Derived from the Data | Similar to SOE |

**Table 2 - Attributes for Payment Rails**

## 5.2. Attribute Comparison - New Vs. Existing Systems

SOE has approximately the same characteristics as the already existing ACSS system. However, the main difference in attributes is that SOE has a higher settlement speed, which allows for end-of-day settlement instead of the next day. Additionally, the acceptance level is higher, meaning that the access to financial institutions is less restrictive and allows a larger number of banks to use the system, compared to ACSS.

Lynx aims to settle all payments on an immediate basis, whereas LVTS payments are netted and settled end-of-day only. Additionally, Lynx has a higher safety level since it is required for payments to be fully backed with liquidity, compared to LVTS which uses a collateral pool for Tranche 2 transactions. In that case, any default that might occur in Lynx is fully covered. Speaking of liquidity, Lynx just like LVTS has two mechanisms, which can be chosen by financial institutions while submitting a payment: Lynx's Liquidity Savings Mechanism (LSM) and Lynx's Urgent Payment Mechanism (UPM). LSM allows banks to delay payment and also decrease the level of liquidity required for the settlement of a payment processed. In order to be able to do that, LSM uses queuing, intraday liquidity recycling, and payment offsetting. If a payment has to be submitted immediately and settled without any delay, financial institutions can use UPM. However, in this case, the amount of required liquidity is not allowed to decrease.

Since RTR is a brand-new capability, there is no existing system it can be compared to. However, funds availability and liquidity requirements for RTR are the same as it is for Lynx UPM since in both cases payments are settled immediately. Compared to Lynx UPM, RTR has a more open access regime and does not have an option for payments to be sent cross-border.

## 5.3. Assumptions in Attributes

We made several assumptions on the attributes of the core streams. The following assumptions are mainly material in nature and define the realization as well as relative proximity scoring of core streams.

For example, end-user transaction fees are calculated based on the empirical analysis of the current pricing of services provided by various financial institutions. Specifically, it is assumed that the pricing process is done similarly to already existing ACSS and LVTS fees (Bewaji 2018). Additionally, wire transfer fees are calculated as the sum of fees financial institutions charge their customers for both receiving and sending a single wire payment (Bewaji 2018). The following information is taken from the fees and charges data posted on the websites of various Canadian financial institutions. RTR transactions follow the same logic, where fees are per transaction fees as published by the institutions.

In terms of settlement speed, assumptions were made with respect to the constraints placed on the associated liquidity savings mechanisms (LSMs), as well as the rules and behavior of participating financial institutions and their liquidity management.

Additionally, average transaction value data is taken directly from ACSS and LVTS dataset, as well as INTERAC, PayPal, and Canadian Payments Methods and Trends survey that was done by Payments Canada. Under the current rules for each core stream, only cheques and AFT debit transactions are revocable (Bewaji 2018). The rest is assumed to be irrevocable (Bewaji 2018). Operating hours are assumed to be within 18-hour business days for all streams except for AFT and RTR, which are assumed to be 23-hour and 24-hour business days respectively (Bewaji 2018).

Finally, when it comes to importance in migration we weigh all attributes evenly, with our customer choice model providing insights on the most relevant attributes.

## 6. Modeling Approach

Given the aim of the study is to create a forecasting model that captures COVID-19 influence, we propose a 3-step modeling approach.

We first model the past transaction volume data using a wide range of macroeconomic factors that are representative of payments activities and then forecast transaction volume for 5 years. The forecasting step captures the natural trend in payment streams with the COVID-19 impacts.

Second, we generate a customer choice model to find relevant attributes that potentially affect payment decisions. This step highlights the influence and importance of the supply-side attributes. Utilized as inputs in the final migration model, the calculated proximity between the core streams depends on the most important attributes with adjustable weights. This step develops a better understanding of the end-users incentives.

Third, we utilized the idea from the population migration study to calculate the net migrations between channels by synthesizing the economically adjusted transaction volume from step 1 and important attributes. Then, we fit a migration model to find the relationship between the transaction volume and the net migrations. The migration modeling step projects the total transaction volume that captures both economic and migration trends.

A major advantage of the multi-step modeling approach is that our predictions are more robust when the analysis is performed separately on each of the influencing factors of payment behavior. Moreover, each modeling step is composed of functions, where future information can be adopted and the impacts of such changes can be identified directly. For example, sensitivity analysis is conducted to validate different assumptions on customer preferences with regard to channel attributes. Policymakers are able to implement consumer bias toward payment and measure the impacts that are helpful in decision-making processes and resource allocations.

### 6.1 Forecasting Modeling Approach

Given the modeling approach and the assumption given, the SARIMAX modeling is used to predict the total volume of transactions for each payment stream. SARIMAX is a short form of Seasonal Auto-Regressive Integrated Moving Average with exogenous factors, which is an extension of the ARIMA model. There are 5 major components of this model including the Autoregression Model (AR), Moving Average Model (MA), the Integration term (I), the Seasonality factors (S), and the inclusion of exogenous variables (X) (Chatfield,2014).

The Autoregressive Model (AR) is given by the lag variable $p$, which is used to regress on the prior dependent variable values. Taking $\Theta(L)^p$ with the lag operator $L$, the AR model is:

$$y_t = \Theta(L)^p y_t + \epsilon_t$$

The Moving Average model (MA) is given by the size of the moving average window $q$, which is used to regress on the prior values of errors. Defining $\Phi$ analogously to $\Theta$, the MA model is:

$$y_t = \Phi(L)^q \epsilon_t + \epsilon_t$$

In order to tackle non-stationary data like the payment transaction volume, the integrated term (I) is used with operator $\Delta^d$, where d is the number of times that the raw observation is differenced:

$$\Delta^d y_t = y_t^{d-1} - y_{t-1}^{d-1}$$

Combining three components, the ARIMA (p,d,q) model is summarized as:

$$\Delta^d y_t = \Theta(L)^p \Delta^d y_t + \Phi(L)^q \Delta^d \epsilon_t + \Delta^d \epsilon_t$$

$$\Theta(L)^p \Delta^d y_t = \Phi(L)^q \Delta^d \epsilon_t$$

Considering the strong seasonality effect of the payment volume for each year, the seasonality decomposition shows a strong seasonality effect on the transaction volume with a period of 12 months. The seasonality factor $s$ is introduced to the ARIMA model. By applying the differencing operator $\Delta_s^{\ D}$, the seasonal difference of the time series is eliminated. The variables take on a similar meaning to $d, p, q$ in ARIMA but represent the seasonal terms specifically. The SARIMA term (Q,D,Q,s) is:

$$\Delta_s^{\ D} y_t = \theta(L^s)^P \ \ \Delta_s^{\ D} y_t + \phi(L^s)^Q \Delta_s^{\ D} \epsilon_t + \Delta_s^{\ D} \epsilon_t$$

With multiple with ARIMA(p,d,q), the general form of the SARIMA(p,d,q)(Q,D,Q,s) is:

$$\Theta(L)^p \theta(L^s)^P \Delta^d \Delta_s^{\ D} y_t = \Phi(L)^q \phi(L^s)^Q \Delta^d \Delta_s^{\ D} \epsilon_t$$

From Section 3, the correlations have indicated the strong relationship of the macroeconomics indexes with transaction volume. With consideration of the exogenous variables $x_t^{\ i}$ and the coefficients $\beta_i$ is included for the SARIMAX model.

$$\Theta(L)^p \theta(L^s)^P \Delta^d \Delta_s^{\ D} y_t = \Phi(L)^q \phi(L^s)^Q \Delta^d \Delta_s^{\ D} \epsilon_t + \sum_{i=1}^{n} \beta_i x_t^{\ i}$$

## 6.2 Customer Choice Modeling Approach

Beyond forecasting, the customer choice modeling approach was utilized to help us determine what attributes are most influential for end-users to adopt new payment systems. A customer choice model can help researchers understand the choices consumers make in the market or why they choose one system over the other. This approach is similar to the one applied in the An Economic Perspective of Payments Migration and Predicting Payment Migration in Canada by Anneke Kosse, Zhentong Lu, & Gabriel Xerri paper where the utility for a given payment system was calculated to be the log distance of the market shares of two payment systems. By utilizing the attributes selected as a vector of predictors for each payment system j at time t to predict mean payoff, we can gain insights on what attributes influence end-user decisions the most. A formula and step-by-step description of the process are shown below (Kosse 2021).

$$log(\frac{s_{j,t}}{s_{0,t}}) = \delta_{j,t} = X_{j,t}\beta + \xi_{j,t}$$

$$\pi_{i,j,t} = \delta_{j,t} + \epsilon_{j,t}$$

$$= X_{j,t}\beta + \xi_{j,t} + \epsilon_{j,t}$$

$\delta_{j,t}$ is the mean payoff for system *j* at time *t* that is common across all decision-makers.

$\varepsilon_{j,t}$ is the preference shock or logit error for system *j* at time *t*

$s_j$ is the observed market share for system *j* at time *t*

$x_j$ is the vector of attributes of system *j*

Determine market share for each payment system at time t.

1. Find the net distance between the market share of two payment channels at time t by taking the logarithm.
2. Use net distance as a target variable to find the beta coefficients for $x_{j,t}$=vector of attributes.
3. Determine the statistical significance and magnitude of influence of an attribute on the payoff of one payment channel to another.

The mean payoff is calculated by taking the fraction of the market share of a payment system i to a base payment system j and log transforming it (Kosse 2021). When measuring the log distance of market shares, one system's mean payoff needs to be normalized to zero. Since the paper volume forecast is zero after 2025, it was assumed that paper volume and value are both normalized to zero. Afterward, we use a Random Forest algorithm to extract the feature importance of all attributes. Random Forest algorithm took default specifications of 100 trees and it was chosen because of the lowest RMSE score after using a 70/30 training/test split with a pipeline of Gradient Boosting, Decision Tree, and SVM. Feature importance is the relative importance of each predictor in predicting the target variable. Figure 4 is an example output of our customer choice modeling approach.

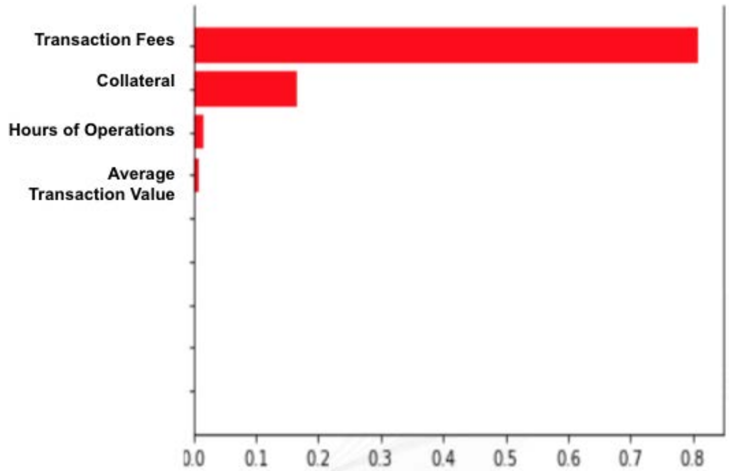


**Figure 4 - Customer Choice Modeling Approach Output, Paper to RTR Migration**

Based on the results, we notice that the attributes that influence migration the most are cost-based such as transaction fees, average transaction value, and collateral, with hours of operations having a small influence. Attributes such as acceptance, safety, and irrevocability were not shown to be influential in any migration pair. This pattern can be seen in every migration combination, indicating that cost is the most influential factor when deciding on a payment channel. In times of distress like COVID-19, this pattern is assumed to be even stronger today than ever before. Therefore, when policymakers are deciding on the attributes that make up RTR, Lynx, and SOE, cost needs to always be considered. Speed or ease of use does not matter if the utility lost by higher cost overruns the utility gained from those features.

## 6.3 Migration Modeling Approach

After forecasting the economic impacts and finding the influencing attributes, a migration model is created that examines the impacts of migration on transaction volume. We first calculate the net migration flows between channels by utilizing the idea from population migration in demographic studies. As shown in Figure 5 (Bewaji 5), core streams reside within their payment rails. Two core streams are connected to represent the payment migration flows between them. The magnitude and direction of migration are determined by the proximity that is evaluated in attribute similarities and efficiency gains as a result of that migration. Table 3 also demonstrates possible migrations of interests in detail between the core streams.

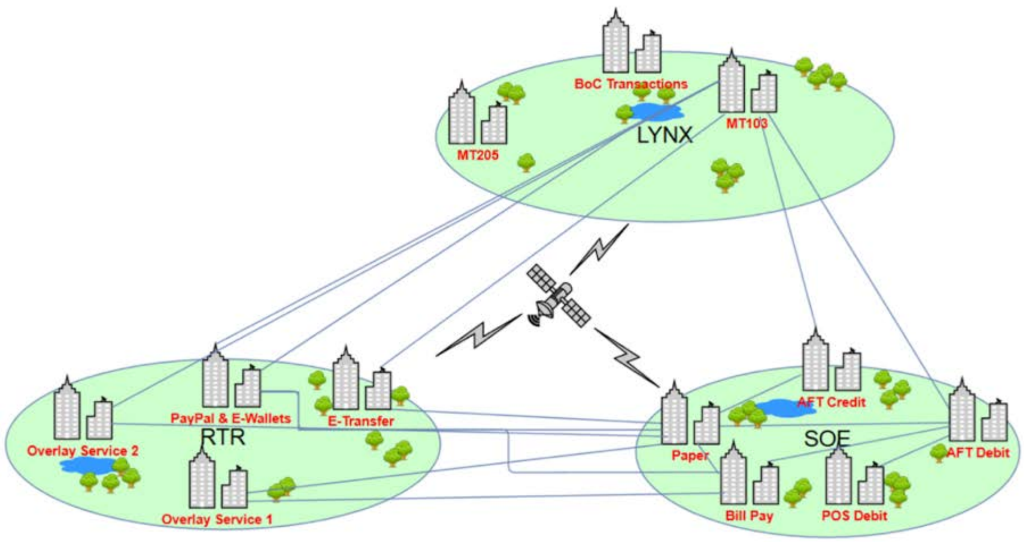


**Figure 5 - Geo-Spatial Representation of Core Streams**

| FROM \ TO | Paper | BillPay | AFTCredit | AFTDebit | POSDebit | LessThan10K | 10KTo25K | 25KTo50K | RTR |
|---|---|---|---|---|---|---|---|---|---|
| Paper | | ✓ | ✓ | ✓ | ✓ | | | | ✓ |
| BillPay | ✓ | | ✓ | ✓ | ✓ | | | | ✓ |
| AFTCredit | ✓ | ✓ | | ✓ | ✓ | | | | ✓ |
| AFTDebit | ✓ | ✓ | ✓ | | ✓ | | | | ✓ |
| POSDebit | ✓ | ✓ | ✓ | ✓ | | | | | ✓ |
| LessThan10K | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| 10KTo25K | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ |
| 25KTo50K | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| RTR | | | | | | | | | |

**Table 3 - Possible Migration between Core Streams**

Assuming 2021 as the cut-off date to go live, the impacts of Modernization are delivered with 5-year volume forecasts for each core stream at Target State. The Vector Autoregressive (VAR) model and the Ordinary Least Squares (OLS) models are selected to find the relationship between the calculated net migration volume and the total volume for different streams. The migration models predict the transaction volume for each of the core stream with a system of equations as the following:

$$Y_t^j = \boldsymbol{\alpha} + \boldsymbol{\beta}_0 Y^j_{t-1} + \boldsymbol{\beta}_1 \{Y^i_{t-1}, \ldots, Y^k_{t-1}\} + \boldsymbol{\beta}_2 \{N_t^{i,j}, \ldots, N_t^{k,j}\} + \varepsilon_t$$

Target variables:

- $Y_t^j$ : the transaction volume for jth core stream at time t

Explanatory variables:

- $Y_{t-1}^j$ : the lagged transaction volume for jth core stream at time t-1
- $Y_{t-1}^i$ : the lagged transaction volume for all core streams (i to k) at time t-1
- $N_t^{i,j}$ : the calculated pairwise proximity for all possible migrations from target stream j to other core streams

Parameters for the model:

- $\boldsymbol{\alpha}$, $\boldsymbol{\beta}_0$, $\boldsymbol{\beta}_1$: intercept and coefficients
- $\varepsilon_t$: error term

The proximity calculations are useful for describing payment migration flows. One of the advantages of the VAR model is its ability to incorporate multivariate time series data. When payment systems get implemented there will be an increase in transaction volume. The VAR model satisfies the uplift of the initial implementation and is consistent with industry expectations. Additionally, the VAR model is more flexible because we can tune the model and decide how much past information is taken into account when predicting the future. However, there are some disadvantages to the VAR model. Although some initial studies evaluate whether the data support the stationarity assumption of VAR, the stability of the estimated model is rarely verified. Moreover, since RTR is a new rail to be launched in the future, its stationarity can hardly be tested. On the other hand, the linear regression model is more stable compared to the VAR model and can be easily interpreted and implemented. There is a trade-off in choosing between the 2 models and the results are computed with a 50-50 weighted average. The weighting is open for interpretation for Payments Canada in balancing the trade-offs.

## 7. Results and Validation

### 7.1 Forecast Analysis

As part of the first step of the modeling process, the volume forecast is computed with the implementation of the SARIMAX model as discussed in Section 6.1. The validation for the total transaction volume is shown from 2017 to 2020 in figure 6. The result indicates that the model can capture major fluctuations from economic activities. The validation test shows a very good fit of the model to reflect the general trend and the covid impact. The drop for 2020 can be expected given from the economic indexes. Having used the same tuning parameters from the validation, the five-year volume forecast is computed with a 95% confidence interval. The overall trend shows that covid is likely to be a shock to the system as the economy and payments are going back to normal levels. The other payment streams are computed as well shown in Appendix 1.

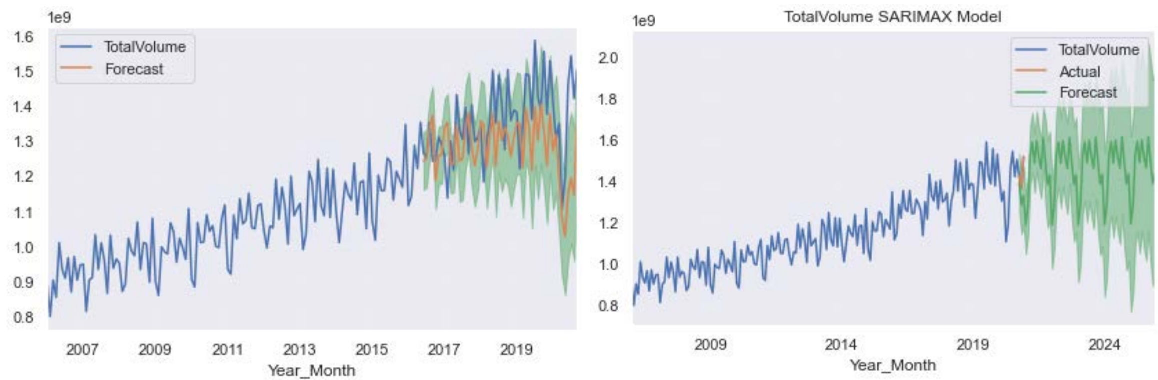


**Figure 6 - The validation for the total transaction volume, 2017-2020**

From comparing other forecast streams, the confidence interval varies dramatically as well illustrated in Figure 7. In terms of the Bill Payments, the confidence interval is narrow with a relatively consistent prediction. On the other hand, the POS Debit confidence interval is very wide. This indicates that different payments have different resilience towards external factors, i.e. economic factors. Bill Payments is more persistent with the payment volume forecast with more accurate predictions. For instance, in the current pandemic situation, end users are still required to make their electricity bill payments or internet bills. Regardless of the market fluctuation or economic situation, bill payments are persistent. On the other hand, POS Debit is more correlated to external factors as it is heavily impacted by the COVID situation. With the uncertainty for future economic trends, the confidence increased dramatically. This insight is also applicable to the payments migration. Since bill payments are more persistent than other streams, it would require more incentives or attribute the difference to induce a more significant migration.

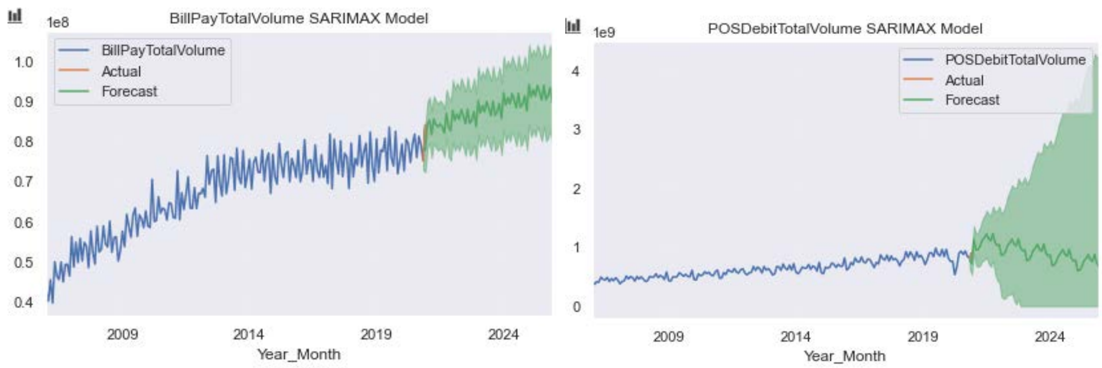


**Figure 7 - The future forecast for Bill Pay and POS Debit**

Once 2021 volume and value transaction data for ACSS and LVTS became available, we performed the validation of the forecast for each payment stream. The average accuracy of the forecasted volume for ACSS is 81.7%, which is a relatively high number. However, when the accuracy is analyzed stream by stream, it can be noticed that some of the streams perform significantly better than others. For example, Bill Payments and AFT Credit streams both reach an accuracy of 92% on average, whereas Paper and POS Debit payment streams only have the accuracy of 50% and 75% respectively (Appendix 1.1.2). The following outcome is in line with the insights obtained from the prior validation based on the train and test 2020 data. Figure 7 represents how the forecast confidence intervals differ for bill and POS Debit payments. Bill payments are indeed more persistent than other streams, such as Paper or POS Debit which can be easily affected by the external factors. Main example of an external factor that massively influences the ACSS payment trends is consumer behavior. For instance, in March and April 2021 there were record-breaking movements in spending patterns. Since the majority of restrictions were lifted, households did not just return to their normal spending patterns, but went above pre-pandemic levels, resulting in a so-called pent-up demand. The following trend caused a lot of volatility in POS Debit and its abnormal volumes that were impossible to predict back in 2020. Since the model assumes that consumer behavior is rational, any irrationality in spending patterns results in deviations from the forecasted values.

The average accuracy of LVTS forecasts is 78.8% which is slightly lower than ACSS but still above the 75% benchmark (Appendix 1.2.2). One of the insights obtained during the LVTS validation process is that lower value forecasts, specifically batches of below 10k, 10k to 25k, 25k to 50k, and 50k to 250k have a high accuracy of 85-95%. Whereas higher value forecast batches, such as 250k to 750k, 750k to 1M, and above 1M have an average accuracy of 68% which is significantly lower than the lower value batch accuracy. The following trend signals that lower value LVTS transactions are more persistent and easier to forecast compared to the high value LVTS transactions that occur less frequently and have a wide confidence interval of its forecast.

### 7.1.2 Customer Choice Model Analysis

The most prevalent attributes of importance are shown to be the average transaction value, transaction fee, and collateral saving. In addition to that, in some cases such as paper to RTR migration, hours of operation are shown to be influential. However, from our analysis, the cost is the primary reason why one payment channel is chosen over another. It is important to notice that collateral savings are not the most important attributes when it comes to migration between SOE or ACSS payments systems. Collateral only matters when migration involves LVTS transactions, which is due to the higher collateral requirements needed for LVTS transactions. This can be demonstrated in the graphs below.

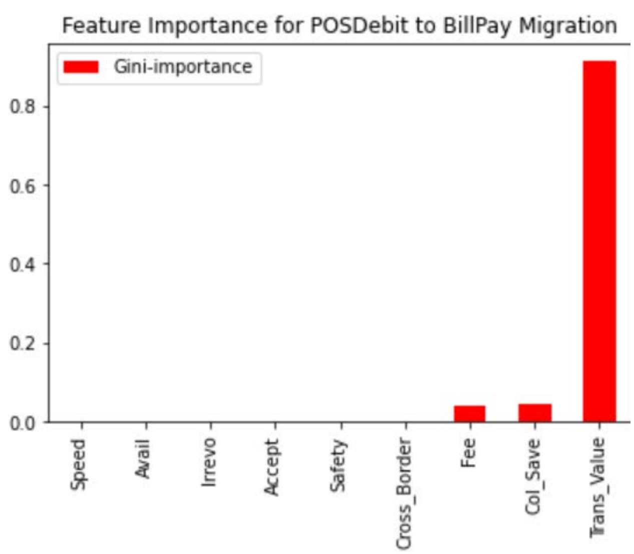


**Figure 8 - Feature Importance for POS Debit to Bill Payments Migration**

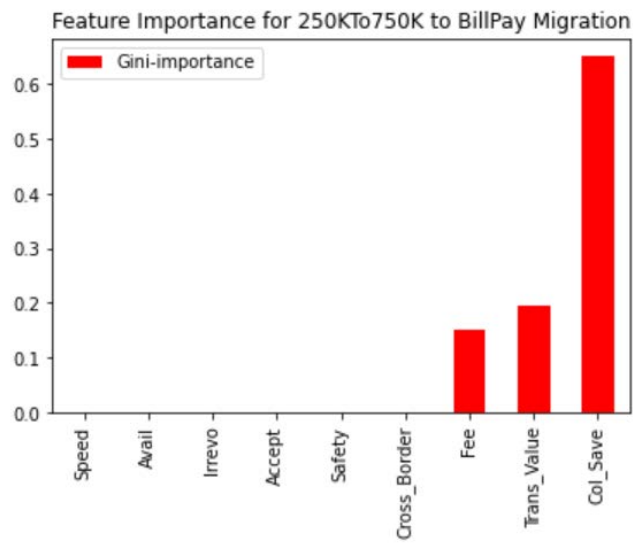


**Figure 9 - Feature Importance for 250-750K LVTS to Bill Payments Migration**

As you can see from the figures above, the importance of collateral becomes emphasized at higher value payments. The average transaction value for POS Debit is not as high as the 250K to750K LVTS bin, therefore the collateral requirement is not relevant either.

Our results show, at the end of the day, regardless of attributes such as speed or availability, the cost is the ultimate deciding factor for end-users. Therefore, when forecasting migration, emphasizing speed or availability may not be the most realistic of assumptions. Historically, this has also been seen to be what has allowed for the successful implementation of RTR in other countries. For example, in Singapore, because the pricing differential for cheques and real-time transactions was too large, the adoption by businesses was slow. The new features the new payment system brought were not enough for business owners in Singapore to offset the higher price.

### 7.1.3 Migration Model Analysis

The market share forecasts are based on core streams of interest. In other words, MT205 and Bank of Canada payment (BoC), and other streams are excluded. Moreover, LVTS (Lynx) refers to LYNX LSM for which only payments less than 50k are included in our forecasts. As shown in Figure 10, the volume market share is forecasted with only the natural growth of the streams and the COVID impacts. In the next 5 years, the volume market share of RTR accounts for 5 to 7%, which is relatively small. The volume share of RTR starts with 4.7% in 2021 because INTERAC and Paypal payments are assumed to fall directly under RTR when it is launched. Furthermore, the RTR volume share is expected to increase slowly to around 6.9% at the end of 2025. This implies that real-time payments slowly gain its popularity.

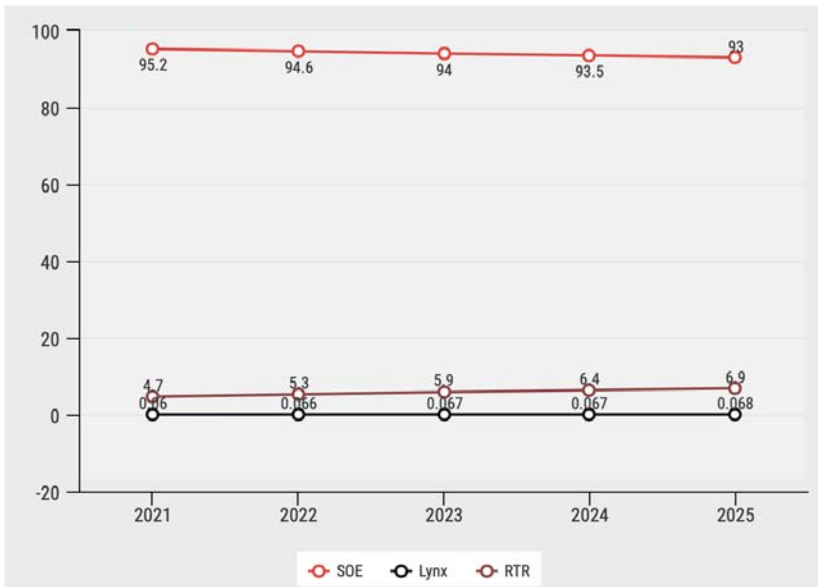


**Figure 10 - Volume Market Share with only COVID impacts in Next 5 Years**

Based on the volume forecasts of the core streams, the migration flows to RTR and the migration flows between ACSS and LVTS payments are then analyzed with a focus on directionality. Under the base case where it is assumed that stream attributes are equally weighted, the net migration plots are shown in Appendix 4.

First of all, paper payments continue migrating to RTR in the future. However, the amount of migration decreases because of the shock on paper payments due to COVID-19 in 2020 as well as the diminishing trend in cheque usage over time. At the same time, paper payments also migrate to other ACSS payments such as bill, AFT, and POS payments with decreasing trends. The total paper volume declines and reaches zero at the end of 2025. The migration flow out of paper payments is observed as fewer people use cheques and it can be completely replaced by other types of payments.

Following the historical trend, bill payments become more frequent in the future. They are not affected much by COVID-19 because bill payments consist of essential payments that are more stable. They are expected to migrate to RTR where the amount of migration also slowly increases. Bill payments and RTR are similar with regard to their attributes. However, they are used for different purposes. Moreover, fewer bill payments flow to paper and more flow to POS over time.

Overall, there has been an increasing trend in AFT payments activities in the past. However, we observe a drop in AFT Credit payments in 2020 and a plateau in the next 5 years. The AFT Credit payments are significantly impacted by the pandemic because they are commonly used for payrolls and their recovery depends on the length of the pandemic. On the other hand, there is a jump in AFT Debit payments under COVID-19 because benefits are paid quickly with direct deposits. Both AFT Credit and Debit migrate to RTR almost exponentially and they are the key contributors of RTR growth.

The point-of-sale debit card has been gradually increasing in the past. However, we observed a drop in early 2020, followed by an upsurge of POS usage in late 2020 and it will fall back to normal in the next 5 years. The migration from POS to RTR also experiences a drop and grows afterward. This is due to the fact that major users of POS terminals are retailers that are significantly affected by lockdowns and reopenings.

Lastly, LVTS payments of less than 50k have been increasing slowly in the past. However, we observe a small decline in the 10k to 25k payment group in 2020 due to the pandemic. Lower value LVTS payments migrate to RTR exponentially in the next 5 years, which are crucial in value market share.

Since lower value LVTS are only the client wire transfers that are not so urgent, more efficient transfers are inclined because of the benefits RTR brings. There is also a tendency for lower value LVTS to migrate to ACSS payments, for example, bill payments.

Shown in Figure 11, the volume market share forecasts incorporate the COVID and migration impacts. SOE takes up the majority of the volume and its market share decreases from 94% to 90%. The total volume of low-value LYNX is relatively small at around 0.7%. RTR starts with around 6% and increases to around 10% in the next 5 years. The results are consistent with our migration analysis that core streams under SOE and LVTS indeed migrate to RTR. Moreover, the detailed market share predictions from the VAR and OLS models are shown in Appendix 2 and Appendix 3.

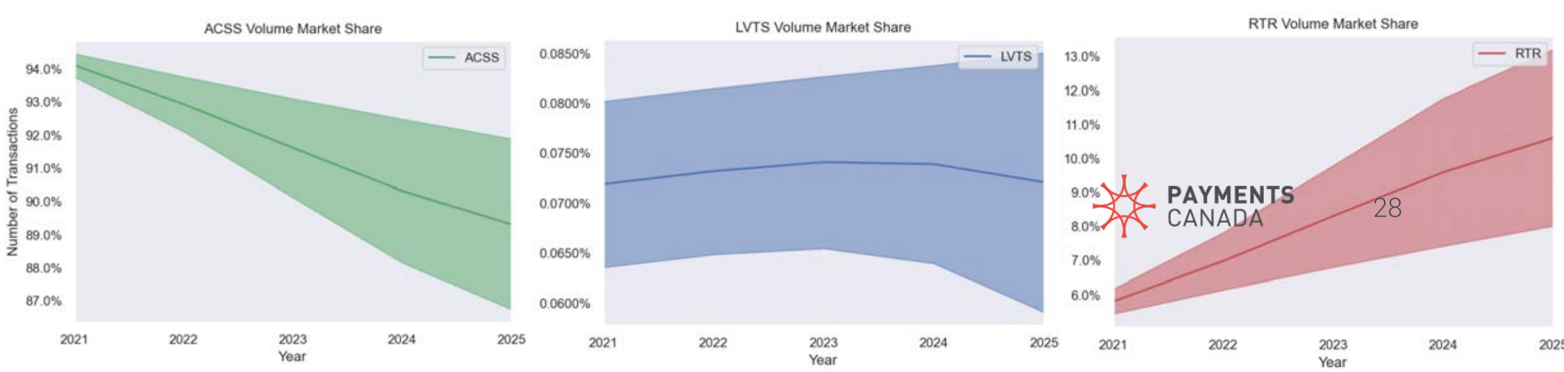

**Figure 11 - Volume Market Share with COVID and Migration impacts in Next 5 Years**

## 7.2 Sensitivity Analysis

The migration analysis under the base case discussed in Section 7.1 is based on equally weighted attributes. Specifically, consumers and financial institutions are homogenous on the attributes of the core streams. In addition, sensitivity analysis is conducted with different weighting on the attributes with the interest of revealing the impacts of various end-users perceptions. 2 scenarios are presented in Sections 7.2.1 and 7.2.2 below.

### 7.2.1 Scenario 1: Consumer Bias on End-UserTransaction Fee

The first scenario is when consumers value the end-user transaction fee more than the other attributes. Primary weighting is given to end-user transaction fees and the other attributes are equally weighted. As shown in Appendix 7, the volume migration from ACSS payments toward RTR grows with the exception of paper payments. Although consumers are biased on end-user fees, the benefits RTR brings with regard to the rest of the attributes are not negligible. The results show that the benefits of RTR increase the migration flows overall. Consumers potentially believe that a slightly higher transaction fee in RTR payments brings more benefits and they are willing to sacrifice fees for more efficient transactions such as longer availability time and quicker speed. In addition, the volume migration of paper and lower value LVTS payments to RTR decrease. The seasonal effects of the net migration from LVTS to RTR are amplified. Specifically, the differences are larger between the high and low levels of net migrations. As a result, Appendix 5 and Appendix 6 show that the volume market share of SOE is lower while Lynx and RTR are higher than the base case under both the VAR and OLS models.

### 7.2.2 Scenario 2: Bias on Average Transaction Value

The average transaction value is now assumed to be the only driver for end-user choice of core stream. Payment streams that are close in average values being processed are more likely to migrate. Shown in Appendix 10, the net volume migration from ACSS and LVTS of less than 10k payments to RTR declines. Additionally, the net volume migration of LVTS of 10k to 25k and 25k to 50k payments to RTR grows. This indicates that when the average transaction value is the only attribute considered, larger values of LVTS payments between 10k to 50k are more likely to migrate to RTR. Therefore, one should be mindful of payment system risks such as fraud risks when more LVTS transactions are flowing into RTR. As a result, Appendix 8 and Appendix 9 show that the volume market share of SOE is lower and RTR is higher than the base case under both the VAR and OLS model. Lynx is slightly higher compared to the base case from the VAR model and slightly lower from the OLS model. Therefore, a weighted average of the 2 models can be implemented where the weighting is flexible for interpretation with future growth in Lynx.

## 7.3 Industry Expectations

To validate the migration projections we look towards the experts to determine if similar insights are being concluded. Multiple case studies published by Payments Canada, Bank of Canada, and others can be utilized as expert opinions on payments migration. Our research, An Economic Perspective of Payments Migration and Predicting Payment Migration in Canada by Anneke Kosse, Zhentong Lu, & Gabriel Xerri are direct comparisons we can utilize to validate our results. Comparing the results we achieved from the other case studies demonstrates a significant difference in payments volume, but not direction. At the time of these case studies, COVID-19 was not prevalent, so dips in payments volume and fundamental changes to the economy were not taken into consideration (Bewaji 2018). Understanding this, what can be gained from these studies are to make sure the directionality aligns, and that insights gained are consistent with our findings.

Target state volume projections differ from projections made by the Bank of Canada, however, the directionality for the streams is consistent (Kosse 2021). Transactions are observed to consistently be moving towards RTR, especially for those that involve a physical component such as paper or POS debit. Electronic payments have been shown to capture more market share over the years and this trend is likely to continue as evidenced by the graph below.

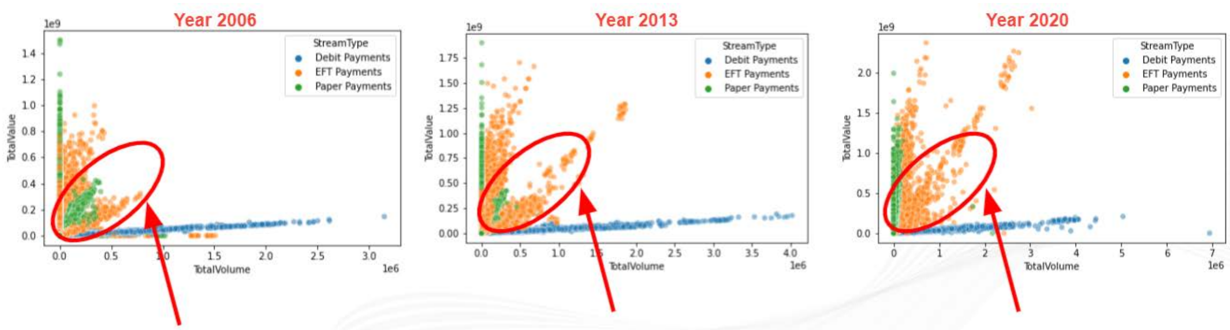


**Figure 12 - Trend Towards Digital Payments**

The difference in target state volume projections can be explained by a difference in assumptions and attributes utilized to determine migration. Our model assumes end-users are rail agnostic, however, this is not true by the papers published by the Bank of Canada. Our model is also consistent to an extent with the Canadian Bankers Association target projections as well (Bewaji 2018).

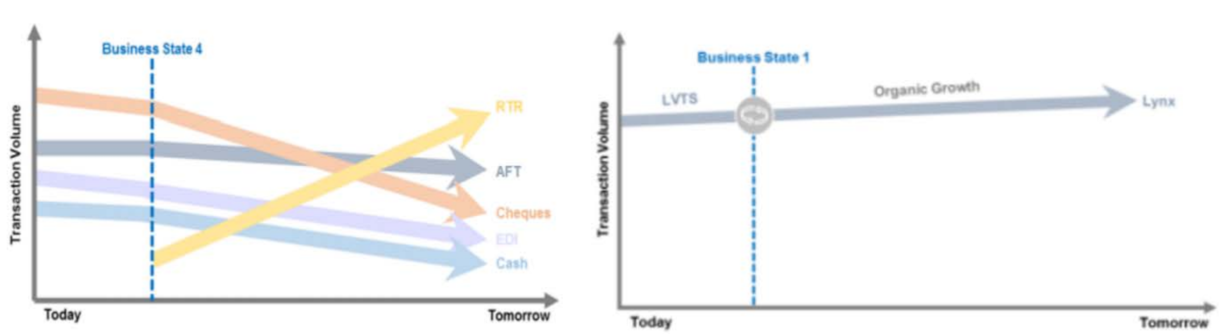


**Figure 13 - Canadian Bankers Association Target State Projections**

According to the graph, RTR is assumed to increase significantly with other payment systems like AFT and cheques decreasing. This is consistent with the projections from our final model. However, the Canadian Bankers Association assumes that LVTS will grow organically, which according to our model is only true for LVTS transactions valued at over $5000 (Bewaji 2018). Any payment less than that will migrate towards RTR. The modernization and introduction of RTR offer a faster and cheaper alternative to end-users for lower value LVTS payments making it so we do not align with the expectations made by the Canadian Bankers Association (Bewaji 2018).

## 7.4 Model Validation

Beyond testing the accuracy of the SARIMAX approach, a neural network model and exponential smoothing model were also created and tested to test which algorithm was the most accurate. From our findings, the neural network model was better at catching the sudden shock COVID-19 had caused to transaction volume amount, however, it did not capture the recovery process as well as exponential smoothing and SARIMAX. Overall, SARIMAX led to a lower RMSE value compared to exponential smoothing and neural net approach, and was able to both capture the sudden shock to an extent, but also completely capture the recovery period after shutdowns with a 95% confidence interval.

In terms of the customer choice model, to make sure the insights gained on the relative importance of attributes is accurate, we can experiment with multiple different regressors such as Decision Trees and Gradient Boosting to determine if feature importance scores are consistent. Based on the results of these models, feature importance is shown to be consistent across methodologies. The results of the validation are shown in the appendix below.

Finally, to validate our results for the migration model, sensitivity analysis was utilized to measure the robustness of our predicted directionality. By changing the different preferences for end-users when selecting one payment system over the other, we can demonstrate how robust our model's predictions are to the general direction of a migration pair. The two figures below demonstrate this.

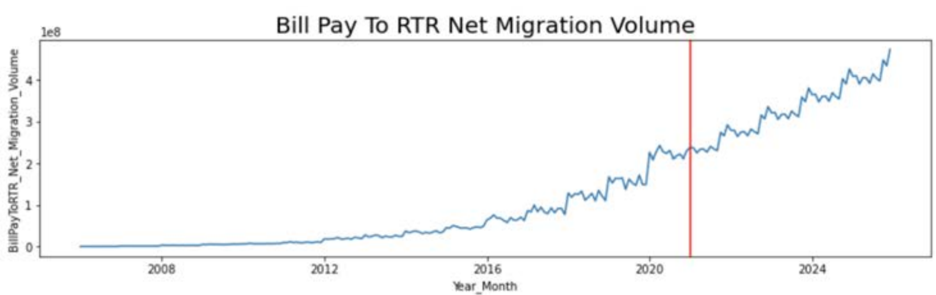


**Figure 14 - Equal Preferences**

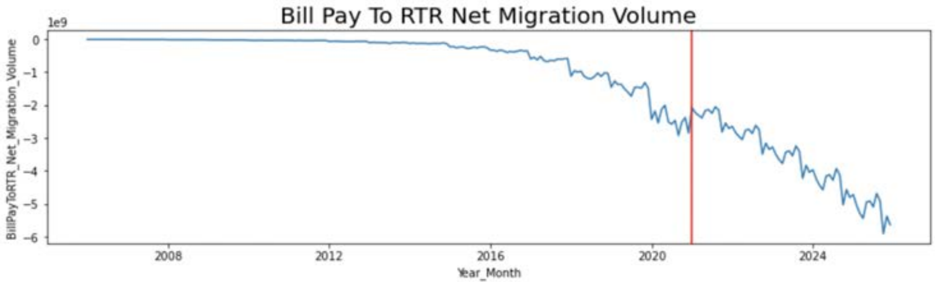


**Figure 15 - Doubled Preference for End User Fees**

From the two figures above, we notice that when end-user fee preference is doubled, then the Bill Pay to RTR net migration direction reverses. If end-user fees are twice as important to end-users than other attributes then the migration will occur from RTR and not Bill Pay. However, this is an extreme case of increasing preferences by 100%. After analyzing the migration direction when increasing preference by 20%, 30%, and even 40%, we observe the same directionality. This allows us to conclude that our model, in terms of directionality, is robust. Misestimating preference by over 40% would be due to a structural change in end-user preference rather than our model.

## 8. Conclusion

Through our model, we can determine the direction and final market share of the new payment systems that will be implemented. We have also, additionally, determined key insights for policymakers when creating incentives for payment system adoption. From our findings, in terms of COVID-19, we have found that some payment systems such as POS Debit have persisted even with the pandemic, while others, unfortunately, were severely hindered by the lockdowns limiting transaction volume. These “persistent” payment systems are important to understand as they imply a need for stronger incentives by policymakers to induce migration or adoption.

In terms of attributes, the most relevant attributes that influence an end-users decision to use one channel over another are ultimately cost-based. Unsurprisingly, end-users care more about saving money rather than speed or availability. However, in some cases, we have found that attributes such as hours of operation do influence an end user's decision. This knowledge can be helpful for policymakers that want RTR to be widely adopted, as the utility gained from the availability in RTR can be offset if it is too expensive for users compared to other payment rails.

Finally, in terms of migration, we have generated graphs demonstrating the direction of migration for all migration pairs available. We have discovered that there is a decreasing trend for SOE and a rising trend for RTR. Interestingly, for Lynx, smaller value payments seemingly will migrate towards RTR, which can be consequential in terms of risk exposure and collateral requirements for Lynx. Our model is robust to changes in user preference in terms of directionality and is easily adjustable to new data and additional attributes.

Modernization has an undeniable impact on the payments landscape in Canada and through our models, we have provided insights on what that landscape may look like in 2-5 years. We recognize that these systems are still in development, but hope that our model may be a starting off point for further research once these new systems are better characterized.

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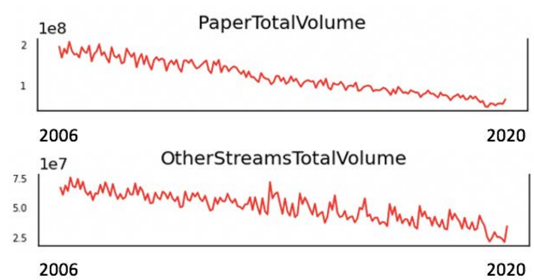
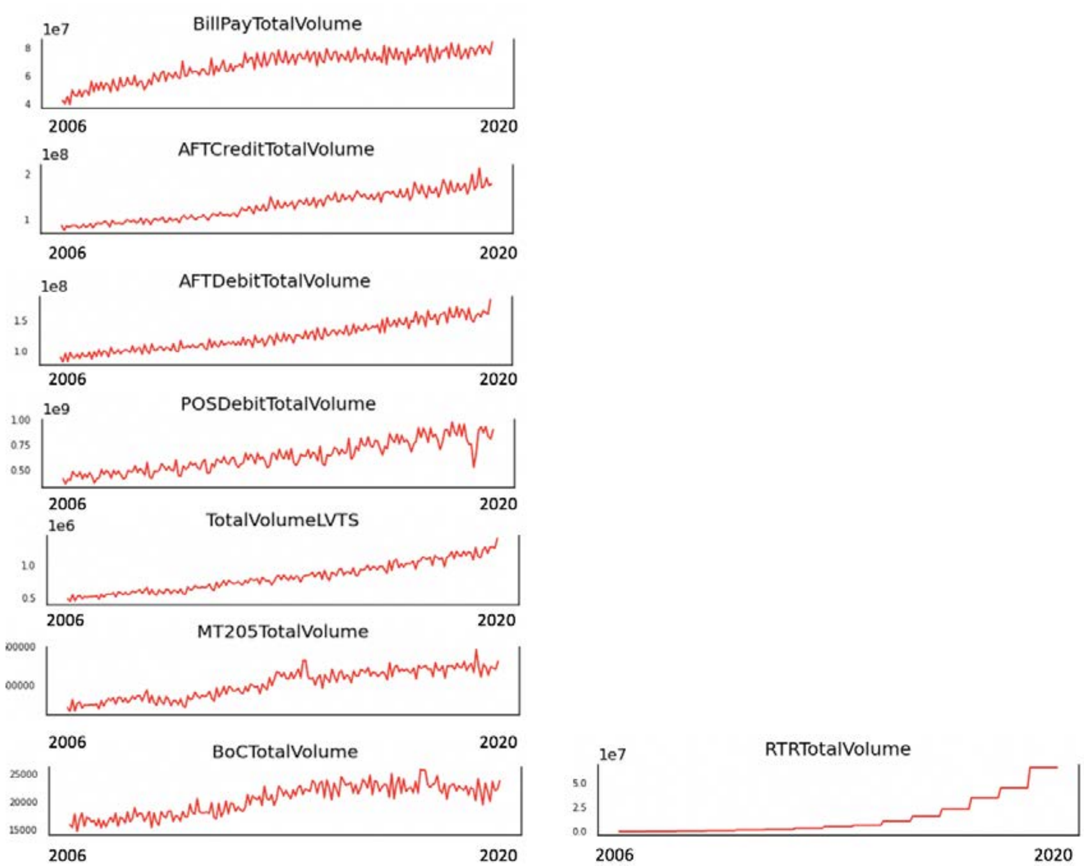
## 10. Appendix

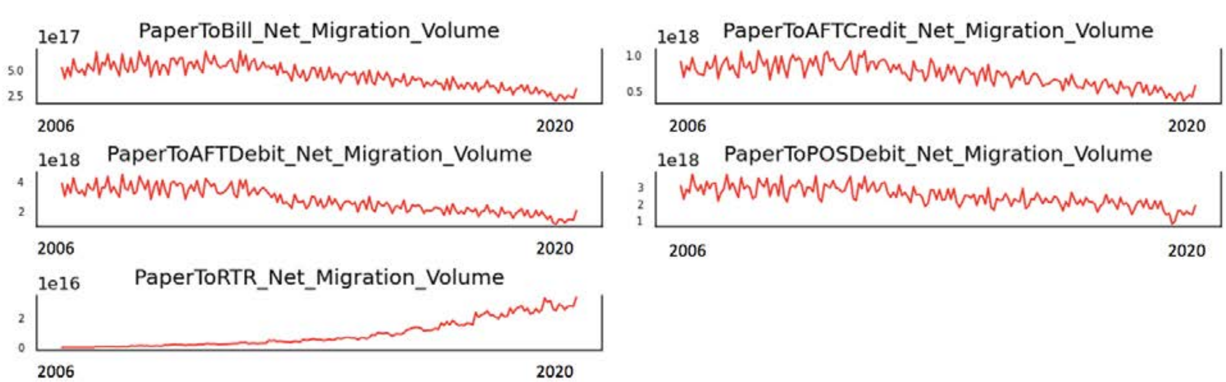
### Appendix 1. General Trends in Volume



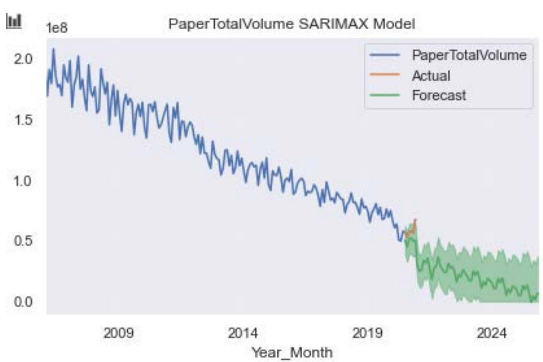

**EDA - A decreasing trend**

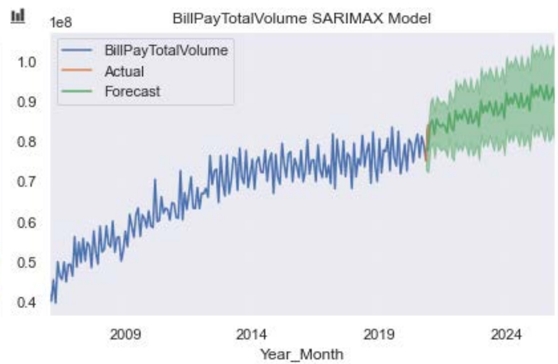


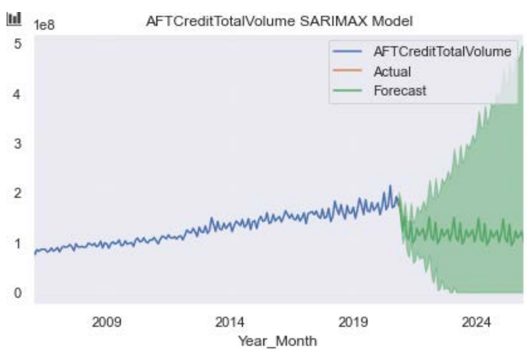

**EDA - An increasing trend**

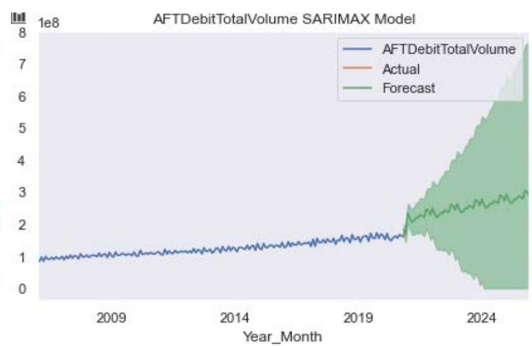


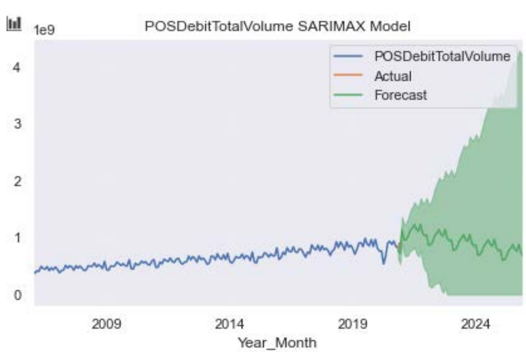
## Appendix 1.1.1. ACSS Volume Forecast

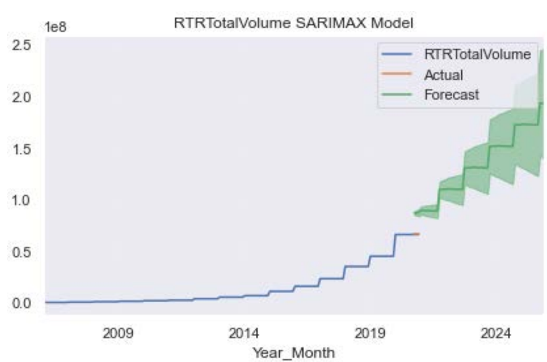


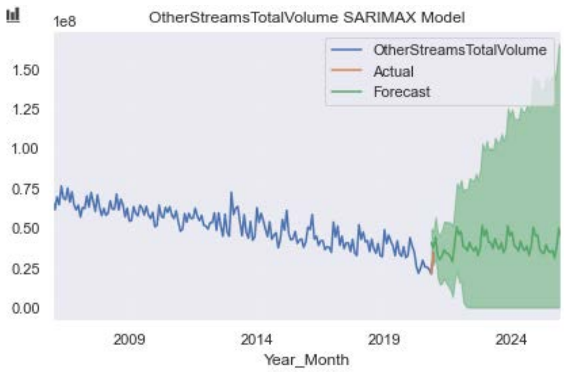



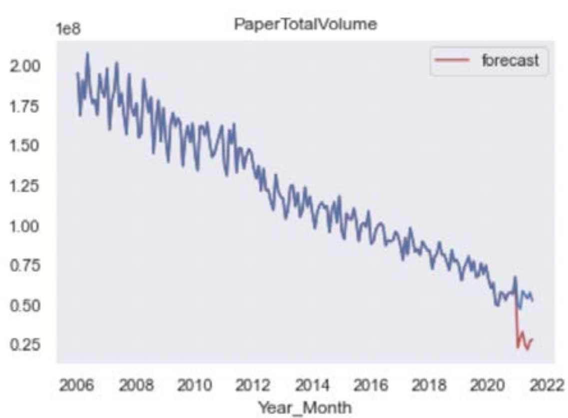



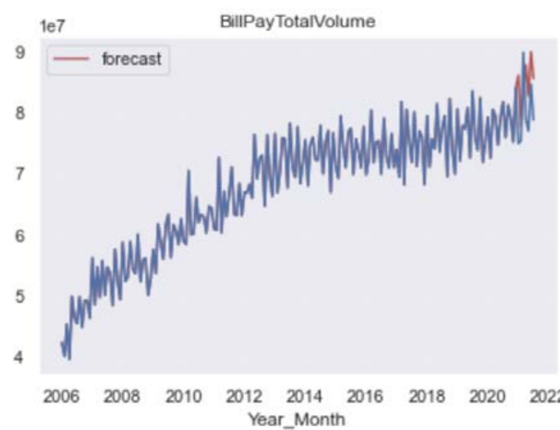



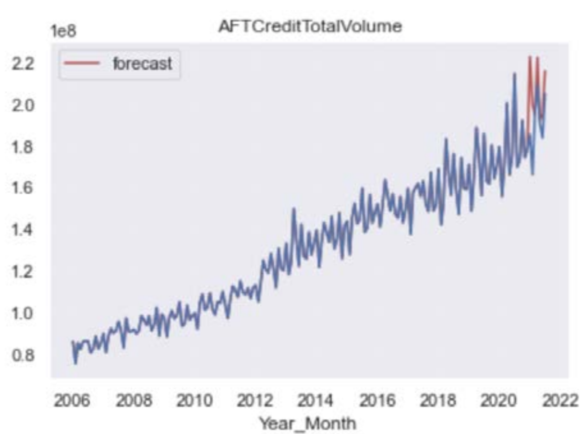



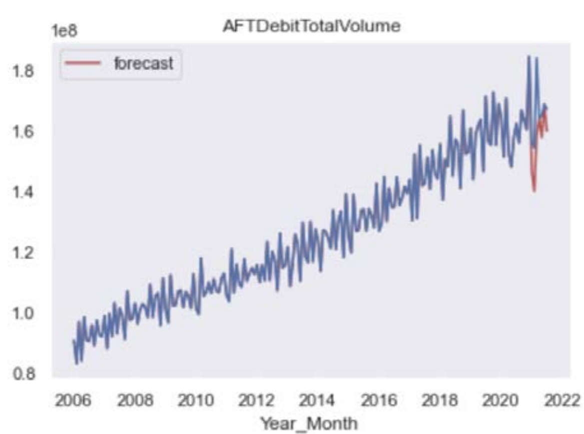


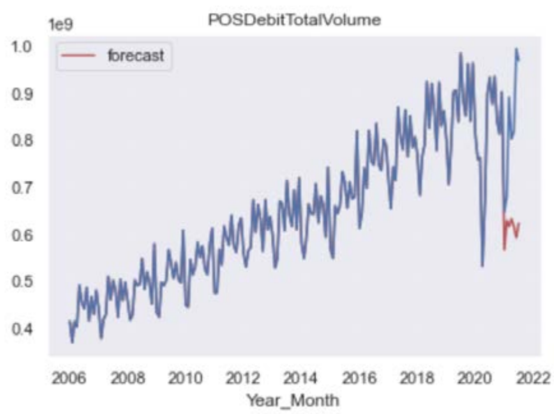

## Appendix 1.1.2. ACSS Volume Forecast Validation

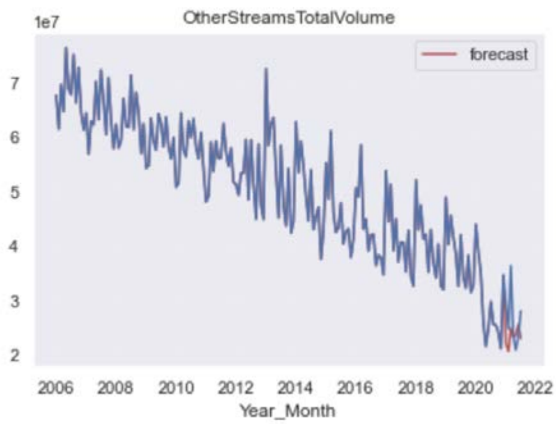


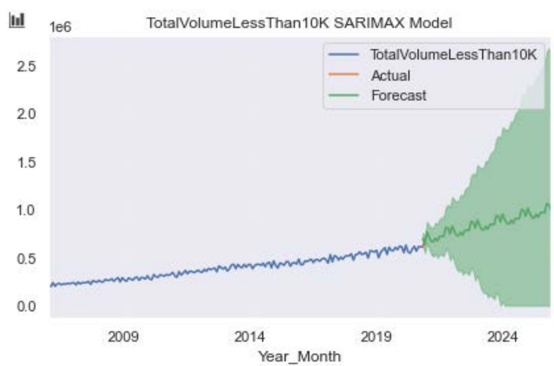



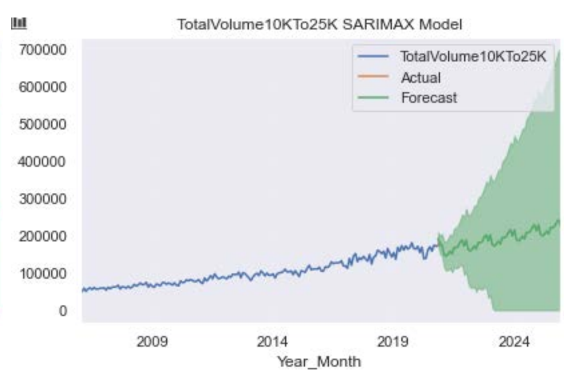



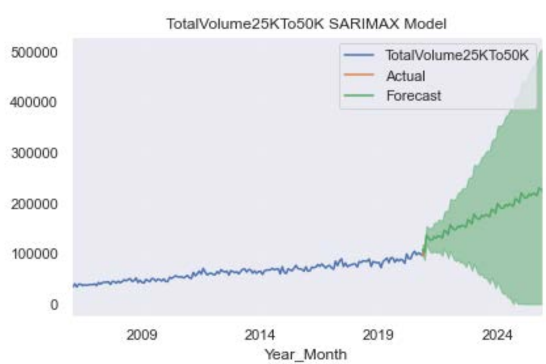


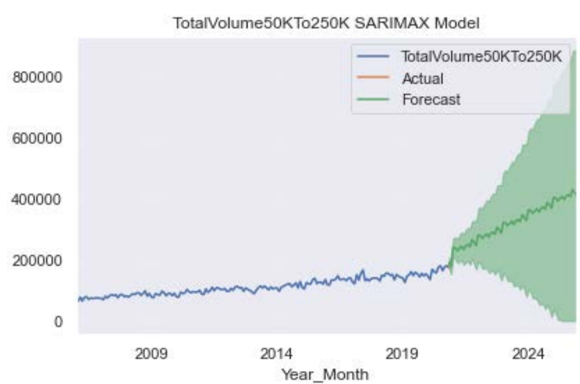



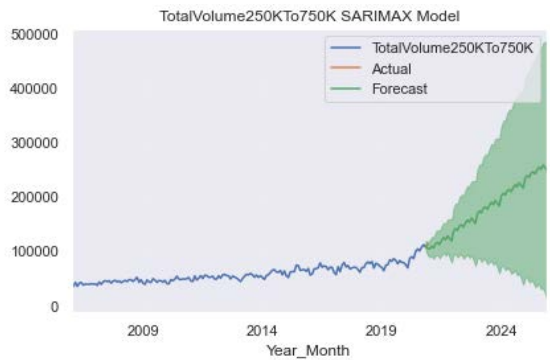

## Appendix 1.2.1. LVTS Volume Forecast

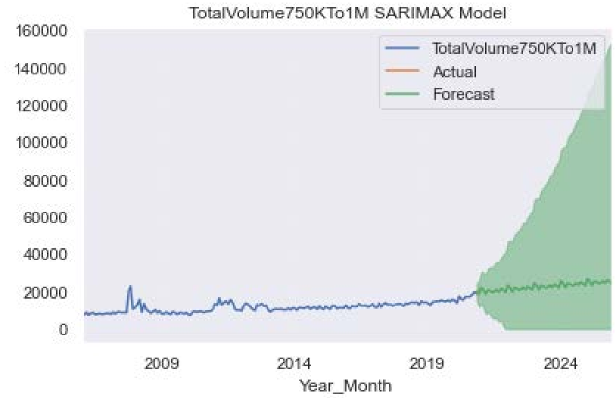


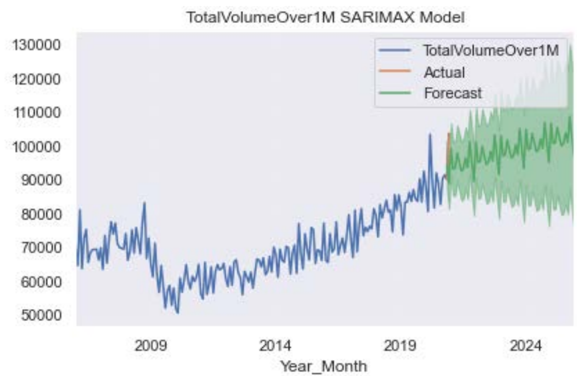



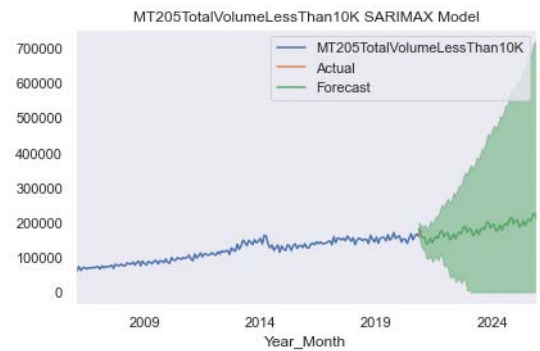



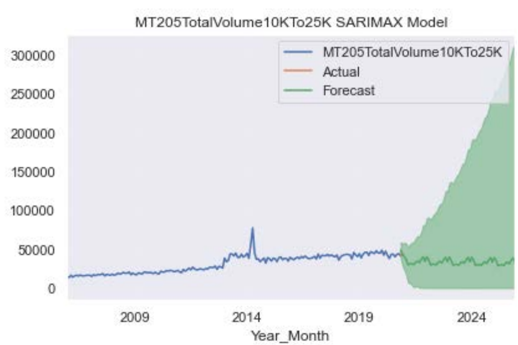



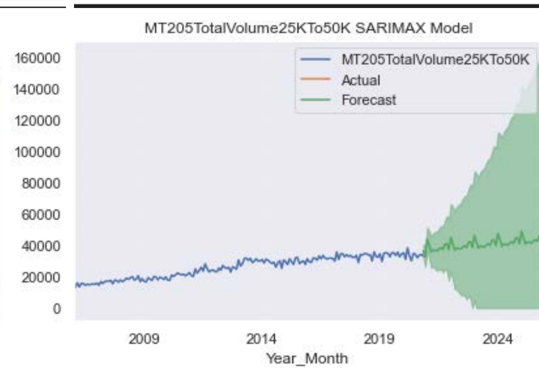

TotalVolume250KTo750K SARIMAX Model
TotalVolume250KTo750K
Actual
Forecast
500000
400000
300000
200000
100000
0
2009
2014
2019
2024
Year_Month

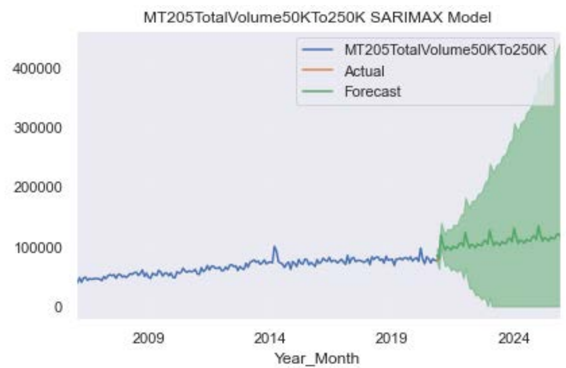

TotalVolume750KTo1M SARIMAX Model
TotalVolume750KTo1M
Actual
Forecast
160000
140000
120000
100000
80000
60000
40000
20000
0
2009
2014
2019
2024
Year_Month

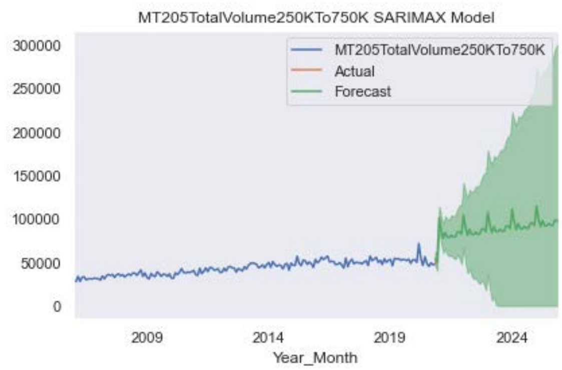

TotalVolumeOver1M SARIMAX Model
TotalVolumeOver1M
Actual
Forecast
130000
120000
110000
100000
90000
80000
70000
60000
50000
2009
2014
2019
2024
Year_Month

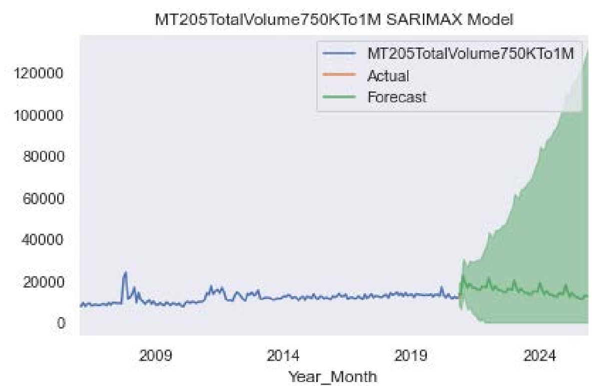

MT205TotalVolumeLessThan10K SARIMAX Model
MT205TotalVolumeLessThan10K
Actual
Forecast
700000
600000
500000
400000
300000
200000
100000
0
2009
2014
2019
2024
Year_Month

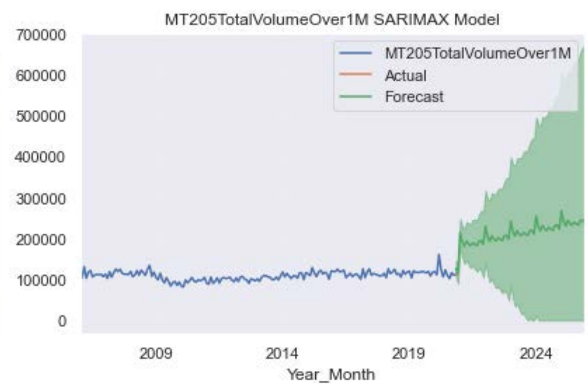

MT205TotalVolume10KTo25K SARIMAX Model
MT205TotalVolume10KTo25K
Actual
Forecast
300000
250000
200000
150000
100000
50000
0
2009
2014
2019
2024
Year_Month

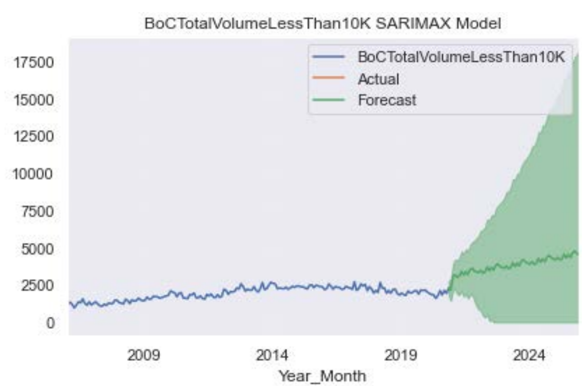

MT205TotalVolume25KTo50K SARIMAX Model
MT205TotalVolume25KTo50K
Actual
Forecast
160000
140000
120000
100000
80000
60000
40000
20000
0
2009
2014
2019
2024
Year_Month

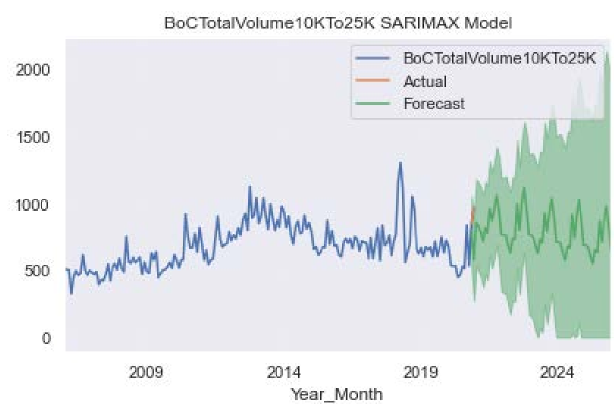

MT205TotalVolume50KTo250K SARIMAX Model
MT205TotalVolume50KTo250K
Actual
Forecast
400000
300000
200000
100000
0
2009
2014
2019
2024
Year_Month

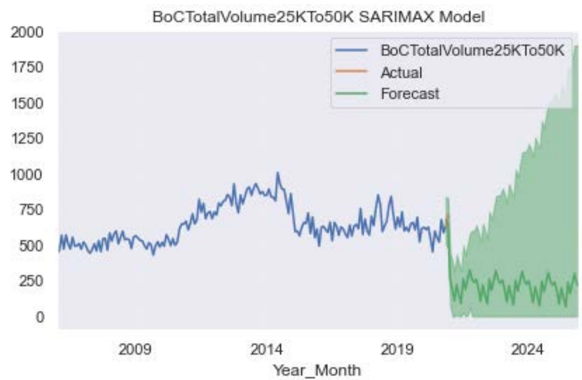

MT205TotalVolume250KTo750K SARIMAX Model
MT205TotalVolume250KTo750K
Actual
Forecast
300000
250000
200000
150000
100000
50000
0
2009
2014
2019
2024
Year_Month

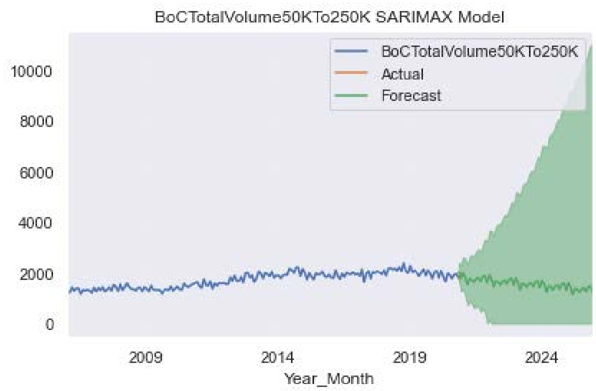

MT205TotalVolume750KTo1M SARIMAX Model
MT205TotalVolume750KTo1M
Actual
Forecast
120000
100000
80000
60000
40000
20000
0
2009
2014
2019
2024
Year_Month

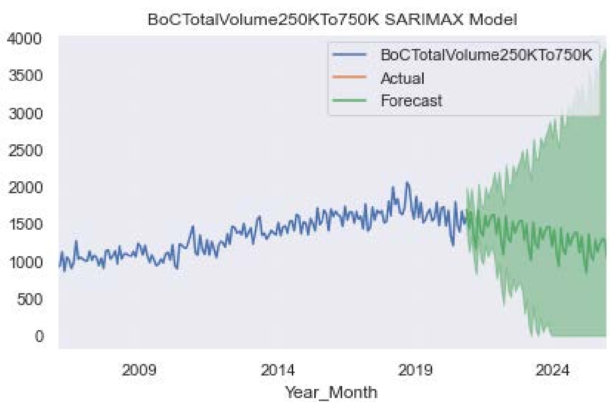

MT205TotalVolumeOver1M SARIMAX Model
MT205TotalVolumeOver1M
Actual
Forecast
700000
600000
500000
400000
300000
200000
100000
0
2009
2014
2019
2024
Year_Month

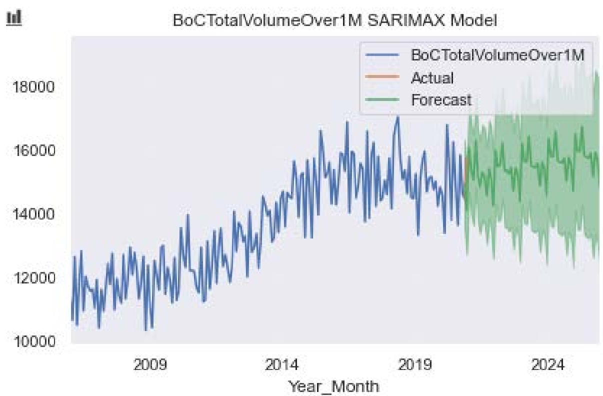

BoCTotalVolumeLessThan10K SARIMAX Model
BoCTotalVolumeLessThan10K
Actual
Forecast
17500
15000
12500
10000
7500
5000
2500
0
2009
2014
2019
2024
Year_Month

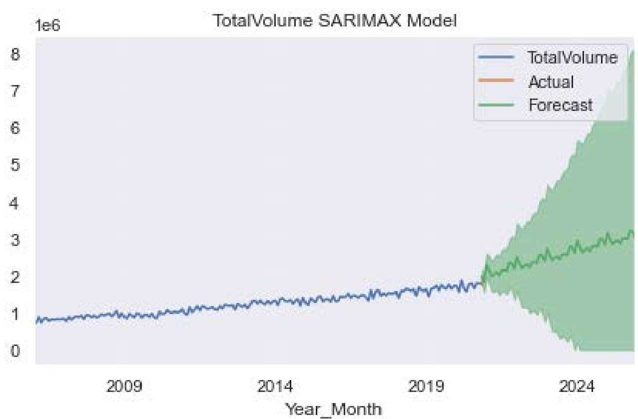

BoCTotalVolume10KTo25K SARIMAX Model
BoCTotalVolume10KTo25K
Actual
Forecast
2000
1500
1000
500
0
2009
2014
2019
2024
Year_Month


BoCTotalVolume25KTo50K SARIMAX Model
BoCTotalVolume25KTo50K
Actual
Forecast
2000
1750
1500
1250
1000
750
500
250
0
2009
2014
2019
2024
Year_Month

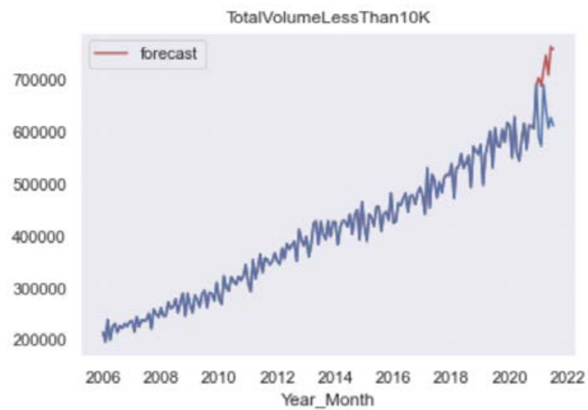

BoCTotalVolume50KTo250K SARIMAX Model
BoCTotalVolume50KTo250K
Actual
Forecast
10000
8000
6000
4000
2000
0
2009
2014
2019
2024
Year_Month

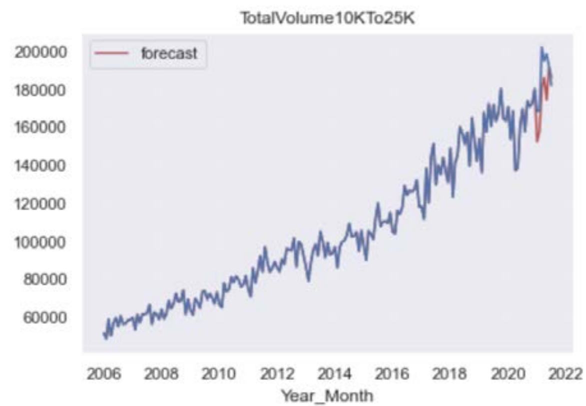

BoCTotalVolume250KTo750K SARIMAX Model
BoCTotalVolume250KTo750K
Actual
Forecast
4000
3500
3000
2500
2000
1500
1000
500
0
2009
2014
2019
2024
Year_Month

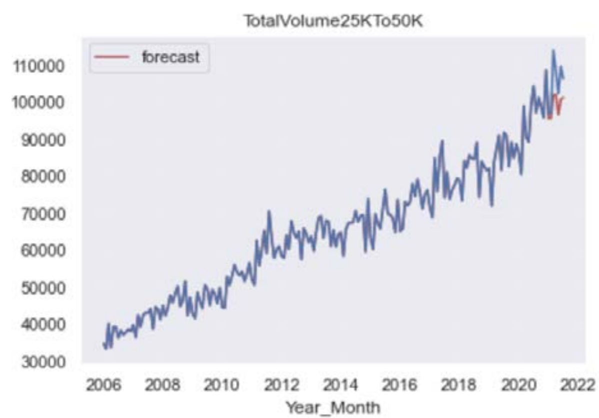

BoCTotalVolumeOver1M SARIMAX Model
BoCTotalVolumeOver1M
Actual
Forecast
18000
16000
14000
12000
10000
2009
2014
2019
2024
Year_Month

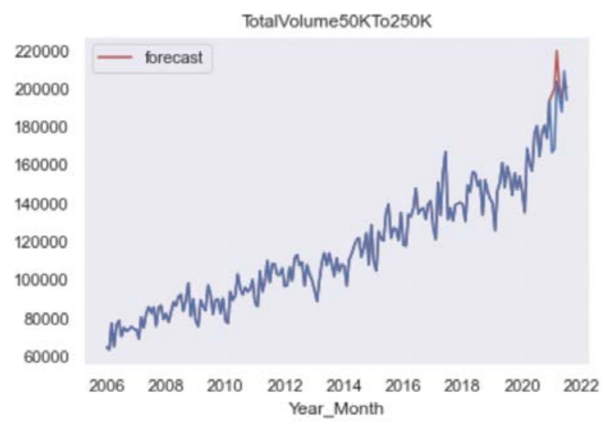

TotalVolume SARIMAX Model
1e6
TotalVolume
Actual
Forecast
8
7
6
5
4
3
2
1
0
2009
2014
2019
2024
Year_Month

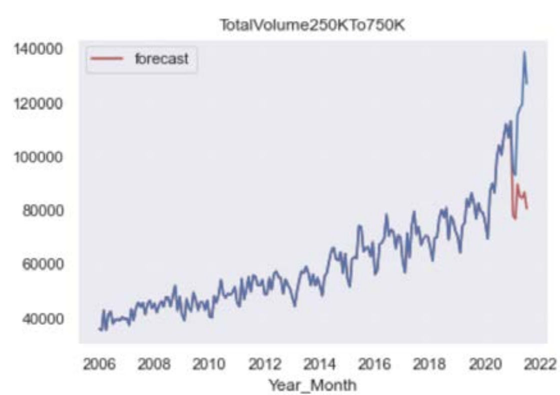
## Appendix 1.2.2. LVTS Volume Forecast Validation

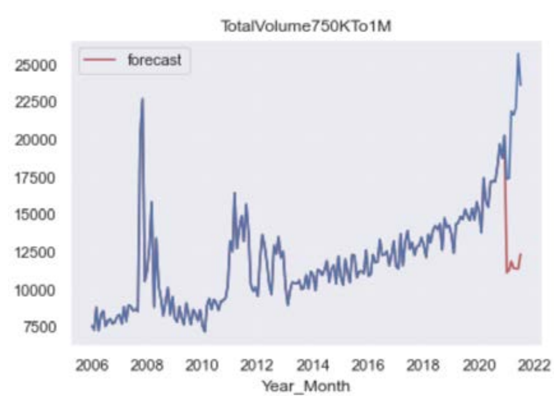


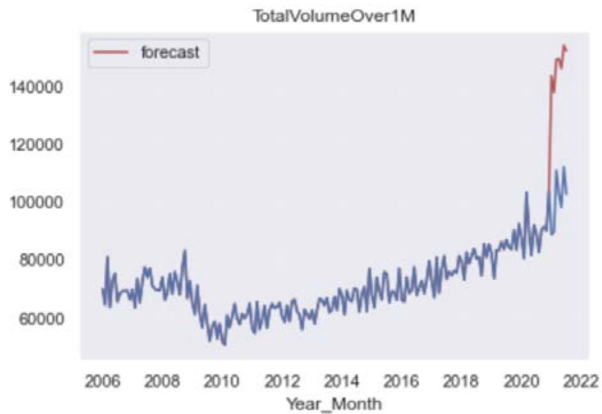



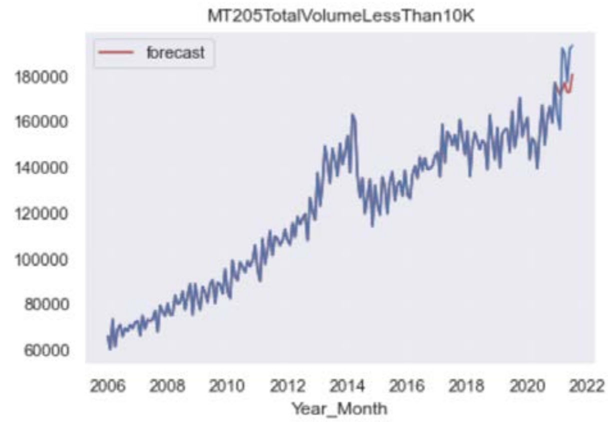



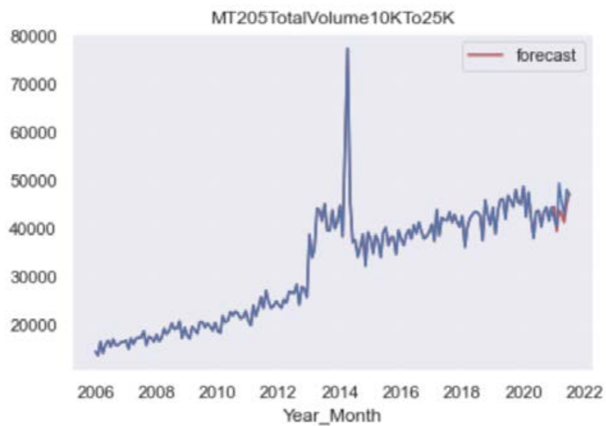



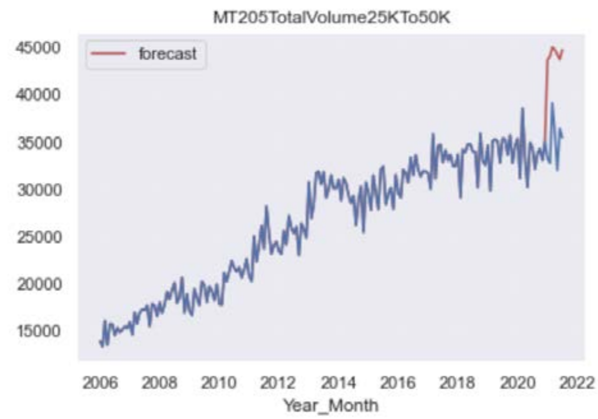



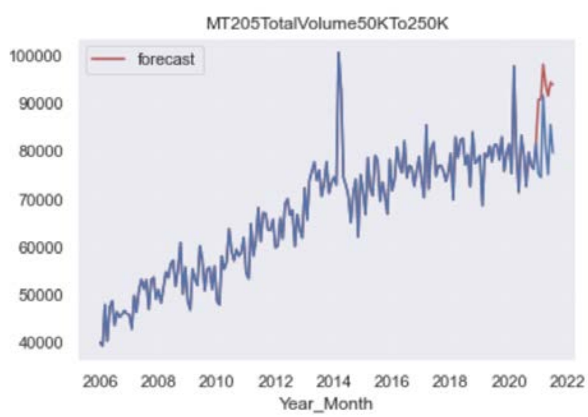



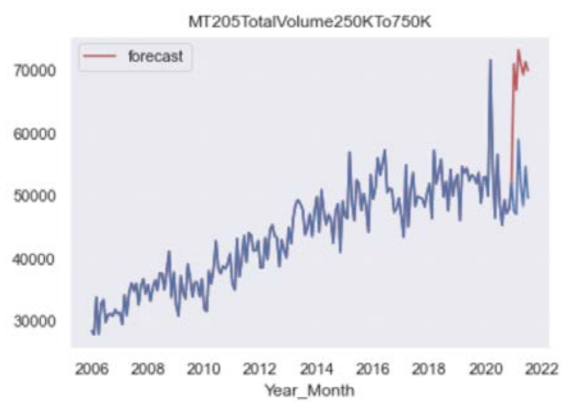

TotalVolumeOver1M
forecast
140000
120000
100000
80000
60000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

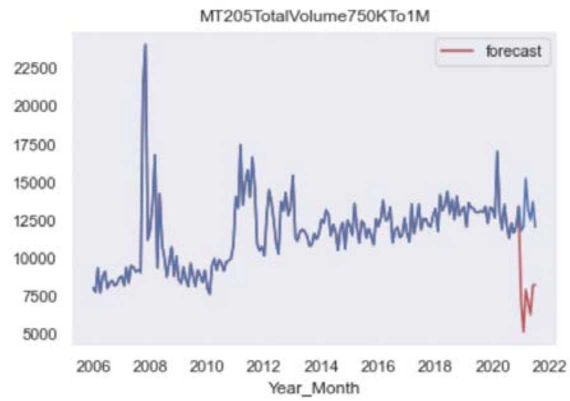

MT205TotalVolumeLessThan10K
forecast
180000
160000
140000
120000
100000
80000
60000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

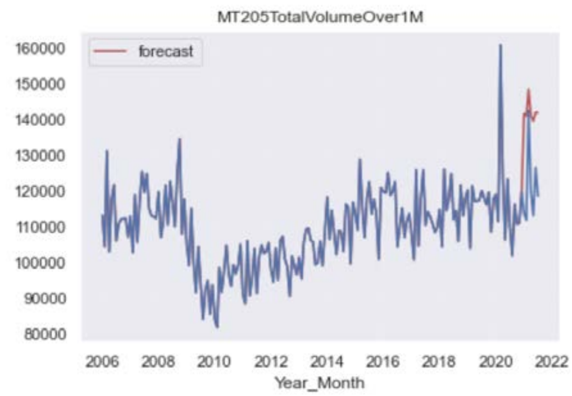

MT205TotalVolume10KTo25K
forecast
80000
70000
60000
50000
40000
30000
20000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

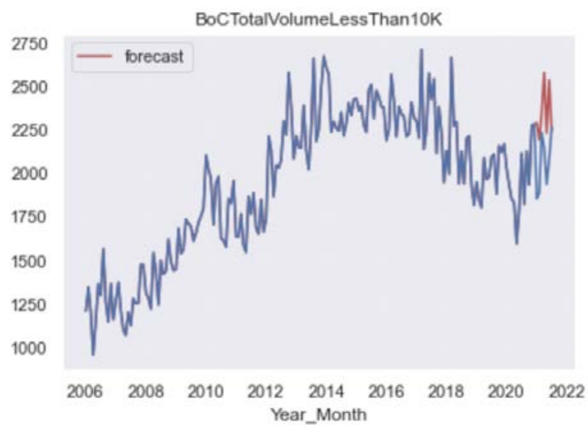

MT205TotalVolume25KTo50K
forecast
45000
40000
35000
30000
25000
20000
15000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

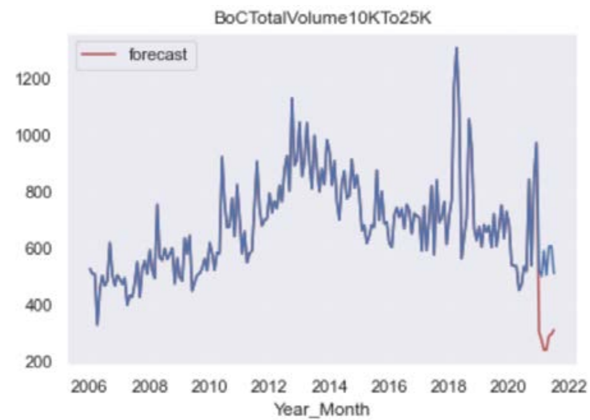

MT205TotalVolume50KTo250K
forecast
100000
90000
80000
70000
60000
50000
40000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month


MT205TotalVolume250KTo750K
forecast
70000
60000
50000
40000
30000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

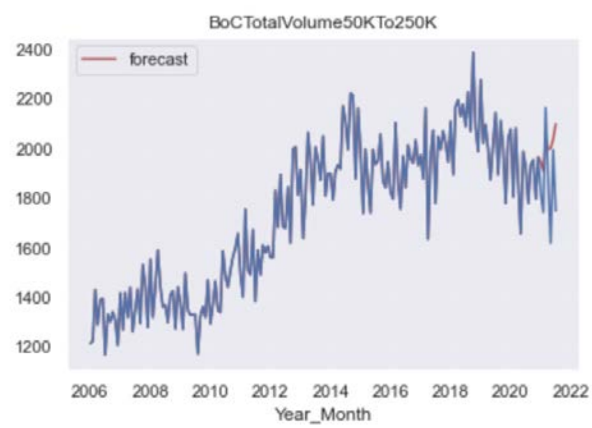

MT205TotalVolume750KTo1M
forecast
22500
20000
17500
15000
12500
10000
7500
5000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

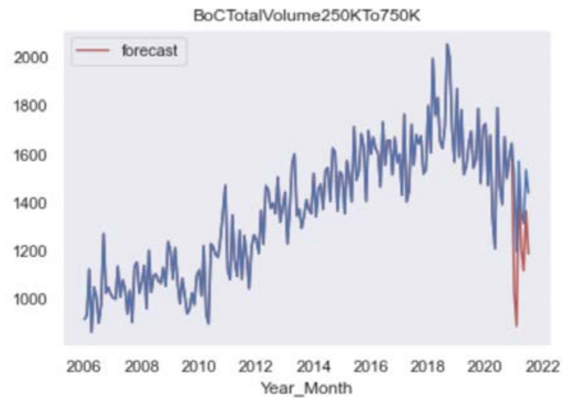

MT205TotalVolumeOver1M
forecast
160000
150000
140000
130000
120000
110000
100000
90000
80000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

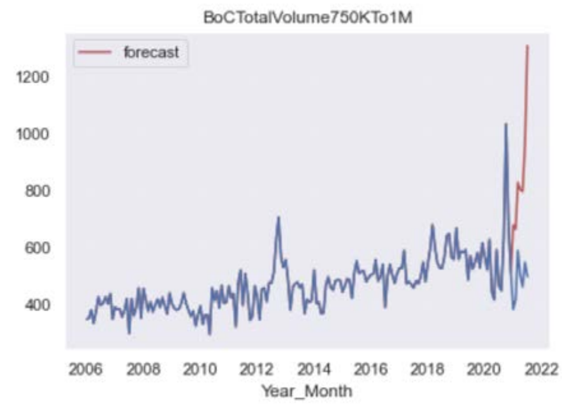

BoCTotalVolumeLessThan10K
forecast
2750
2500
2250
2000
1750
1500
1250
1000
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

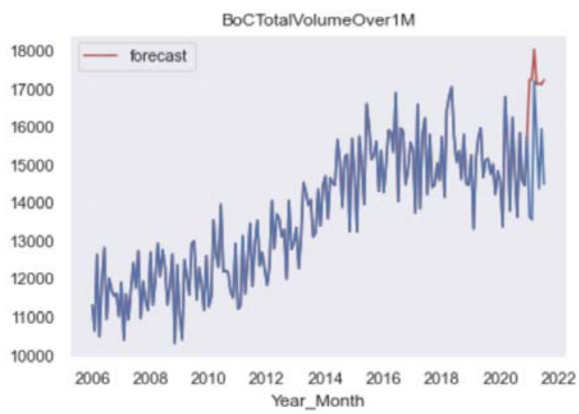

BoCTotalVolume10KTo25K
forecast
1200
1000
800
600
400
200
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month

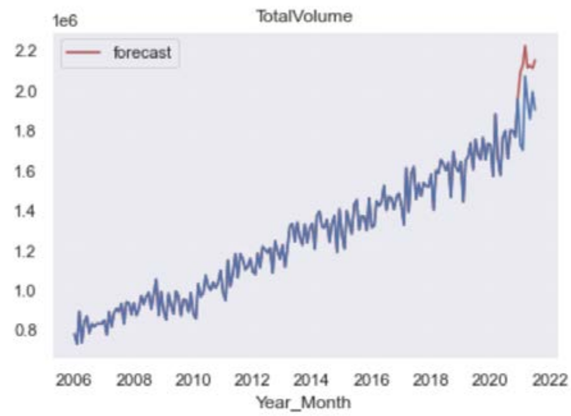

BoCTotalVolume25KTo50K
forecast
1000
900
800
700
600
500
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month


BoCTotalVolume50KTo250K
forecast
2400
2200
2000
1800
1600
1400
1200
2006 2008 2010 2012 2014 2016 2018 2020 2022
Year_Month




## Appendix 2. Forecasts with COVID and Migration Impacts under VAR model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.579444e+10 | 1.039470e+09 | 1.071520e+07 | 1.684462e+10 | 0.937655 | 0.061709 | 0.000636 |
| **2022** | 1.624401e+10 | 1.379863e+09 | 1.143903e+07 | 1.763532e+10 | 0.921107 | 0.078244 | 0.000649 |
| **2023** | 1.702822e+10 | 1.852569e+09 | 1.238059e+07 | 1.889317e+10 | 0.901290 | 0.098055 | 0.000655 |
| **2024** | 1.868161e+10 | 2.495283e+09 | 1.356637e+07 | 2.119046e+10 | 0.881605 | 0.117755 | 0.000640 |
| **2025** | 2.207604e+10 | 3.358934e+09 | 1.505264e+07 | 2.545003e+10 | 0.867427 | 0.131982 | 0.000591 |

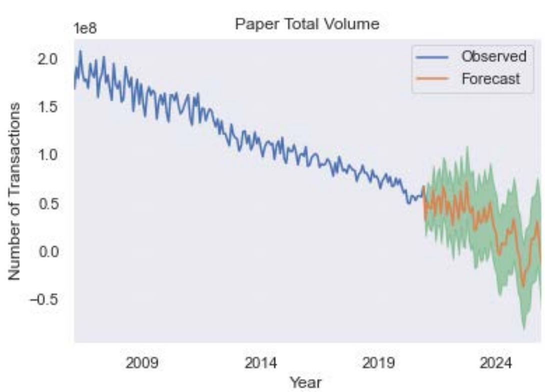
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

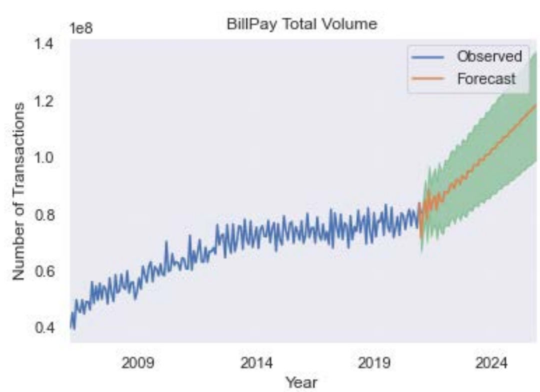
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.810911e+10 | 1.114154e+09 | 1.148411e+07 | 1.923475e+10 | 0.941479 | 0.057924 | 0.000597 |
| **2022** | 1.927467e+10 | 1.504265e+09 | 1.243653e+07 | 2.079137e+10 | 0.927051 | 0.072350 | 0.000598 |
| **2023** | 2.028002e+10 | 2.028306e+09 | 1.348492e+07 | 2.232181e+10 | 0.908529 | 0.090867 | 0.000604 |
| **2024** | 2.208288e+10 | 2.738372e+09 | 1.475538e+07 | 2.483601e+10 | 0.889148 | 0.110258 | 0.000594 |
| **2025** | 2.565355e+10 | 3.692431e+09 | 1.633223e+07 | 2.936231e+10 | 0.873690 | 0.125754 | 0.000556 |

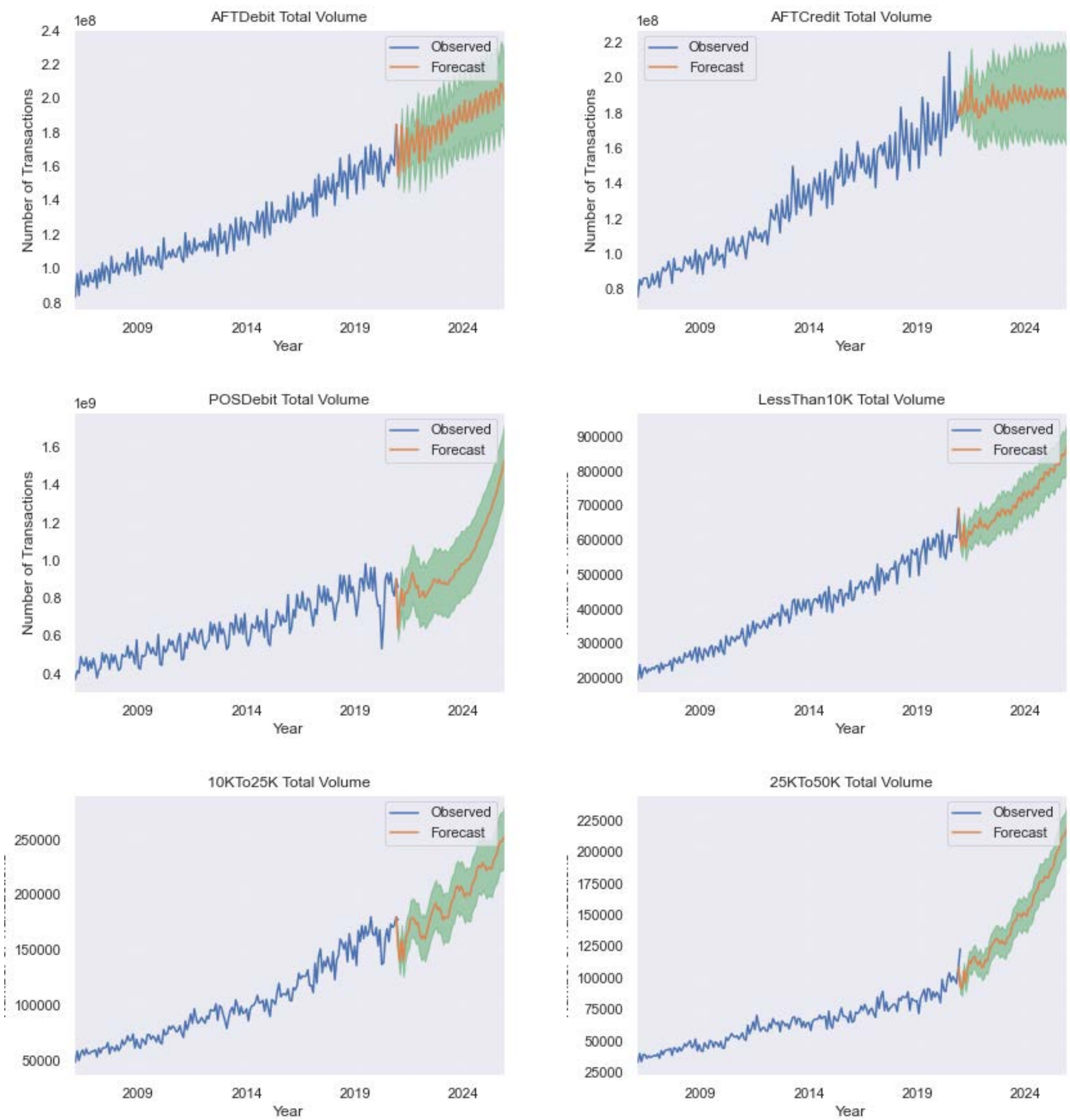
**Volume Market Share with COVID impacts and Migrations in Next 5 Years ( Lower Bound for RTR)**

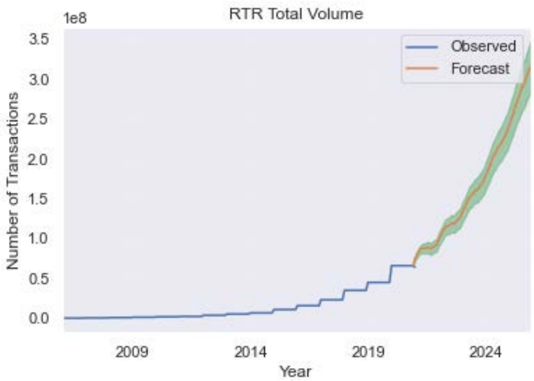
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.347976e+10 | 9.647860e+08 | 9.946286e+06 | 1.445450e+10 | 0.932565 | 0.066746 | 0.000688 |
| **2022** | 1.321336e+10 | 1.255460e+09 | 1.044153e+07 | 1.447926e+10 | 0.912571 | 0.086707 | 0.000721 |
| **2023** | 1.377641e+10 | 1.676831e+09 | 1.127626e+07 | 1.546452e+10 | 0.890840 | 0.108431 | 0.000729 |
| **2024** | 1.528034e+10 | 2.252193e+09 | 1.237736e+07 | 1.754491e+10 | 0.870927 | 0.128367 | 0.000705 |
| **2025** | 1.849854e+10 | 3.025438e+09 | 1.377305e+07 | 2.153775e+10 | 0.858889 | 0.140471 | 0.000639 |

**Volume Market Share with COVID impacts and Migrations in Next 5 Years ( Upper Bound for RTR)**




AFTDebit Total Volume
1e8
Number of Transactions
Year
Observed
Forecast
2009
2014
2019
2024
AFTCredit Total Volume
1e8
Number of Transactions
Year
Observed
Forecast
POSDebit Total Volume
1e9
Number of Transactions
Year
Observed
Forecast
LessThan10K Total Volume
Year
Observed
Forecast
10KTo25K Total Volume
Year
Observed
Forecast
25KTo50K Total Volume
Year
Observed
Forecast




## Appendix 3. Forecasts with COVID and Migration Impacts under OLS model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.617561e+10 | 9.328913e+08 | 1.372453e+07 | 1.712223e+10 | 0.944714 | 0.054484 | 0.000802 |
| **2022** | 1.680719e+10 | 1.102313e+09 | 1.460180e+07 | 1.792410e+10 | 0.937686 | 0.061499 | 0.000815 |
| **2023** | 1.746618e+10 | 1.277275e+09 | 1.551346e+07 | 1.875897e+10 | 0.931084 | 0.068089 | 0.000827 |
| **2024** | 1.815821e+10 | 1.458102e+09 | 1.645969e+07 | 1.963277e+10 | 0.924893 | 0.074269 | 0.000838 |
| **2025** | 1.884408e+10 | 1.644415e+09 | 1.744050e+07 | 2.050594e+10 | 0.918957 | 0.080192 | 0.000851 |

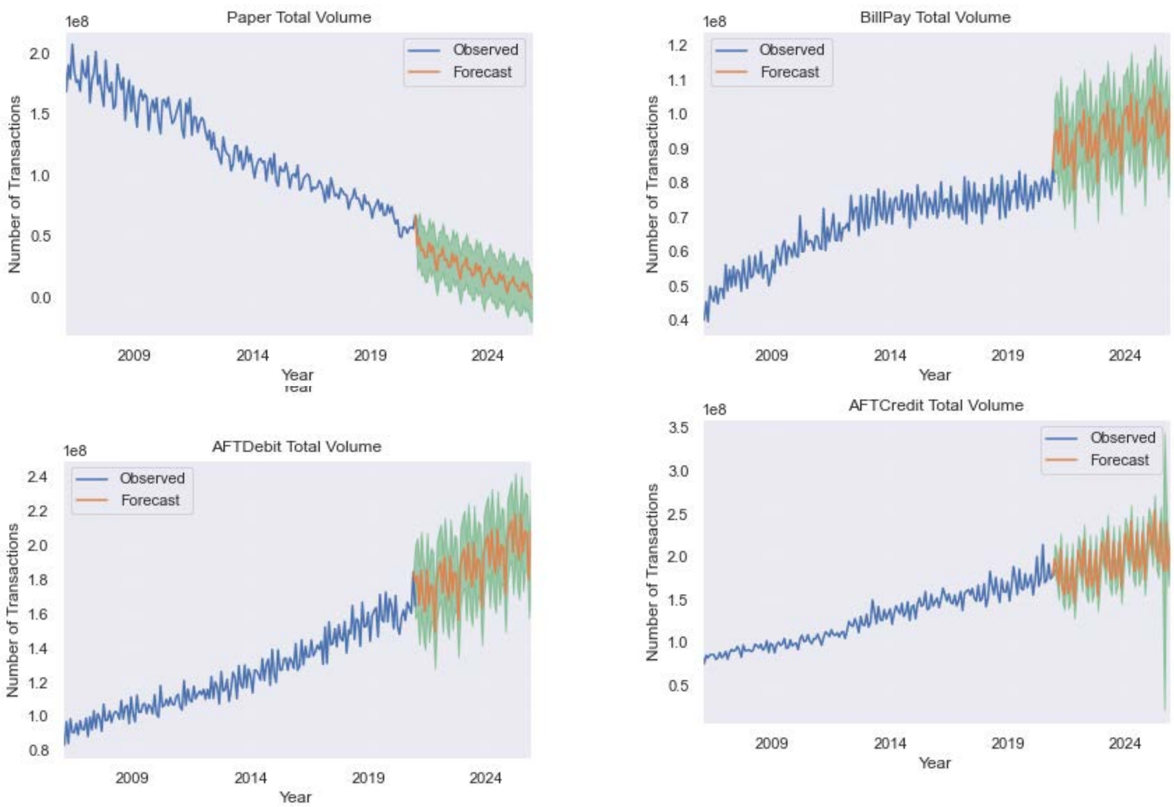
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

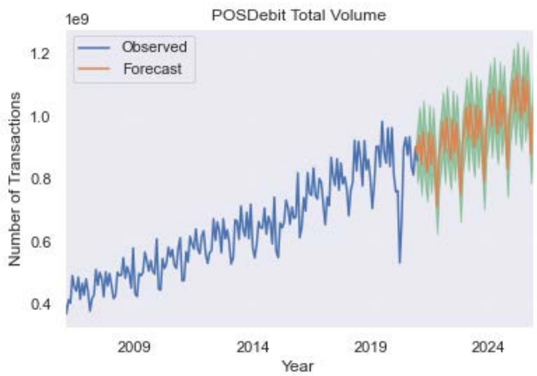
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.813628e+10 | 1.007526e+09 | 1.438919e+07 | 1.915820e+10 | 0.946659 | 0.052590 | 0.000751 |
| **2022** | 1.878916e+10 | 1.184750e+09 | 1.526549e+07 | 1.998917e+10 | 0.939967 | 0.059270 | 0.000764 |
| **2023** | 1.946928e+10 | 1.367453e+09 | 1.617779e+07 | 2.085291e+10 | 0.933648 | 0.065576 | 0.000776 |
| **2024** | 2.018265e+10 | 1.556238e+09 | 1.712679e+07 | 2.175601e+10 | 0.927681 | 0.071531 | 0.000787 |
| **2025** | 2.103444e+10 | 1.751059e+09 | 1.811307e+07 | 2.280361e+10 | 0.922417 | 0.076789 | 0.000794 |

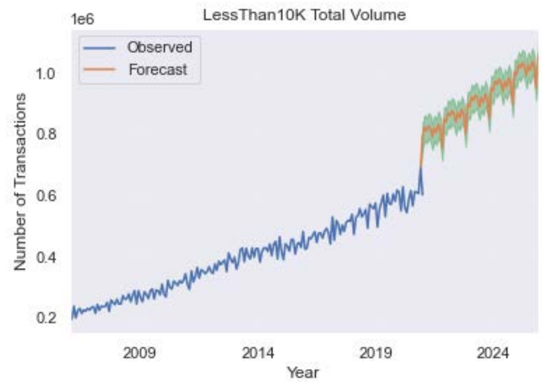
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)**

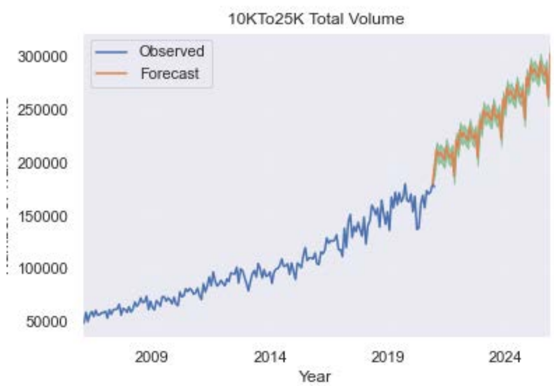
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.421495e+10 | 8.582565e+08 | 1.305987e+07 | 1.508626e+10 | 0.942244 | 0.056890 | 0.000866 |
| **2022** | 1.482522e+10 | 1.019877e+09 | 1.393811e+07 | 1.585904e+10 | 0.934812 | 0.064309 | 0.000879 |
| **2023** | 1.546307e+10 | 1.187096e+09 | 1.484914e+07 | 1.666502e+10 | 0.927876 | 0.071233 | 0.000891 |
| **2024** | 1.613377e+10 | 1.359965e+09 | 1.579260e+07 | 1.750953e+10 | 0.921428 | 0.077670 | 0.000902 |
| **2025** | 1.665372e+10 | 1.537770e+09 | 1.676793e+07 | 1.820826e+10 | 0.914625 | 0.084455 | 0.000921 |

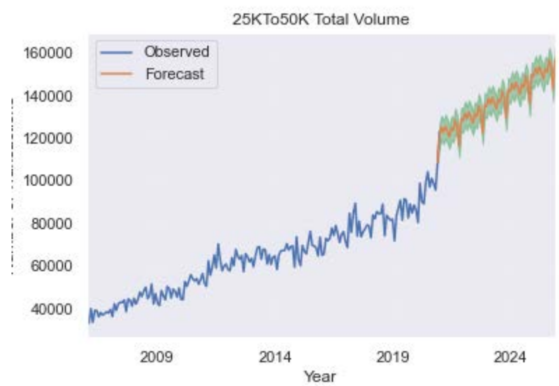
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)**

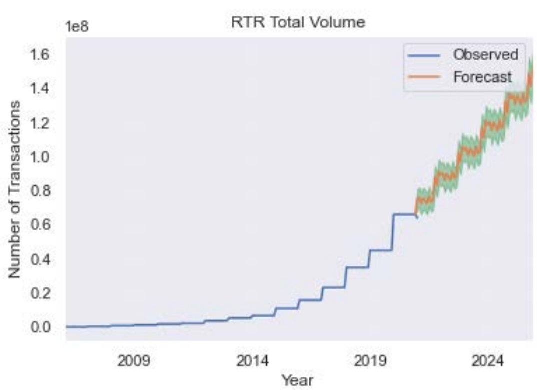



POSDebit Total Volume
1e9
Observed
Forecast
Number of Transactions
Year


LessThan10K Total Volume
1e6
Observed
Forecast
Number of Transactions
Year

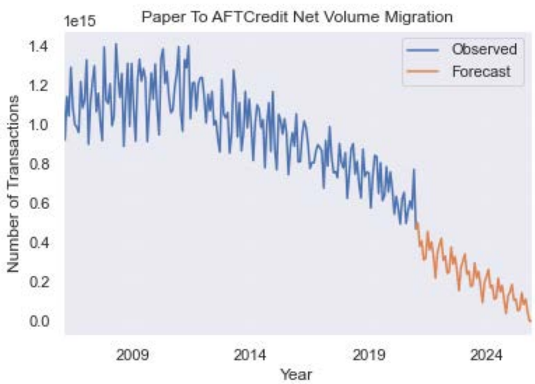

10KTo25K Total Volume
Observed
Forecast
Year

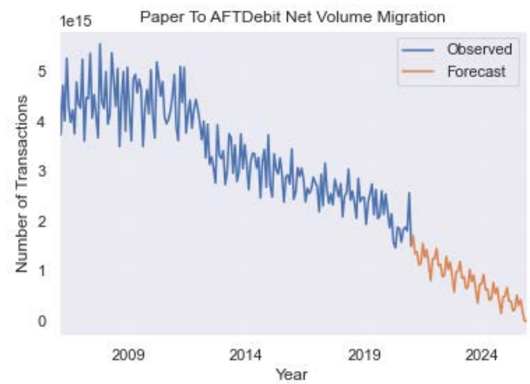

25KTo50K Total Volume
Observed
Forecast
Year

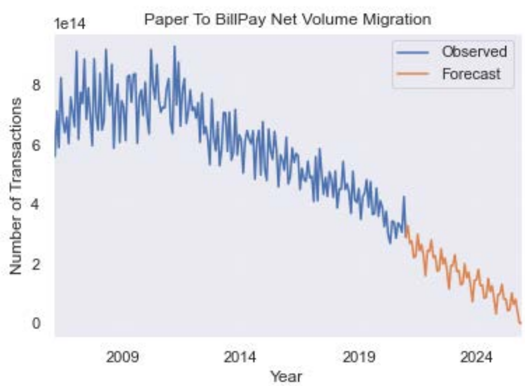

RTR Total Volume
1e8
Observed
Forecast
Number of Transactions
Year

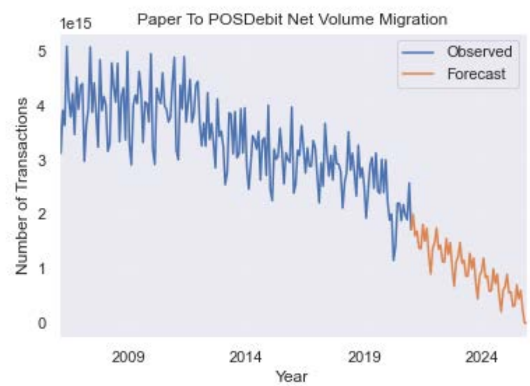
## Appendix 4. Migration Model Baseline

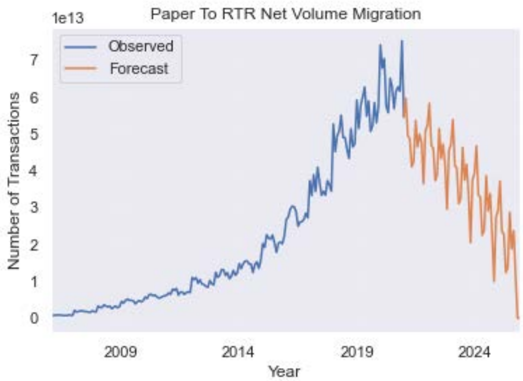
### Appendix 4.1. Migration Model Baseline - ACSS Net Migration

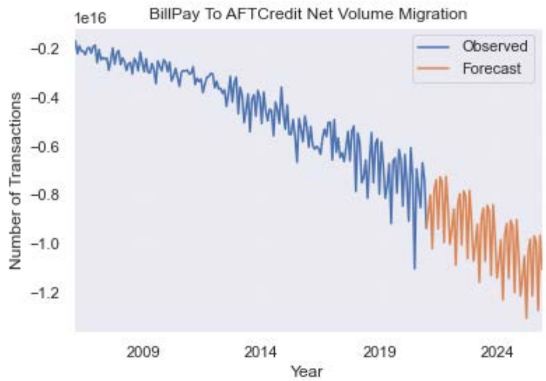


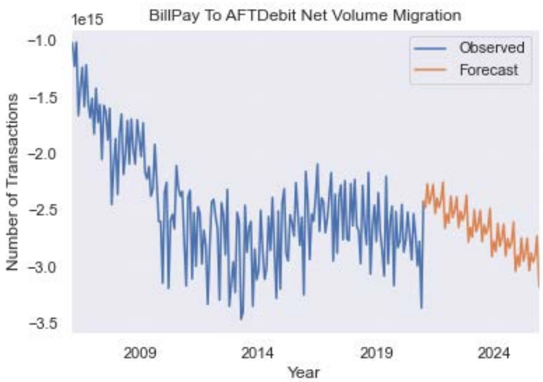



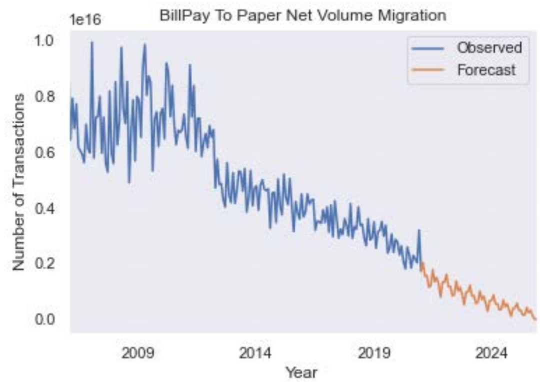



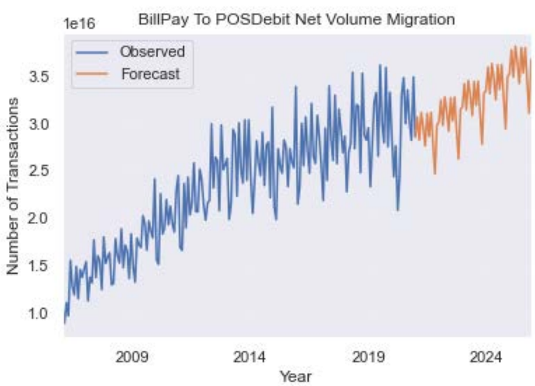



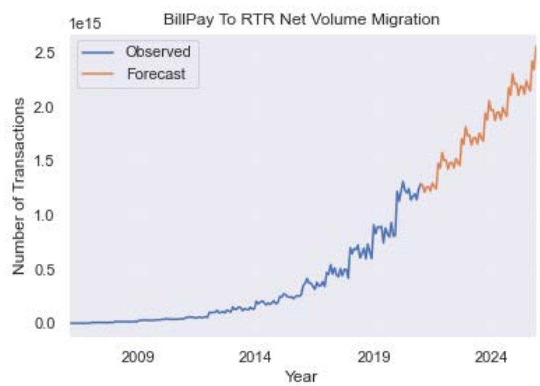

Paper To RTR Net Volume Migration
1e13
Observed
Forecast
Number of Transactions
Year
0
1
2
3
4
5
6
7
2009
2014
2019
2024

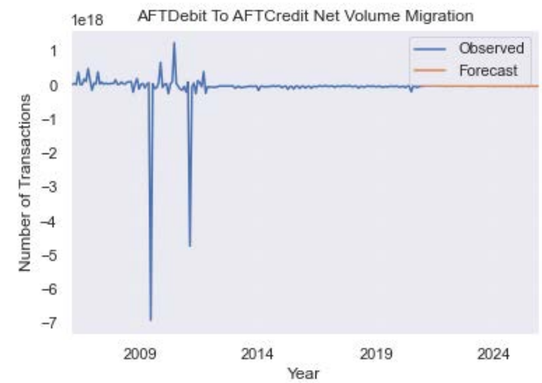

BillPay To AFTCredit Net Volume Migration
1e16
Observed
Forecast
Number of Transactions
Year
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
2009
2014
2019
2024

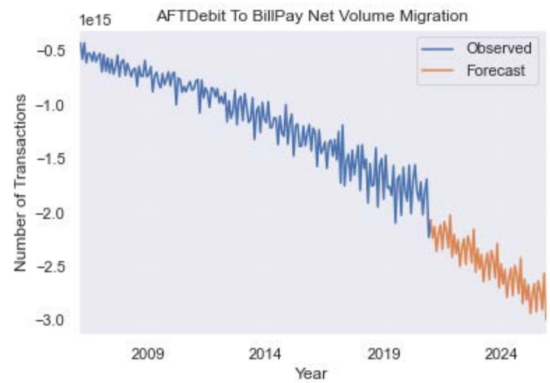

BillPay To AFTDebit Net Volume Migration
1e15
Observed
Forecast
Number of Transactions
Year
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
2009
2014
2019
2024

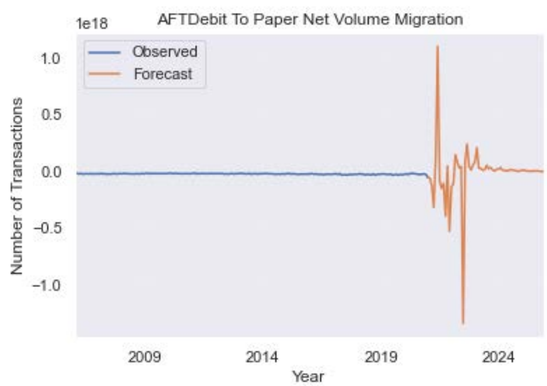

BillPay To Paper Net Volume Migration
1e16
Observed
Forecast
Number of Transactions
Year
1.0
0.8
0.6
0.4
0.2
0.0
2009
2014
2019
2024

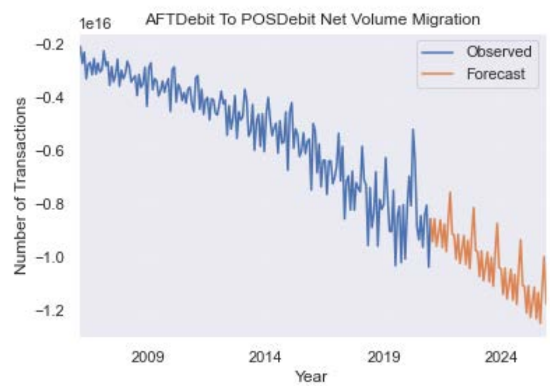

BillPay To POSDebit Net Volume Migration
1e16
Observed
Forecast
Number of Transactions
Year
3.5
3.0
2.5
2.0
1.5
1.0
2009
2014
2019
2024

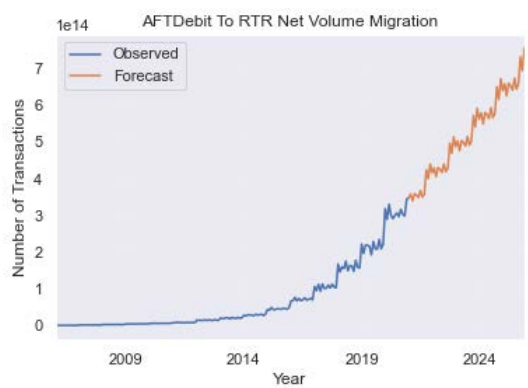

BillPay To RTR Net Volume Migration
1e15
Observed
Forecast
Number of Transactions
Year
2.5
2.0
1.5
1.0
0.5
0.0
2009
2014
2019
2024

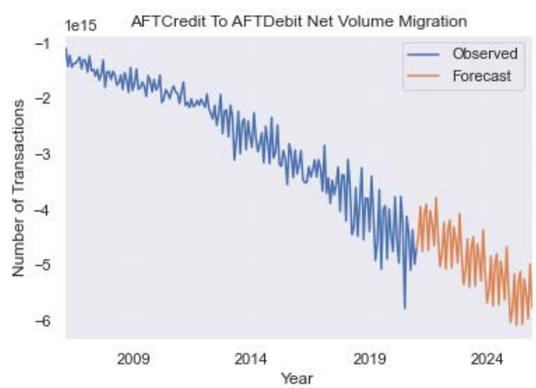

AFTDebit To AFTCredit Net Volume Migration
1e18
Number of Transactions
Year
Observed
Forecast

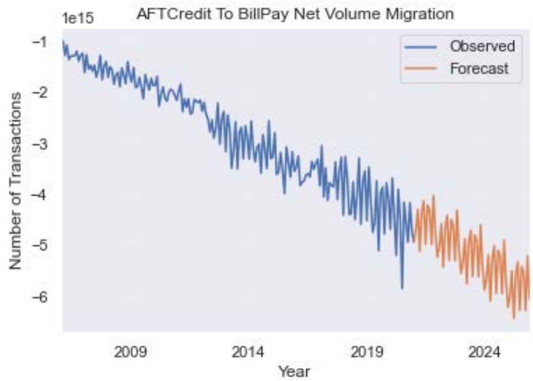

AFTDebit To BillPay Net Volume Migration
1e15
Number of Transactions
Year
Observed
Forecast

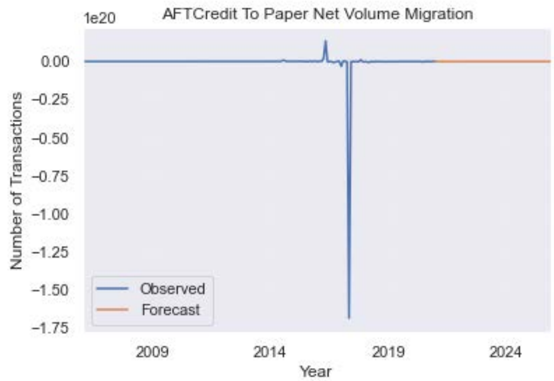

AFTDebit To Paper Net Volume Migration
1e18
Number of Transactions
Year
Observed
Forecast

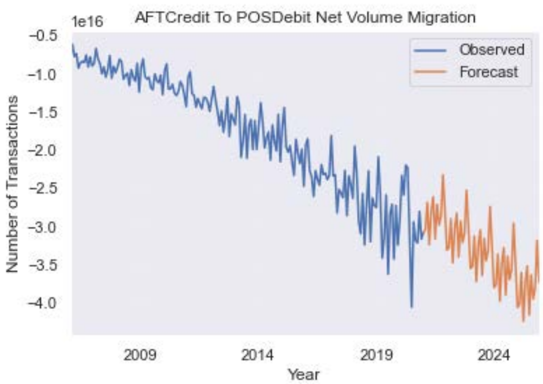

AFTDebit To POSDebit Net Volume Migration
1e16
Number of Transactions
Year
Observed
Forecast

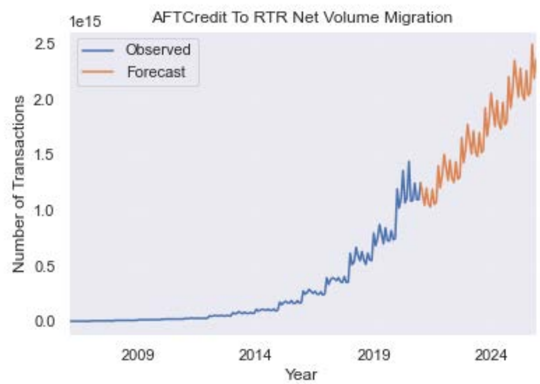

AFTDebit To RTR Net Volume Migration
1e14
Number of Transactions
Year
Observed
Forecast

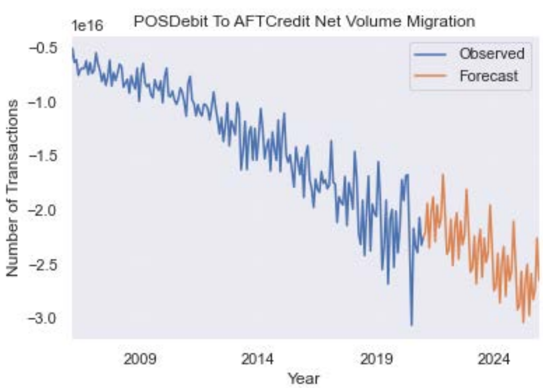

AFTCredit To AFTDebit Net Volume Migration
1e15
Number of Transactions
Year
Observed
Forecast

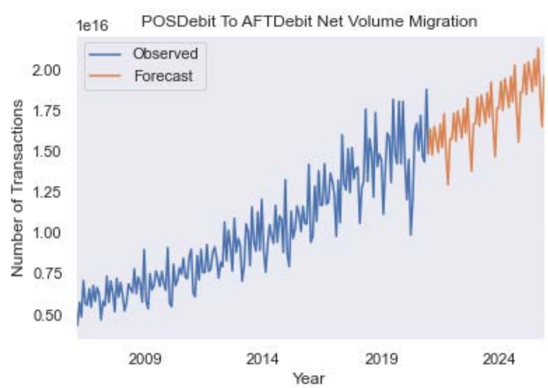

AFTCredit To BillPay Net Volume Migration
1e15
Number of Transactions
Year
Observed
Forecast
-1
-2
-3
-4
-5
-6
2009
2014
2019
2024

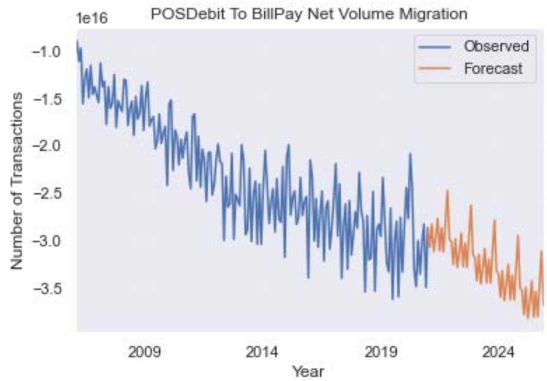

AFTCredit To Paper Net Volume Migration
1e20
Number of Transactions
Year
Observed
Forecast
0.00
-0.25
-0.50
-0.75
-1.00
-1.25
-1.50
-1.75
2009
2014
2019
2024

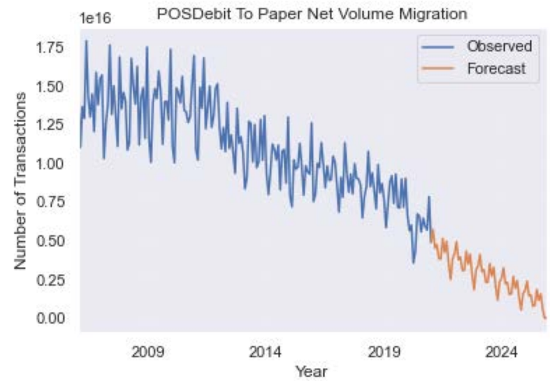

AFTCredit To POSDebit Net Volume Migration
1e16
Number of Transactions
Year
Observed
Forecast
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
-3.5
-4.0
2009
2014
2019
2024

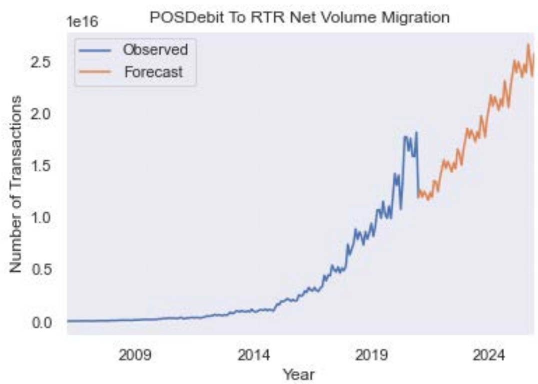

AFTCredit To RTR Net Volume Migration
1e15
Number of Transactions
Year
Observed
Forecast
2.5
2.0
1.5
1.0
0.5
0.0
2009
2014
2019
2024


POSDebit To AFTCredit Net Volume Migration
1e16
Number of Transactions
Year
Observed
Forecast
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
2009
2014
2019
2024

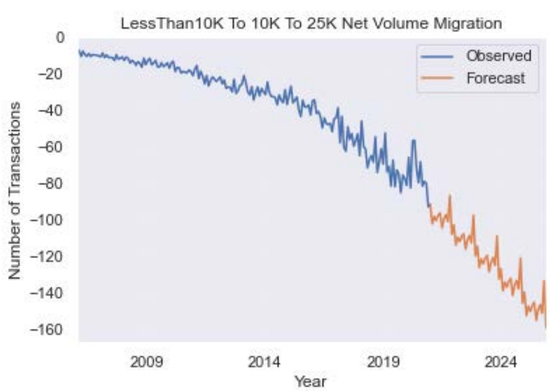

POSDebit To AFTDebit Net Volume Migration
1e16
Number of Transactions
Year
Observed
Forecast
2.00
1.75
1.50
1.25
1.00
0.75
0.50
2009
2014
2019
2024

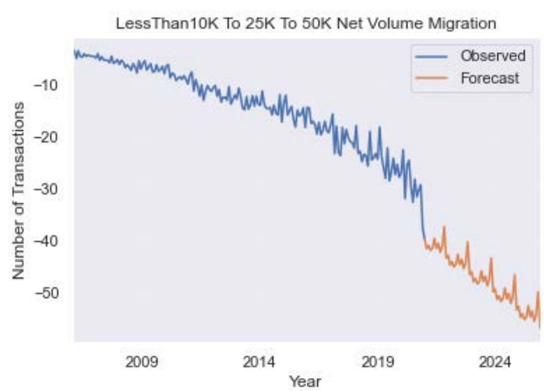


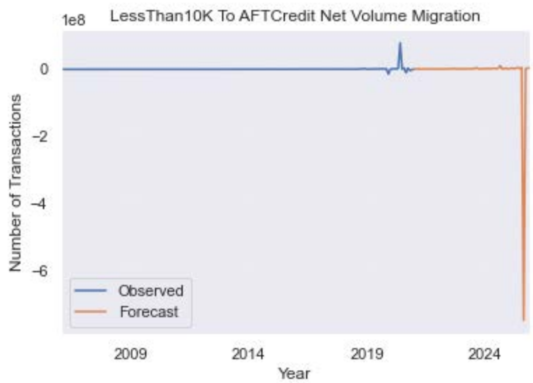



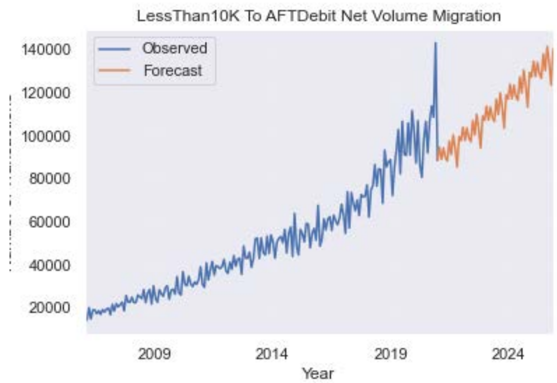



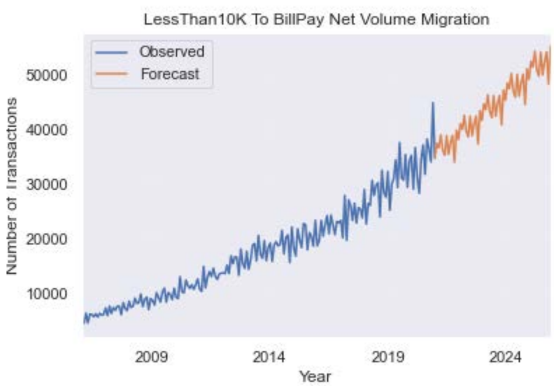

## Appendix 4.2. Migration Model Baseline - LVTS Net Migration

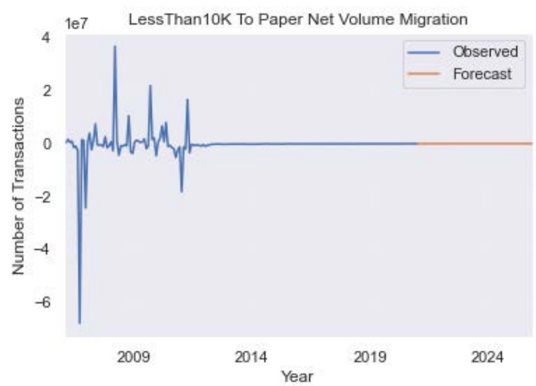


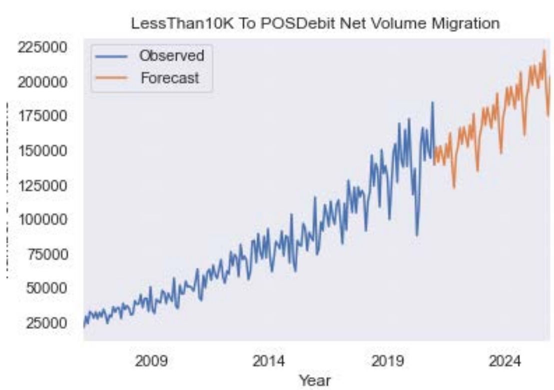



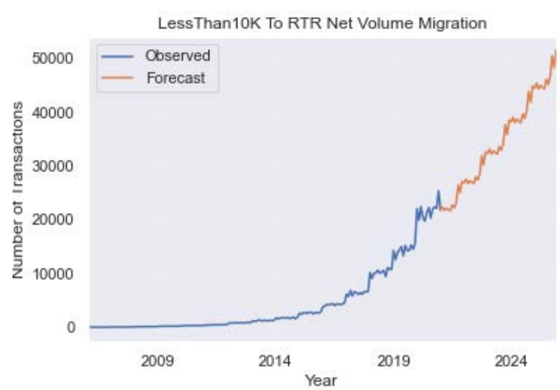

LessThan10K To AFTCredit Net Volume Migration
1e8
0
-2
-4
-6
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

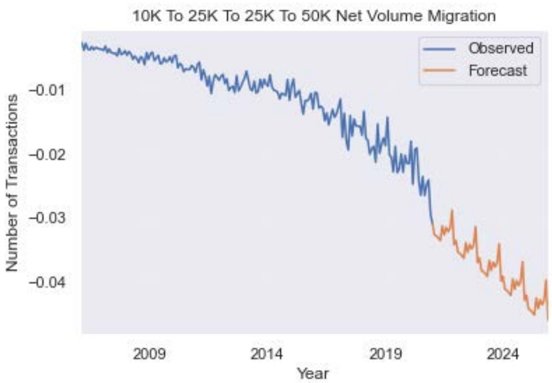

LessThan10K To AFTDebit Net Volume Migration
140000
120000
100000
80000
60000
40000
20000
Observed
Forecast
2009
2014
2019
2024
Year

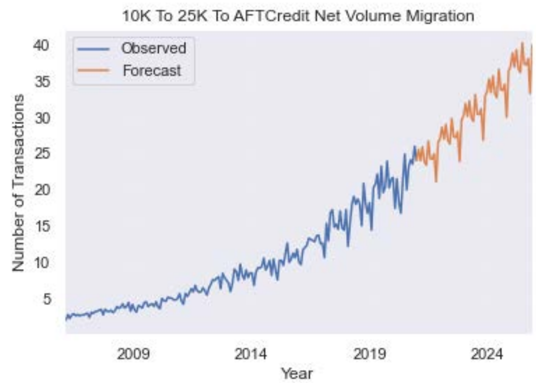

LessThan10K To BillPay Net Volume Migration
50000
40000
30000
20000
10000
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

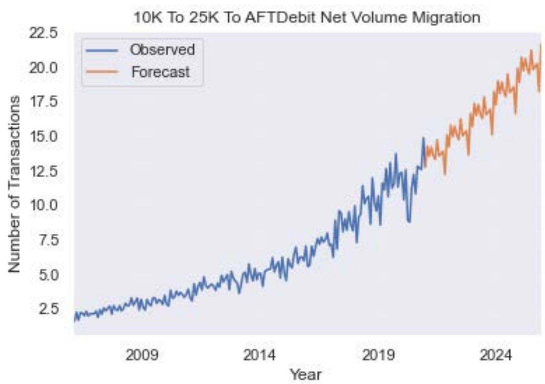

LessThan10K To Paper Net Volume Migration
1e7
4
2
0
-2
-4
-6
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

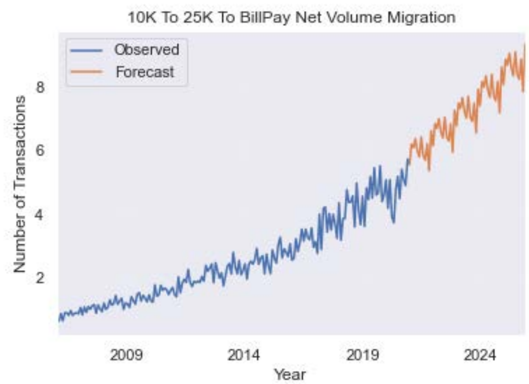

LessThan10K To POSDebit Net Volume Migration
225000
200000
175000
150000
125000
100000
75000
50000
25000
Observed
Forecast
2009
2014
2019
2024
Year

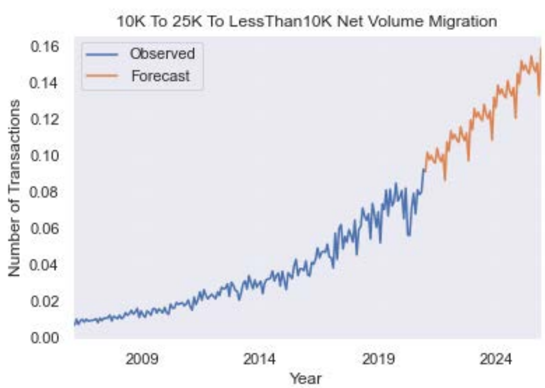

LessThan10K To RTR Net Volume Migration
50000
40000
30000
20000
10000
0
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

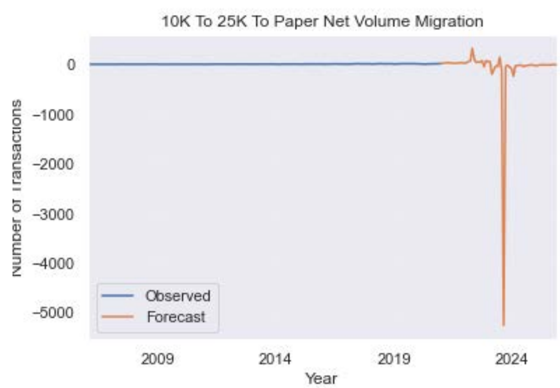

10K To 25K To 25K To 50K Net Volume Migration
Observed
Forecast
Number of Transactions
−0.01
−0.02
−0.03
−0.04
2009
2014
2019
2024
Year

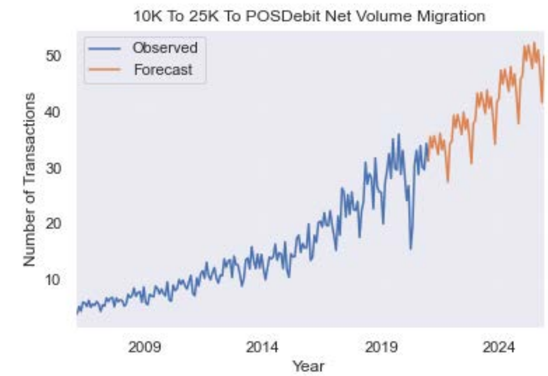

10K To 25K To AFTCredit Net Volume Migration
Observed
Forecast
Number of Transactions
40
35
30
25
20
15
10
5
2009
2014
2019
2024
Year

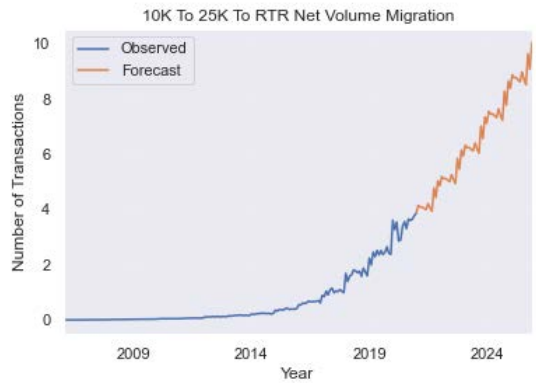

10K To 25K To AFTDebit Net Volume Migration
Observed
Forecast
Number of Transactions
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
2009
2014
2019
2024
Year

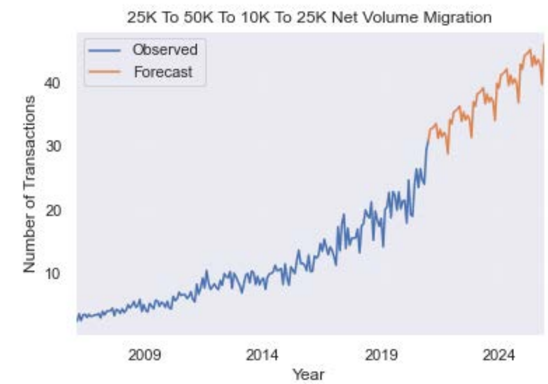

10K To 25K To BillPay Net Volume Migration
Observed
Forecast
Number of Transactions
8
6
4
2
2009
2014
2019
2024
Year

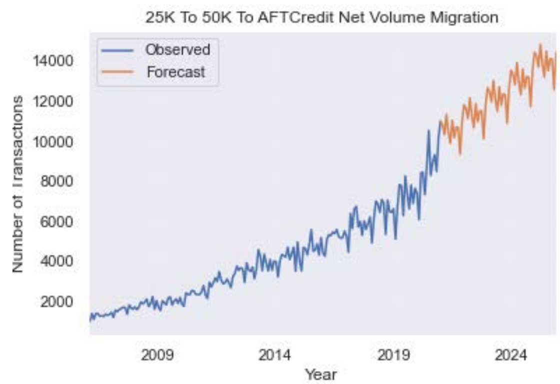

10K To 25K To LessThan10K Net Volume Migration
Observed
Forecast
Number of Transactions
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2009
2014
2019
2024
Year

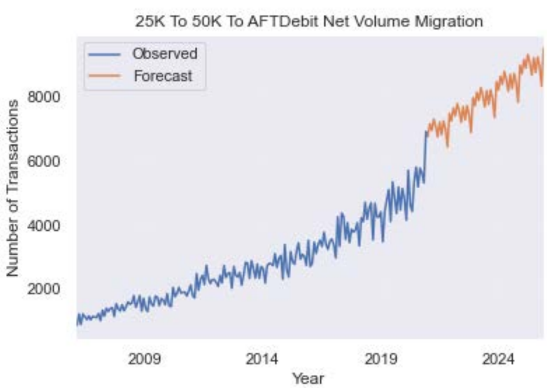

10K To 25K To Paper Net Volume Migration
Observed
Forecast
Number of Transactions
0
−1000
−2000
−3000
−4000
−5000
2009
2014
2019
2024
Year

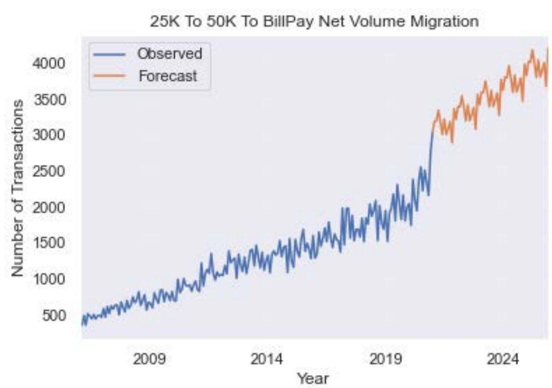

10K To 25K To POSDebit Net Volume Migration
Observed
Forecast
Number of Transactions
50
40
30
20
10
2009
2014
2019
2024
Year

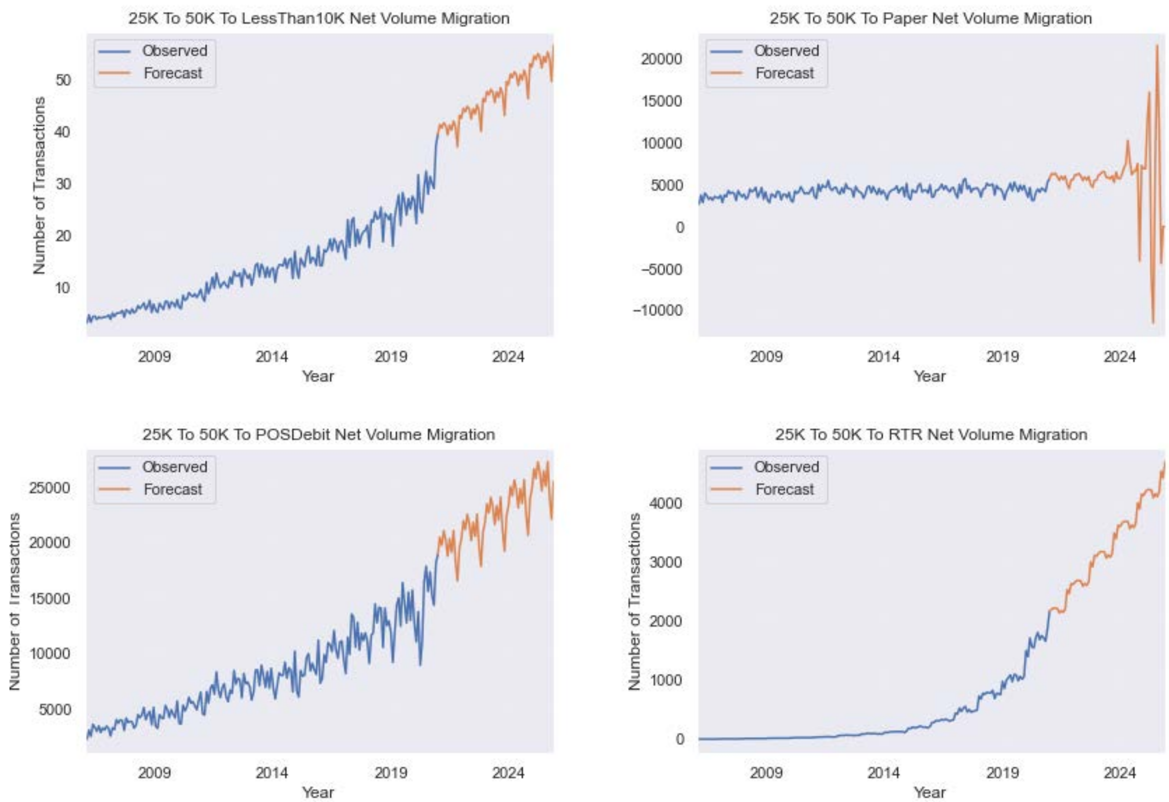

10K To 25K To RTR Net Volume Migration
Observed
Forecast
Number of Transactions
10
8
6
4
2
0
2009
2014
2019
2024
Year


25K To 50K To 10K To 25K Net Volume Migration
Observed
Forecast
Number of Transactions
40
30
20
10
2009
2014
2019
2024
Year


25K To 50K To AFTCredit Net Volume Migration
Observed
Forecast
Number of Transactions
14000
12000
10000
8000
6000
4000
2000
2009
2014
2019
2024
Year


25K To 50K To AFTDebit Net Volume Migration
Observed
Forecast
Number of Transactions
8000
6000
4000
2000
2009
2014
2019
2024
Year


25K To 50K To BillPay Net Volume Migration
Observed
Forecast
Number of Transactions
4000
3500
3000
2500
2000
1500
1000
500
2009
2014
2019
2024
Year




## Appendix 5. Sensitivity Analysis Scenario 1: Heavier Weight on End-User's Fee

### Appendix 5.1. Forecasts with COVID and Migration Impacts under VAR model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.470452e+10 | 1.039470e+09 | 1.071520e+07 | 1.575471e+10 | 0.933341 | 0.065978 | 0.000680 |
| 2022 | 1.475990e+10 | 1.379863e+09 | 1.143903e+07 | 1.615120e+10 | 0.913858 | 0.085434 | 0.000708 |
| 2023 | 1.498606e+10 | 1.852569e+09 | 1.238059e+07 | 1.685101e+10 | 0.889327 | 0.109938 | 0.000735 |
| 2024 | 1.566199e+10 | 2.495283e+09 | 1.356637e+07 | 1.817084e+10 | 0.861930 | 0.137323 | 0.000747 |
| 2025 | 1.720892e+10 | 3.358934e+09 | 1.505264e+07 | 2.058291e+10 | 0.836078 | 0.163190 | 0.000731 |

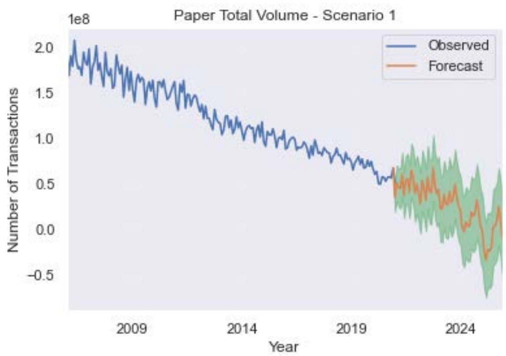
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

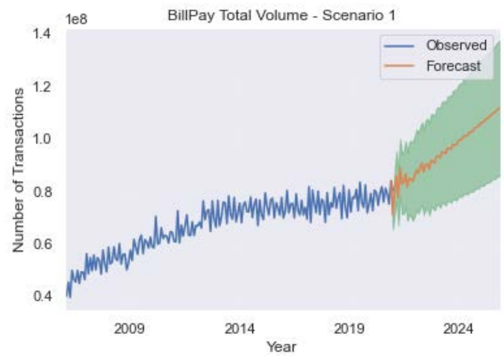
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.691975e+10 | 1.114154e+09 | 1.148411e+07 | 1.804539e+10 | 0.937622 | 0.061742 | 0.000636 |
| 2022 | 1.790816e+10 | 1.504265e+09 | 1.243653e+07 | 1.942486e+10 | 0.921920 | 0.077440 | 0.000640 |
| 2023 | 1.854960e+10 | 2.028306e+09 | 1.348492e+07 | 2.059140e+10 | 0.900843 | 0.098503 | 0.000655 |
| 2024 | 1.950247e+10 | 2.738372e+09 | 1.475538e+07 | 2.225560e+10 | 0.876295 | 0.123042 | 0.000663 |
| 2025 | 2.127808e+10 | 3.692431e+09 | 1.633223e+07 | 2.498684e+10 | 0.851571 | 0.147775 | 0.000654 |

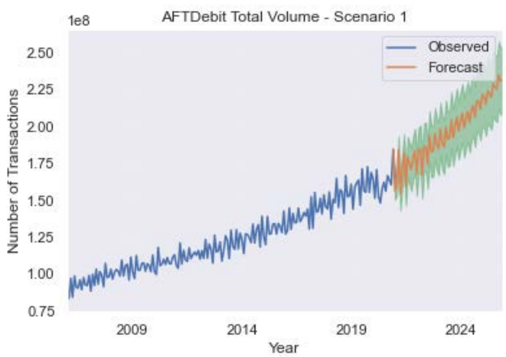
Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)

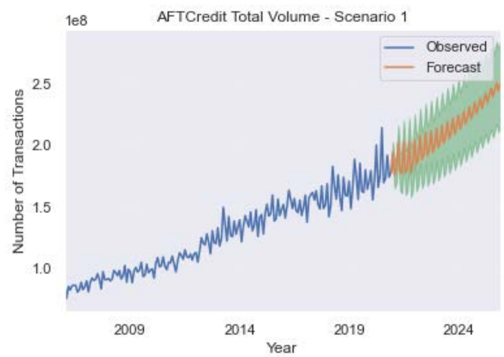
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.248929e+10 | 9.647860e+08 | 9.946286e+06 | 1.346403e+10 | 0.927605 | 0.071657 | 0.000739 |
| 2022 | 1.161164e+10 | 1.255460e+09 | 1.044153e+07 | 1.287755e+10 | 0.901697 | 0.097492 | 0.000811 |
| 2023 | 1.142252e+10 | 1.676831e+09 | 1.127626e+07 | 1.311062e+10 | 0.871241 | 0.127899 | 0.000860 |
| 2024 | 1.182150e+10 | 2.252193e+09 | 1.237736e+07 | 1.408607e+10 | 0.839233 | 0.159888 | 0.000879 |
| 2025 | 1.313977e+10 | 3.025438e+09 | 1.377305e+07 | 1.617898e+10 | 0.812151 | 0.186998 | 0.000851 |

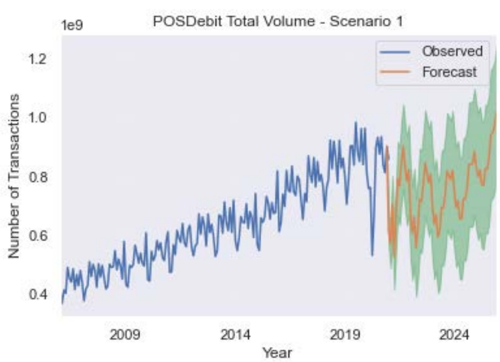
Volume Market Share with COVID impacts and Migrations in Next 5 Years (Upper Bound for RTR)

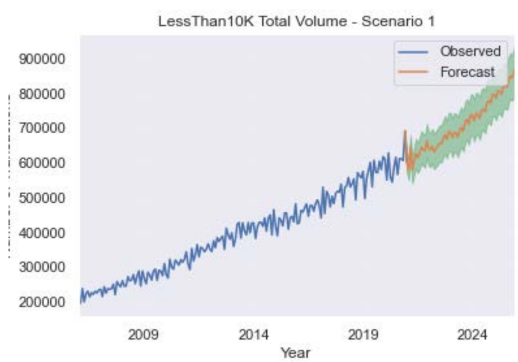

Paper Total Volume - Scenario 1
1e8
2.0
1.5
1.0
0.5
0.0
−0.5
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

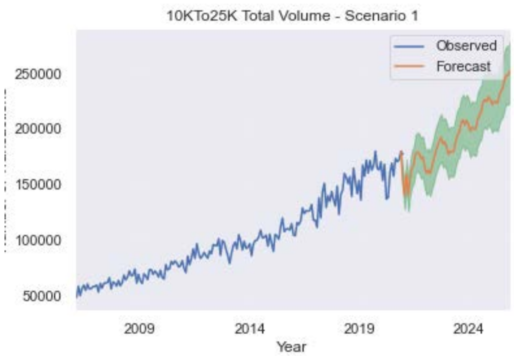

BillPay Total Volume - Scenario 1
1e8
1.4
1.2
1.0
0.8
0.6
0.4
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

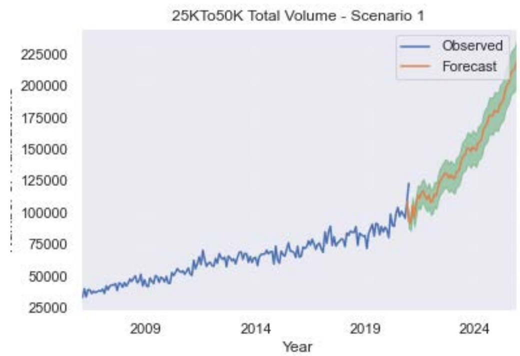

AFTDebit Total Volume - Scenario 1
1e8
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

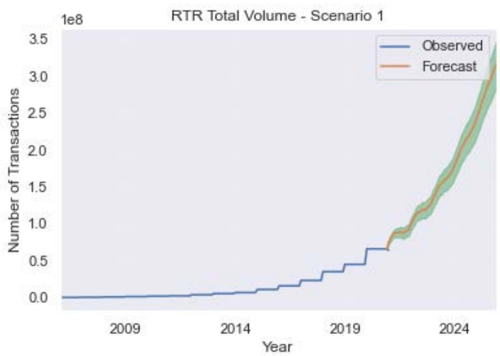

AFTCredit Total Volume - Scenario 1
1e8
2.5
2.0
1.5
1.0
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year


POSDebit Total Volume - Scenario 1
1e9
1.2
1.0
0.8
0.6
0.4
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year


LessThan10K Total Volume - Scenario 1
900000
800000
700000
600000
500000
400000
300000
200000
Observed
Forecast
2009
2014
2019
2024
Year




## Appendix 6. Sensitivity Analysis Scenario 1: Heavier Weight on End-User's Fee

### Appendix 6.1. Forecasts with COVID and Migration Impacts under OLS model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.527064e+10 | 8.733026e+08 | 1.372453e+07 | 1.615766e+10 | 0.945102 | 0.054049 | 0.000849 |
| **2022** | 1.583728e+10 | 1.036521e+09 | 1.460180e+07 | 1.688840e+10 | 0.937761 | 0.061375 | 0.000865 |
| **2023** | 1.641743e+10 | 1.205809e+09 | 1.551346e+07 | 1.763876e+10 | 0.930759 | 0.068361 | 0.000880 |
| **2024** | 1.700200e+10 | 1.380955e+09 | 1.645969e+07 | 1.839941e+10 | 0.924051 | 0.075054 | 0.000895 |
| **2025** | 1.750000e+10 | 1.561573e+09 | 1.744050e+07 | 1.907902e+10 | 0.917238 | 0.081848 | 0.000914 |

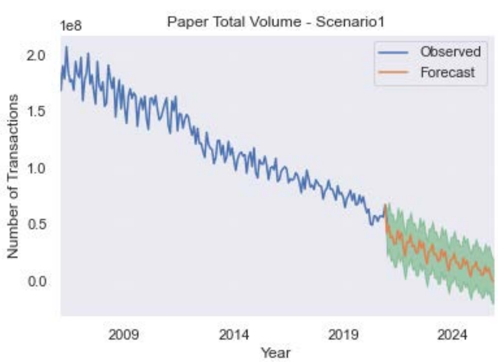
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

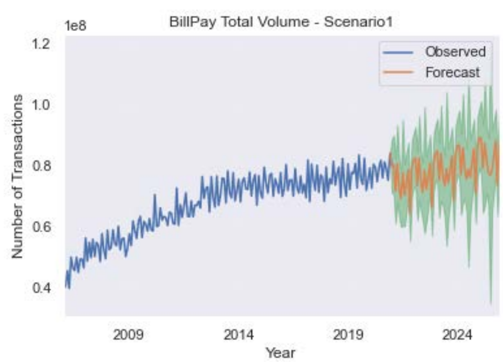
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.744999e+10 | 9.250436e+08 | 1.438919e+07 | 1.838942e+10 | 0.948915 | 0.050303 | 0.000782 |
| **2022** | 1.812726e+10 | 1.097921e+09 | 1.526549e+07 | 1.924045e+10 | 0.942143 | 0.057063 | 0.000793 |
| **2023** | 1.884368e+10 | 1.279695e+09 | 1.617779e+07 | 2.013955e+10 | 0.935655 | 0.063541 | 0.000803 |
| **2024** | 1.961455e+10 | 1.470875e+09 | 1.712679e+07 | 2.110255e+10 | 0.929487 | 0.069701 | 0.000812 |
| **2025** | 2.050649e+10 | 1.672933e+09 | 1.811307e+07 | 2.219754e+10 | 0.923818 | 0.075366 | 0.000816 |

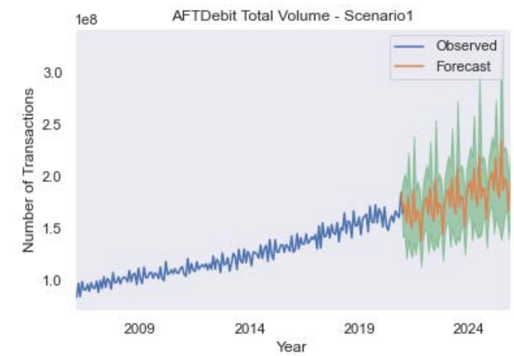
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)**

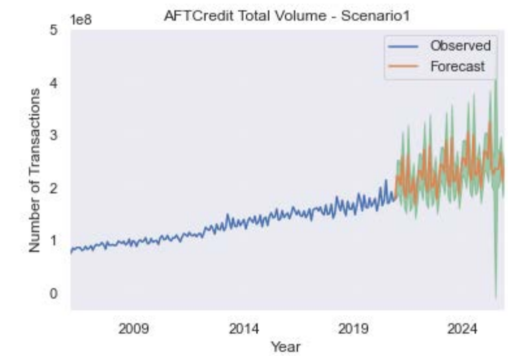
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.309128e+10 | 8.215616e+08 | 1.305987e+07 | 1.392590e+10 | 0.940067 | 0.058995 | 0.000938 |
| **2022** | 1.354730e+10 | 9.751214e+08 | 1.393811e+07 | 1.453636e+10 | 0.931960 | 0.067082 | 0.000959 |
| **2023** | 1.399119e+10 | 1.131924e+09 | 1.484914e+07 | 1.513796e+10 | 0.924245 | 0.074774 | 0.000981 |
| **2024** | 1.438944e+10 | 1.291036e+09 | 1.579260e+07 | 1.569627e+10 | 0.916743 | 0.082251 | 0.001006 |
| **2025** | 1.449351e+10 | 1.450212e+09 | 1.676793e+07 | 1.596049e+10 | 0.908087 | 0.090863 | 0.001051 |

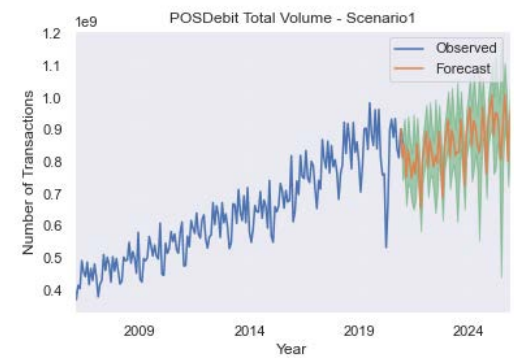
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Upper Bound for RTR)**

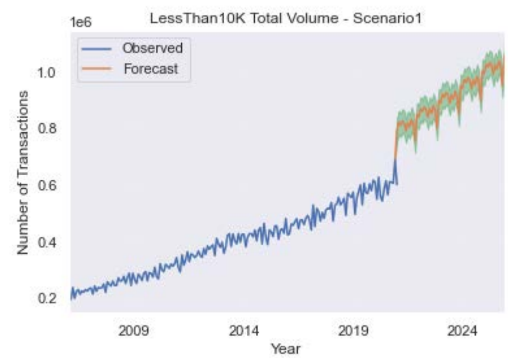


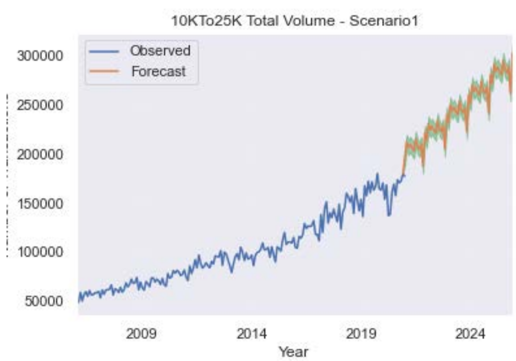



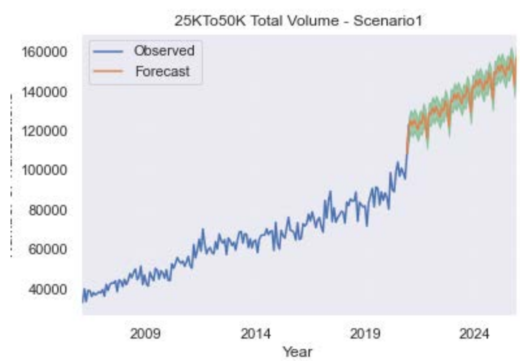

AFTDebit Total Volume - Scenario1
1e8
Number of Transactions
Year
Observed
Forecast

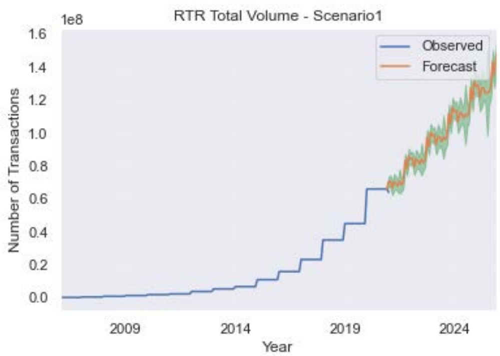

AFTCredit Total Volume - Scenario1
1e8
Number of Transactions
Year
Observed
Forecast


POSDebit Total Volume - Scenario1
1e9
Number of Transactions
Year
Observed
Forecast


LessThan10K Total Volume - Scenario1
1e6
Number of Transactions
Year
Observed
Forecast

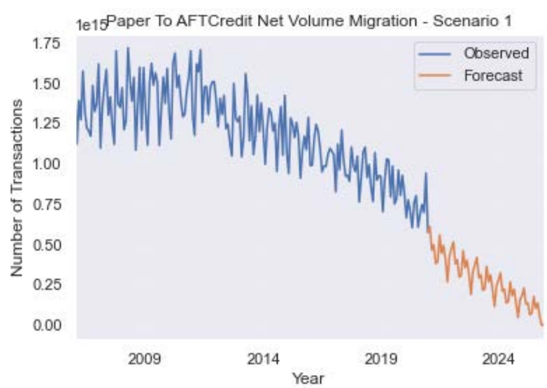

10KTo25K Total Volume - Scenario1
Year
Observed
Forecast

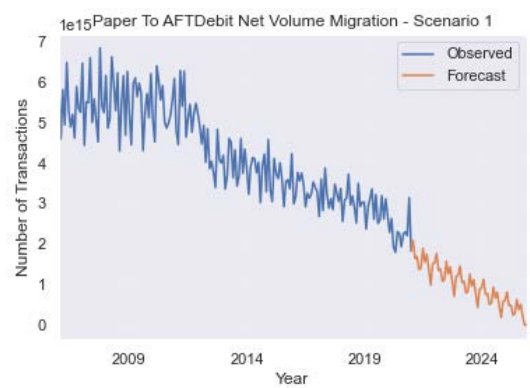

25KTo50K Total Volume - Scenario1
Year
Observed
Forecast

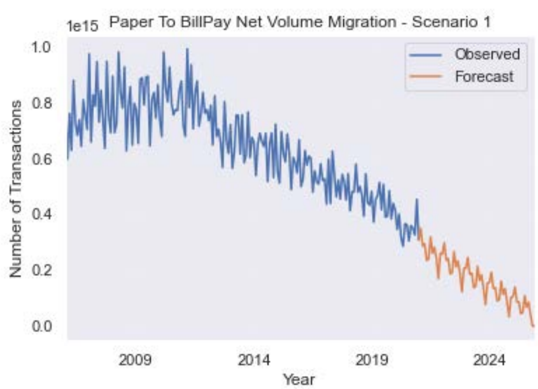


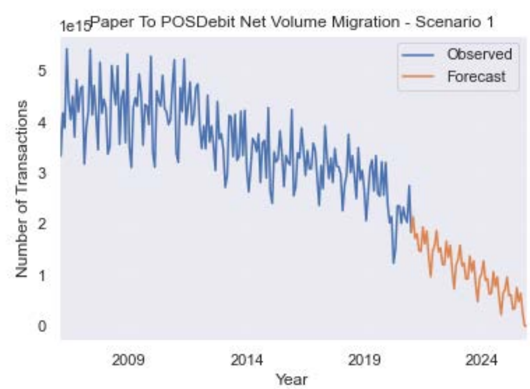

## Appendix 7. Sensitivity Analysis Scenario 1: Heavier Weight on End-User's Fee

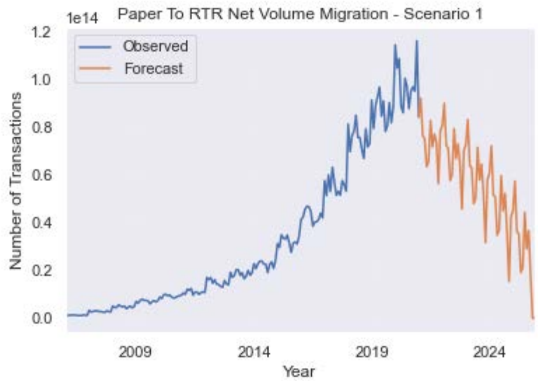
### Appendix 7.1. ACSS Net Migration



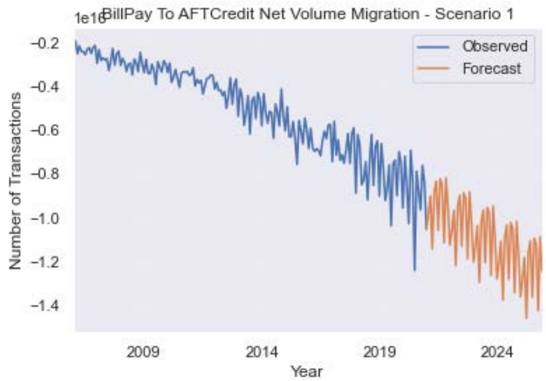



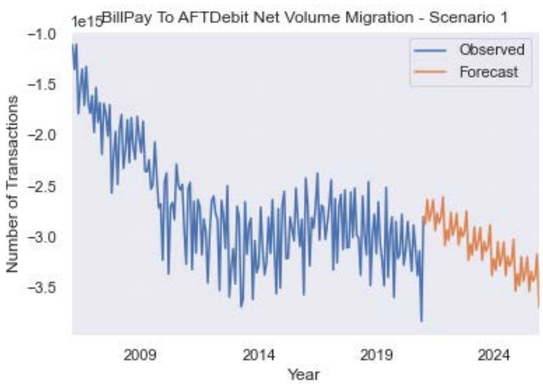





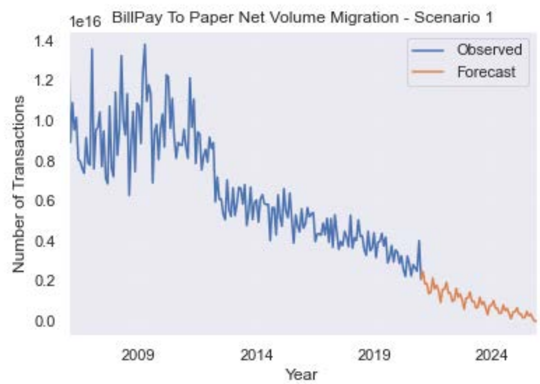
Paper To RTR Net Volume Migration - Scenario 1
1e14
Observed
Forecast
Number of Transactions
Year

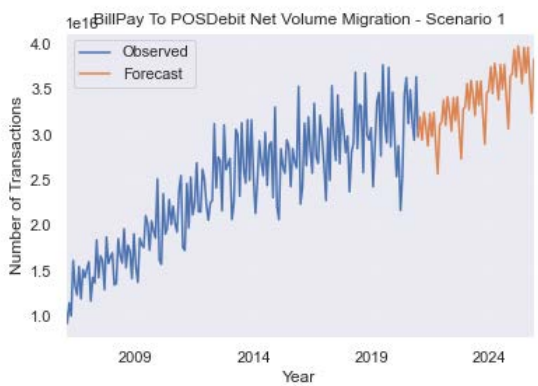
BillPay To AFTCredit Net Volume Migration - Scenario 1
1e16
Observed
Forecast
Number of Transactions
Year

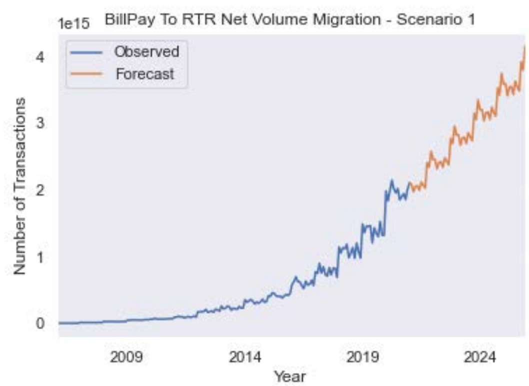
BillPay To AFTDebit Net Volume Migration - Scenario 1
1e15
Observed
Forecast
Number of Transactions
Year

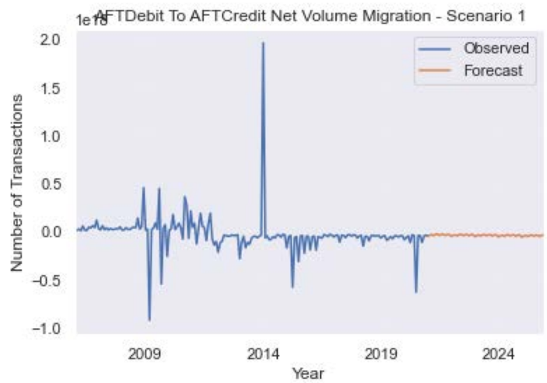
BillPay To Paper Net Volume Migration - Scenario 1
1e16
Observed
Forecast
Number of Transactions
Year

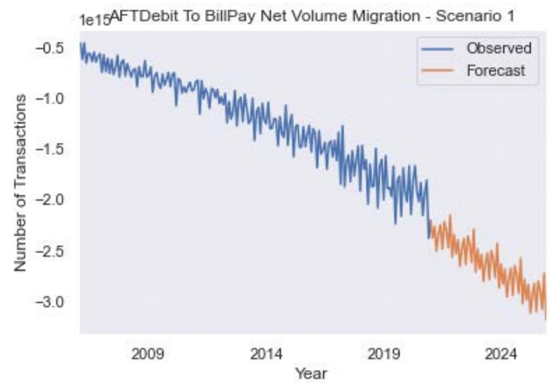



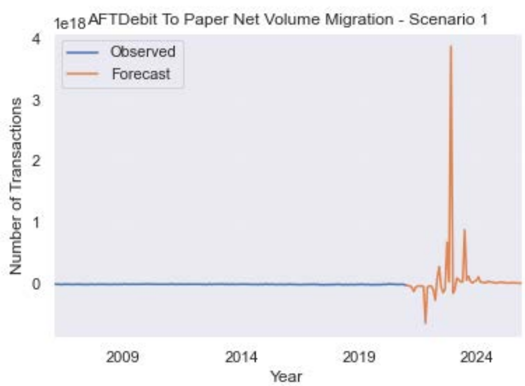
BillPay To POSDebit Net Volume Migration - Scenario 1
1e16
Observed
Forecast
Number of Transactions
Year

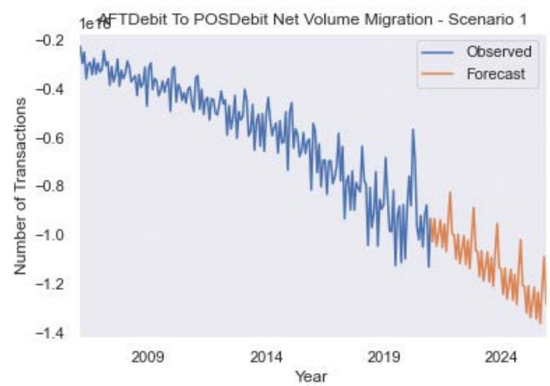



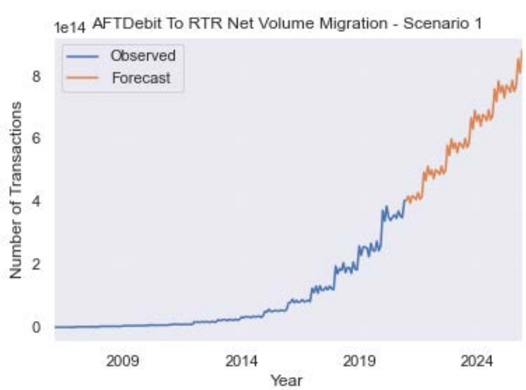
BillPay To RTR Net Volume Migration - Scenario 1
1e15
Observed
Forecast
Number of Transactions
Year

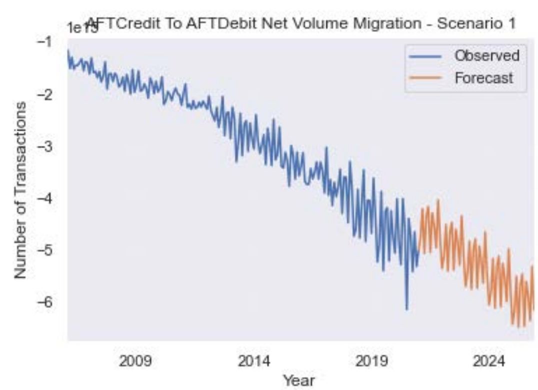

AFTDebit To AFTCredit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

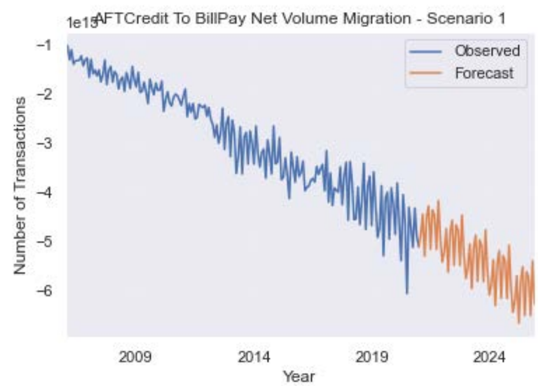

1e15
AFTDebit To BillPay Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

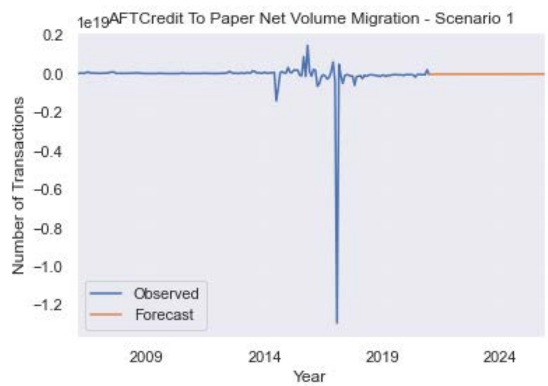

1e18
AFTDebit To Paper Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

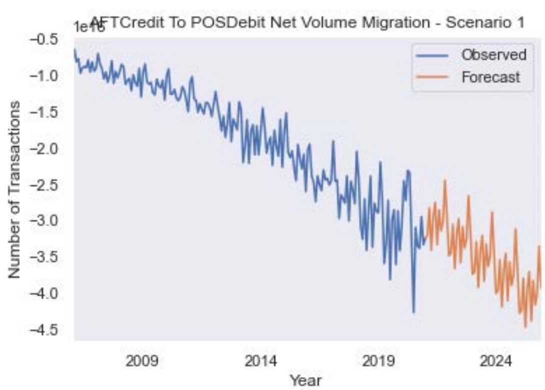

AFTDebit To POSDebit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

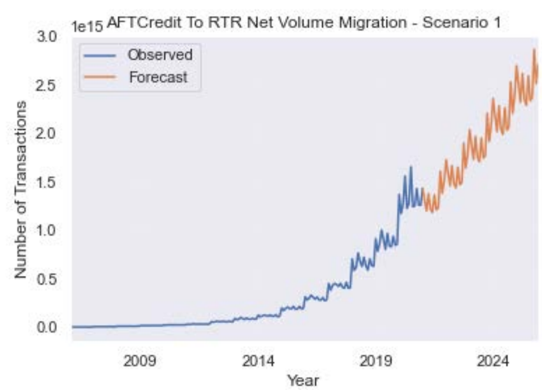

1e14
AFTDebit To RTR Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

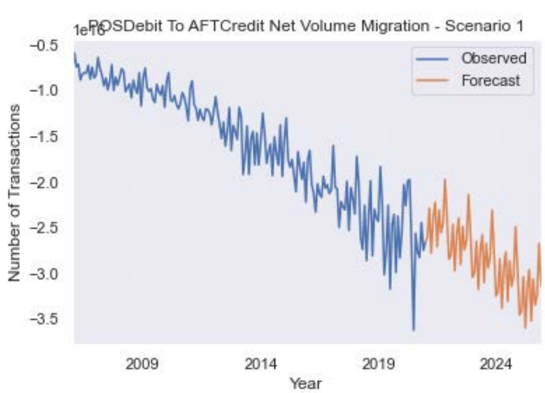

AFTCredit To AFTDebit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year
2009
2014
2019
2024

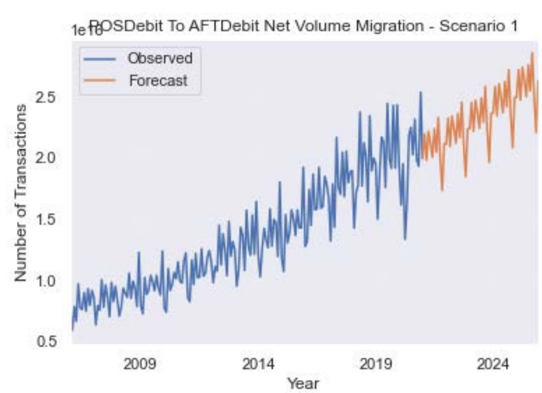

1e15 AFTCredit To BillPay Net Volume Migration - Scenario 1
Number of Transactions
−1
−2
−3
−4
−5
−6
Observed
Forecast
2009
2014
2019
2024
Year

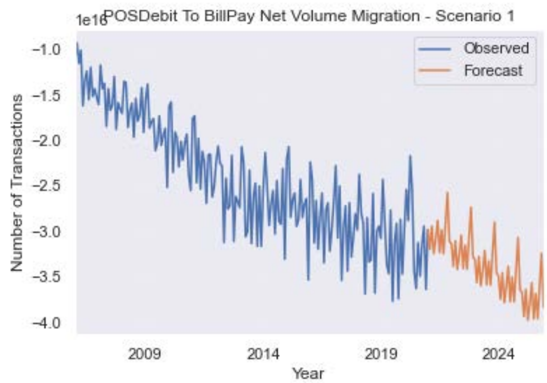

1e19 AFTCredit To Paper Net Volume Migration - Scenario 1
Number of Transactions
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
Observed
Forecast
2009
2014
2019
2024
Year

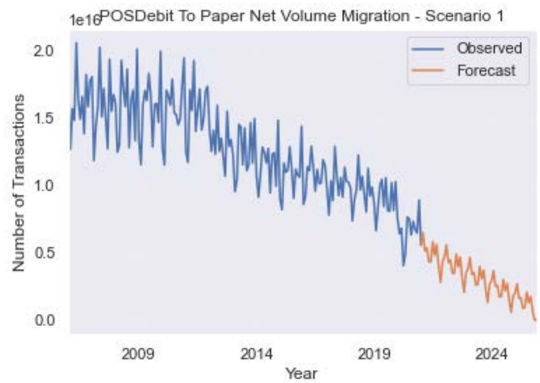

1e16 AFTCredit To POSDebit Net Volume Migration - Scenario 1
Number of Transactions
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
−4.0
−4.5
Observed
Forecast
2009
2014
2019
2024
Year

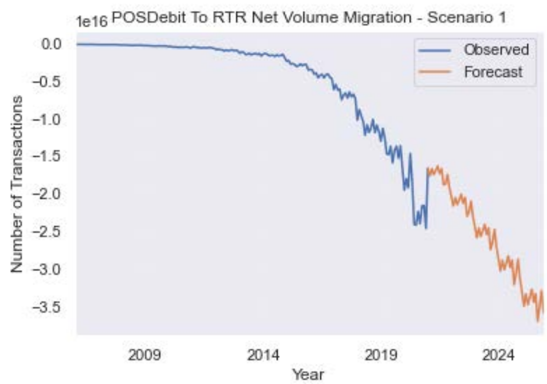

1e15 AFTCredit To RTR Net Volume Migration - Scenario 1
Number of Transactions
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Observed
Forecast
2009
2014
2019
2024
Year


1e16 POSDebit To AFTCredit Net Volume Migration - Scenario 1
Number of Transactions
−0.5
−1.0
−1.5
−2.0
−2.5
−3.0
−3.5
Observed
Forecast
2009
2014
2019
2024
Year

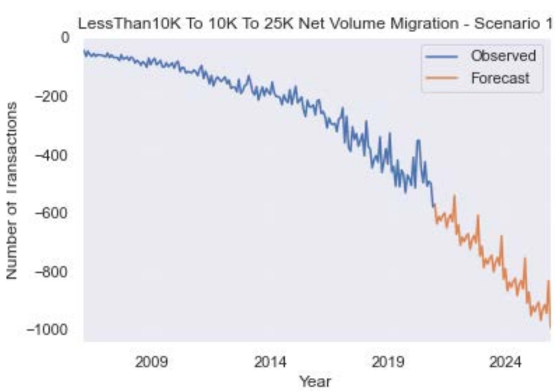

1e16 POSDebit To AFTDebit Net Volume Migration - Scenario 1
Number of Transactions
2.5
2.0
1.5
1.0
0.5
Observed
Forecast
2009
2014
2019
2024
Year

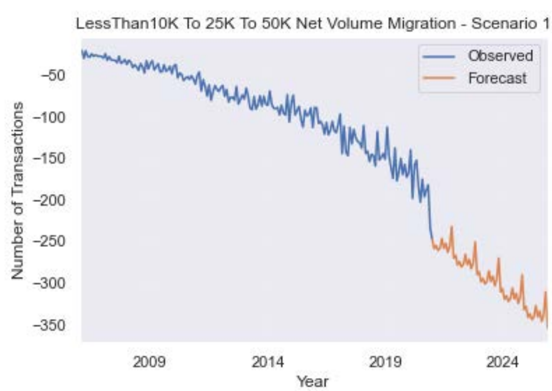


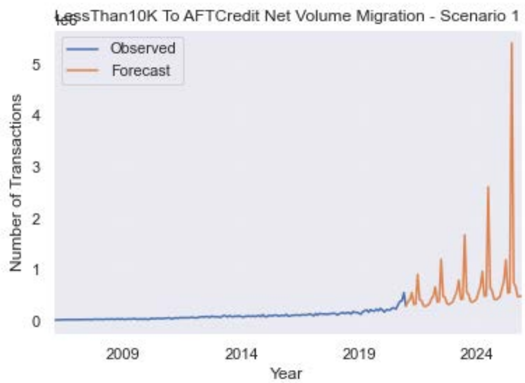



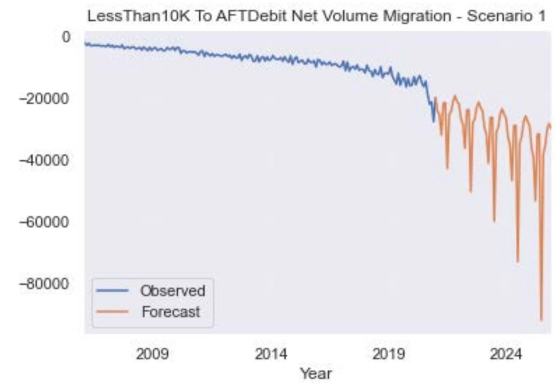



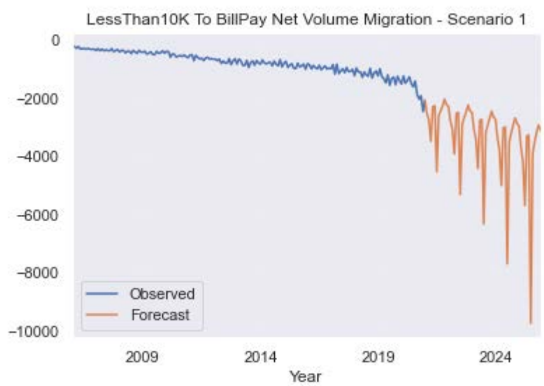

## Appendix 7.2. LVTS Net Migration

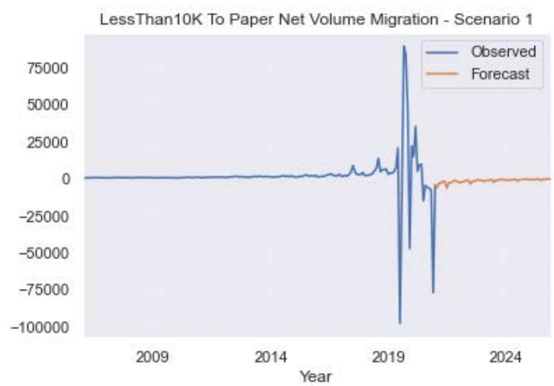


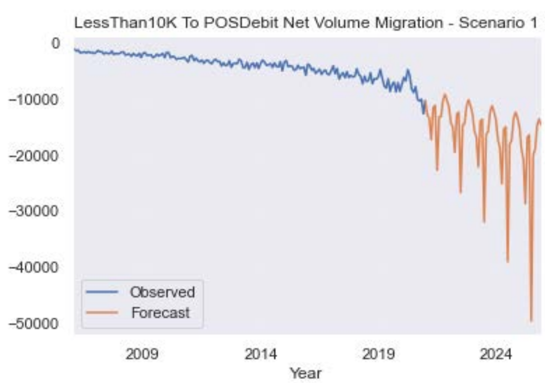



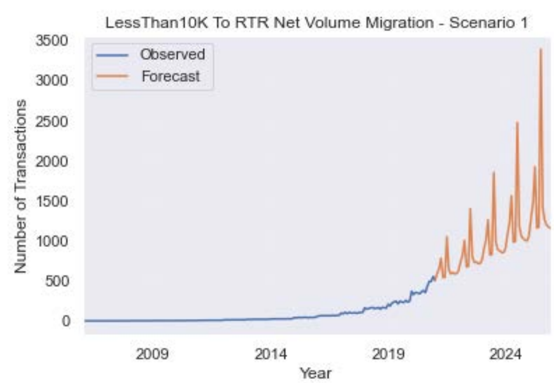

LessThan10K To AFTCredit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

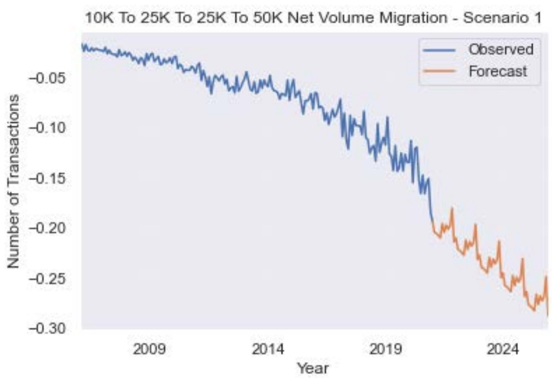

LessThan10K To AFTDebit Net Volume Migration - Scenario 1
Observed
Forecast
Year

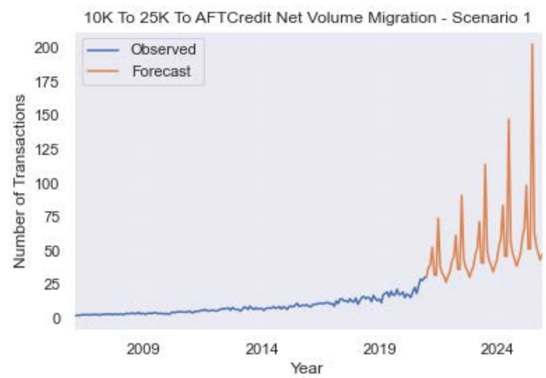

LessThan10K To BillPay Net Volume Migration - Scenario 1
Observed
Forecast
Year

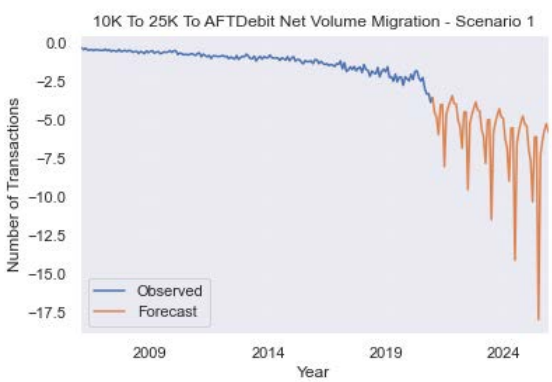

LessThan10K To Paper Net Volume Migration - Scenario 1
Observed
Forecast
Year

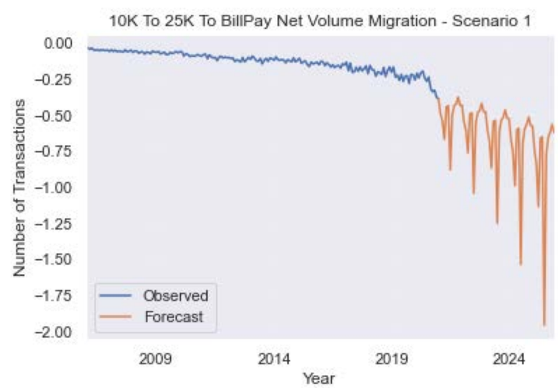

LessThan10K To POSDebit Net Volume Migration - Scenario 1
Observed
Forecast
Year

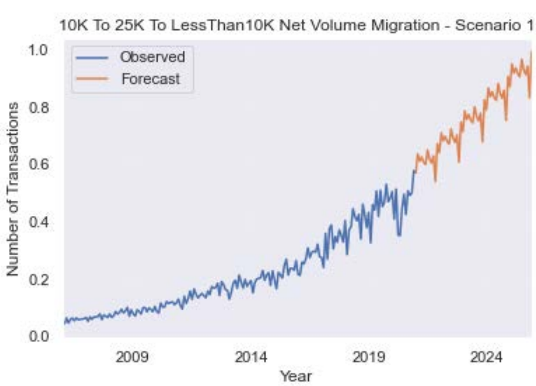

LessThan10K To RTR Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

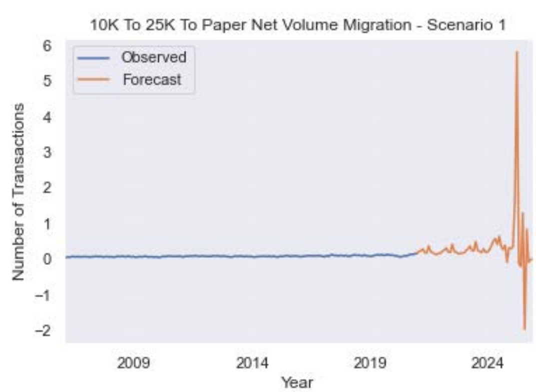

10K To 25K To 25K To 50K Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

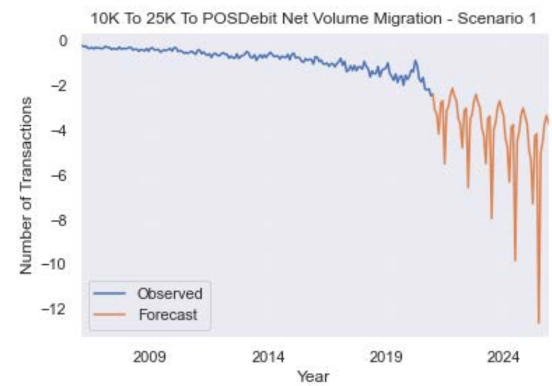

10K To 25K To AFTCredit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

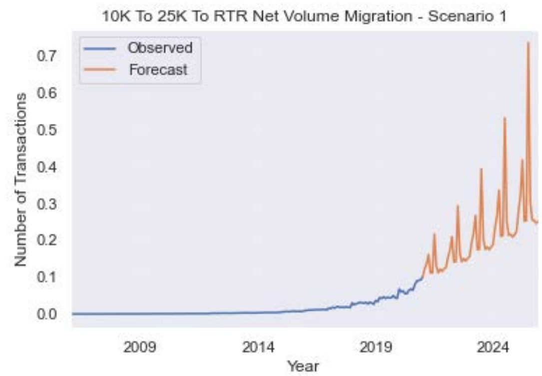

10K To 25K To AFTDebit Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

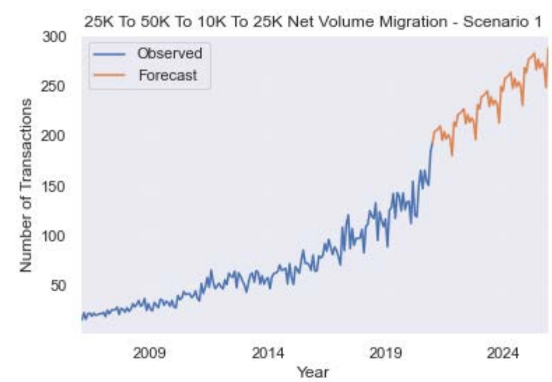

10K To 25K To BillPay Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

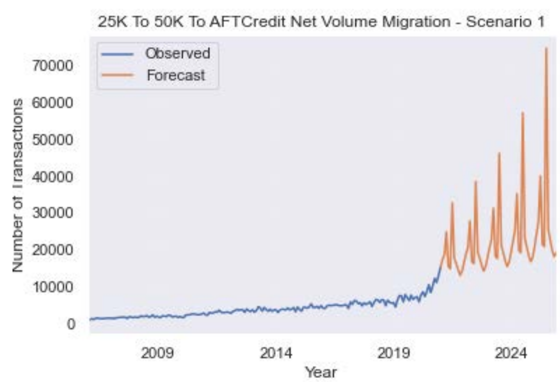

10K To 25K To LessThan10K Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

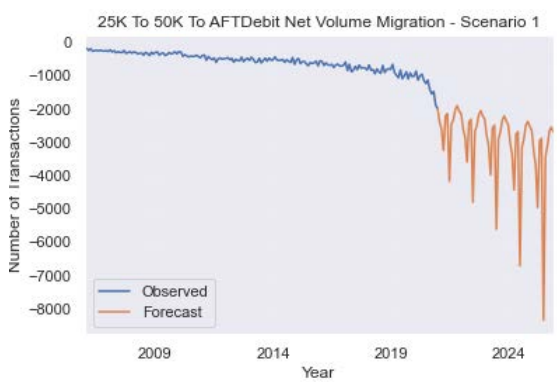

10K To 25K To Paper Net Volume Migration - Scenario 1
Observed
Forecast
Number of Transactions
Year

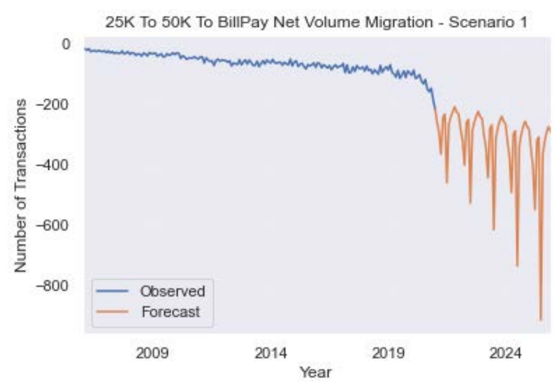

10K To 25K To POSDebit Net Volume Migration - Scenario 1
0
−2
−4
−6
−8
−10
−12
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

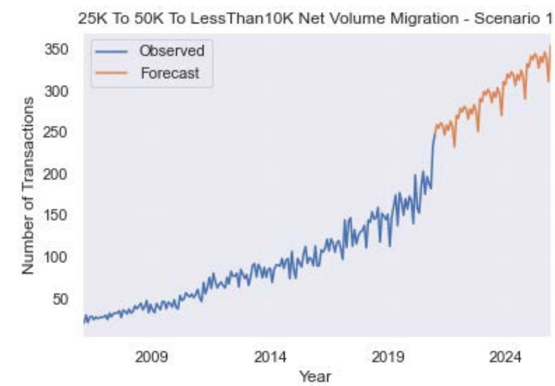

10K To 25K To RTR Net Volume Migration - Scenario 1
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

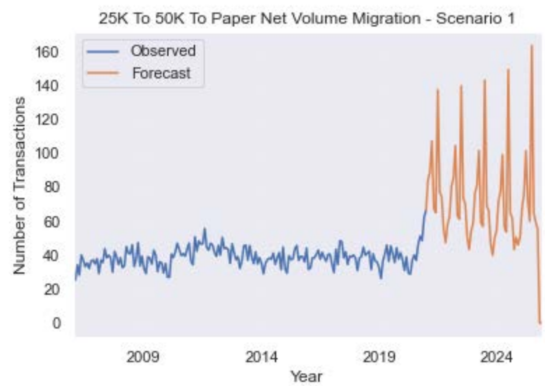

25K To 50K To 10K To 25K Net Volume Migration - Scenario 1
300
250
200
150
100
50
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

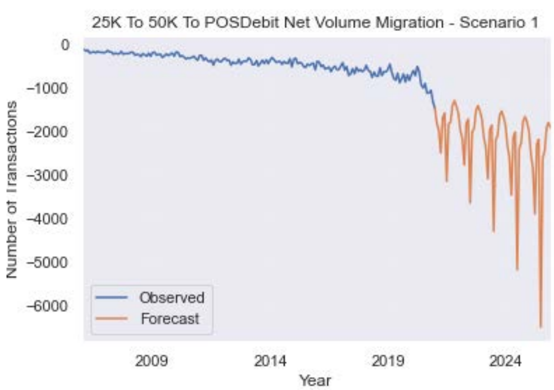

25K To 50K To AFTCredit Net Volume Migration - Scenario 1
70000
60000
50000
40000
30000
20000
10000
0
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

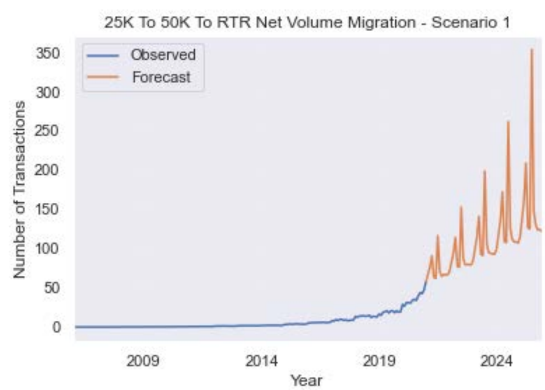

25K To 50K To AFTDebit Net Volume Migration - Scenario 1
0
−1000
−2000
−3000
−4000
−5000
−6000
−7000
−8000
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year


25K To 50K To BillPay Net Volume Migration - Scenario 1
0
−200
−400
−600
−800
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year




## Appendix 8. Sensitivity Analysis Scenario 2: Bias on Average Transaction Value

### Appendix 8.1. Forecasts with COVID and Migration Impacts under VAR model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.533446e+10 | 1.039470e+09 | 1.071520e+07 | 1.638465e+10 | 0.935904 | 0.063442 | 0.000654 |
| 2022 | 1.610008e+10 | 1.379863e+09 | 1.143903e+07 | 1.749138e+10 | 0.920458 | 0.078888 | 0.000654 |
| 2023 | 1.655257e+10 | 1.852569e+09 | 1.238059e+07 | 1.841752e+10 | 0.898740 | 0.100587 | 0.000672 |
| 2024 | 1.697421e+10 | 2.495283e+09 | 1.356637e+07 | 1.948306e+10 | 0.871229 | 0.128074 | 0.000696 |
| 2025 | 1.742861e+10 | 3.358934e+09 | 1.505264e+07 | 2.080260e+10 | 0.837809 | 0.161467 | 0.000724 |

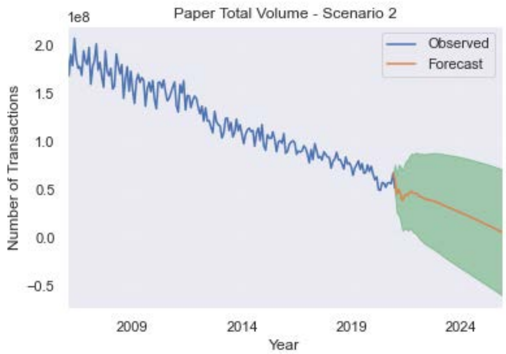
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

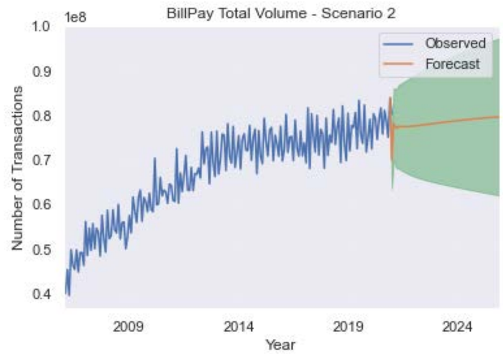
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.809788e+10 | 1.114154e+09 | 1.148411e+07 | 1.922352e+10 | 0.941445 | 0.057958 | 0.000597 |
| **2022** | 1.983119e+10 | 1.504265e+09 | 1.243653e+07 | 2.134789e+10 | 0.928953 | 0.070464 | 0.000583 |
| **2023** | 2.105131e+10 | 2.028306e+09 | 1.348492e+07 | 2.309311e+10 | 0.911584 | 0.087832 | 0.000584 |
| **2024** | 2.248179e+10 | 2.738372e+09 | 1.475538e+07 | 2.523492e+10 | 0.890900 | 0.108515 | 0.000585 |
| **2025** | 2.437398e+10 | 3.692431e+09 | 1.633223e+07 | 2.808275e+10 | 0.867934 | 0.131484 | 0.000582 |

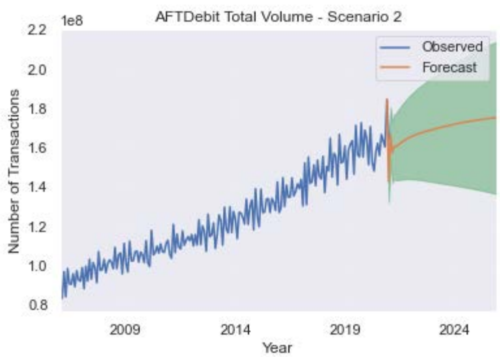
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)**

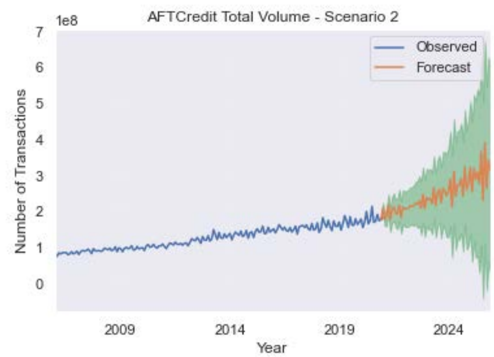
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.257104e+10 | 9.647860e+08 | 9.946286e+06 | 1.354577e+10 | 0.928042 | 0.071224 | 0.000734 |
| **2022** | 1.236897e+10 | 1.255460e+09 | 1.044153e+07 | 1.363487e+10 | 0.907157 | 0.092077 | 0.000766 |
| **2023** | 1.205383e+10 | 1.676831e+09 | 1.127626e+07 | 1.374193e+10 | 0.877157 | 0.122023 | 0.000821 |
| **2024** | 1.146663e+10 | 2.252193e+09 | 1.237736e+07 | 1.373120e+10 | 0.835078 | 0.164020 | 0.000901 |
| **2025** | 1.048325e+10 | 3.025438e+09 | 1.377305e+07 | 1.352246e+10 | 0.775247 | 0.223734 | 0.001019 |

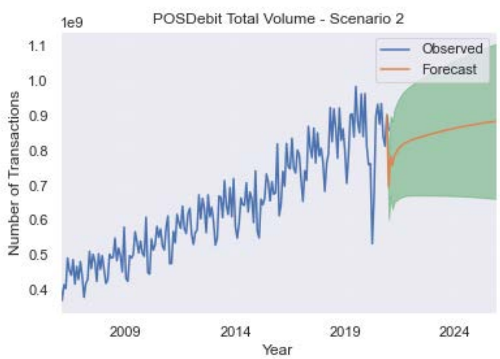
**Volume Market Share with COVID impacts and Migrations in Next 5 Years (Upper Bound for RTR)**

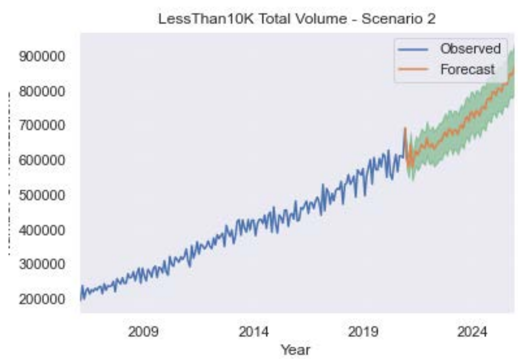

Paper Total Volume - Scenario 2
1e8
2.0
1.5
1.0
0.5
0.0
−0.5
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

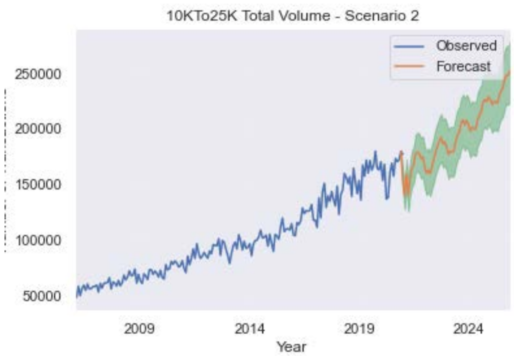

BillPay Total Volume - Scenario 2
1e8
1.0
0.9
0.8
0.7
0.6
0.5
0.4
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

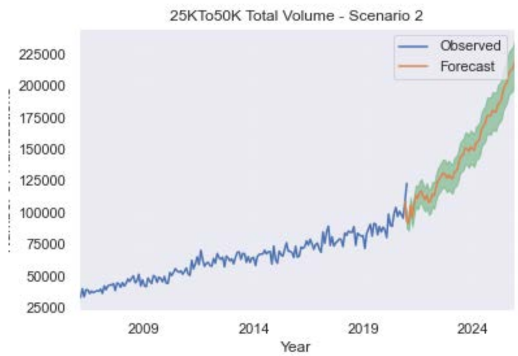

AFTDebit Total Volume - Scenario 2
1e8
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year

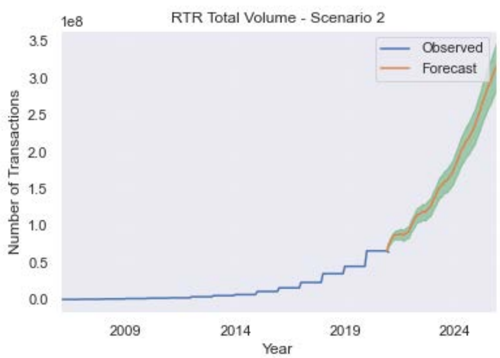

AFTCredit Total Volume - Scenario 2
1e8
7
6
5
4
3
2
1
0
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year


POSDebit Total Volume - Scenario 2
1e9
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
Number of Transactions
Observed
Forecast
2009
2014
2019
2024
Year


LessThan10K Total Volume - Scenario 2
900000
800000
700000
600000
500000
400000
300000
200000
Observed
Forecast
2009
2014
2019
2024
Year




## Appendix 9. Sensitivity Analysis Scenario 2: Bias on Average Transaction Value

### Appendix 9.1. Forecasts with COVID and Migration Impacts under OLS model

| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| **2021** | 1.624813e+10 | 9.944230e+08 | 1.372596e+07 | 1.725628e+10 | 0.941578 | 0.057627 | 0.000795 |
| **2022** | 1.691399e+10 | 1.165388e+09 | 1.460550e+07 | 1.809399e+10 | 0.934785 | 0.064407 | 0.000807 |
| **2023** | 1.761086e+10 | 1.341301e+09 | 1.551964e+07 | 1.896768e+10 | 0.928467 | 0.070715 | 0.000818 |
| **2024** | 1.834382e+10 | 1.522884e+09 | 1.646855e+07 | 1.988317e+10 | 0.922580 | 0.076592 | 0.000828 |
| **2025** | 1.908544e+10 | 1.709536e+09 | 1.745221e+07 | 2.081242e+10 | 0.917021 | 0.082140 | 0.000839 |

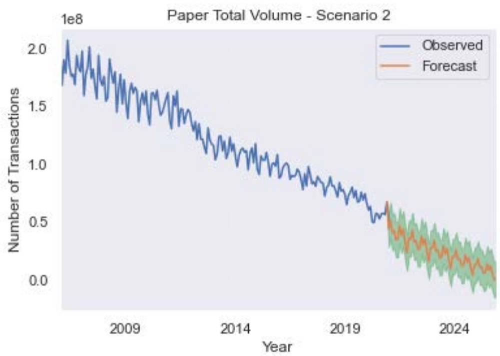
**Volume Market Share with COVID impacts and Migrations in Next 5 Years**

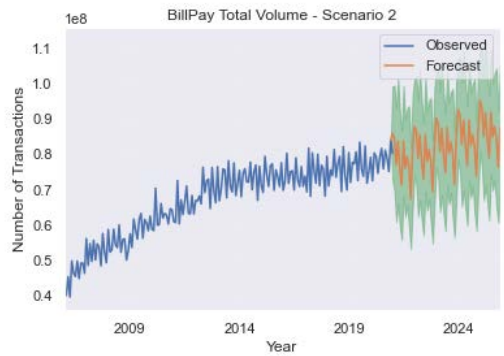
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.831486e+10 | 1.068868e+09 | 1.437852e+07 | 1.939810e+10 | 0.944157 | 0.055102 | 0.000741 |
| 2022 | 1.901825e+10 | 1.248817e+09 | 1.526231e+07 | 2.028232e+10 | 0.937676 | 0.061572 | 0.000752 |
| 2023 | 1.975462e+10 | 1.434100e+09 | 1.618152e+07 | 2.120491e+10 | 0.931606 | 0.067631 | 0.000763 |
| 2024 | 2.052951e+10 | 1.625415e+09 | 1.713642e+07 | 2.217206e+10 | 0.925918 | 0.073309 | 0.000773 |
| 2025 | 2.146752e+10 | 1.822364e+09 | 1.812712e+07 | 2.330801e+10 | 0.921036 | 0.078186 | 0.000778 |

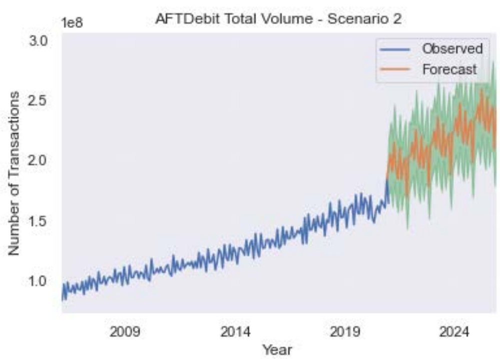
Volume Market Share with COVID impacts and Migrations in Next 5 Years (Lower Bound for RTR)

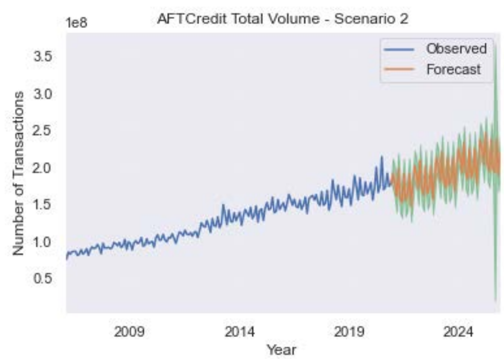
| Year_Month | ACSSTotalVolume | RTRTotalVolume | LVTSTotalVolume | TotalVolume | ACSSShare | RTRShare | LVTSShare |
|---|---|---|---|---|---|---|---|
| 2021 | 1.418140e+10 | 9.199778e+08 | 1.307340e+07 | 1.511445e+10 | 0.938268 | 0.060867 | 0.000865 |
| 2022 | 1.480974e+10 | 1.081960e+09 | 1.394869e+07 | 1.590565e+10 | 0.931099 | 0.068024 | 0.000877 |
| 2023 | 1.546710e+10 | 1.248501e+09 | 1.485776e+07 | 1.673046e+10 | 0.924487 | 0.074624 | 0.000888 |
| 2024 | 1.615812e+10 | 1.420353e+09 | 1.580067e+07 | 1.759428e+10 | 0.918374 | 0.080728 | 0.000898 |
| 2025 | 1.670335e+10 | 1.596709e+09 | 1.677731e+07 | 1.831684e+10 | 0.911912 | 0.087172 | 0.000916 |

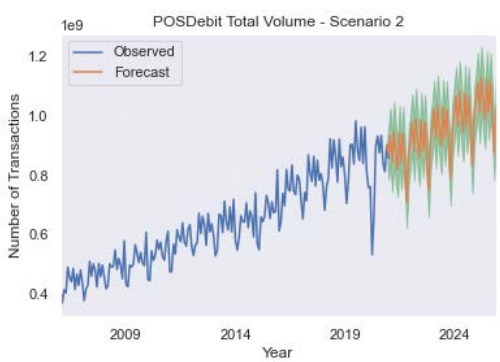
Volume Market Share with COVID impacts and Migrations in Next 5 Years (Upper Bound for RTR)

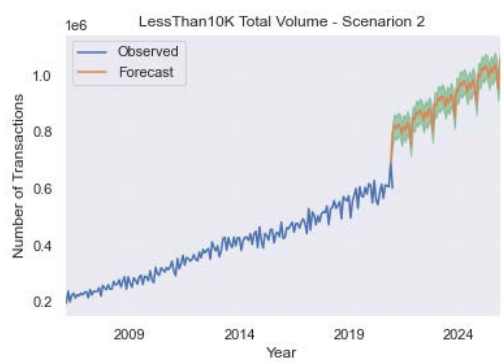

Paper Total Volume - Scenario 2
1e8
Observed
Forecast
Number of Transactions
Year

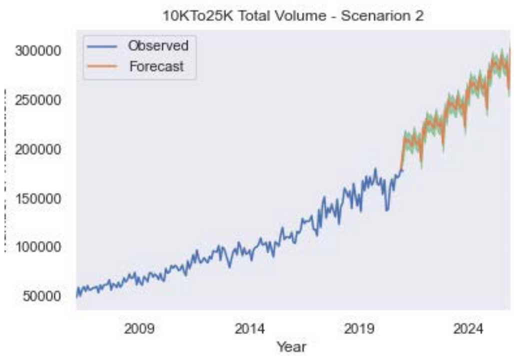

BillPay Total Volume - Scenario 2
1e8
Observed
Forecast
Number of Transactions
Year

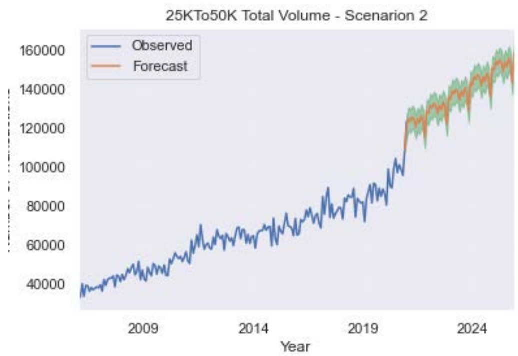

AFTDebit Total Volume - Scenario 2
1e8
Observed
Forecast
Number of Transactions
Year

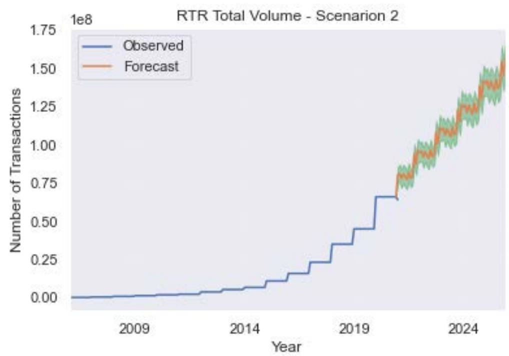

AFTCredit Total Volume - Scenario 2
1e8
Observed
Forecast
Number of Transactions
Year


POSDebit Total Volume - Scenario 2
1e9
Observed
Forecast
Number of Transactions
Year


LessThan10K Total Volume - Scenarion 2
1e6
Observed
Forecast
Number of Transactions
Year

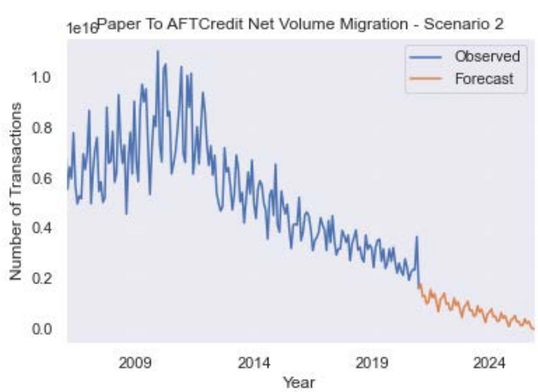


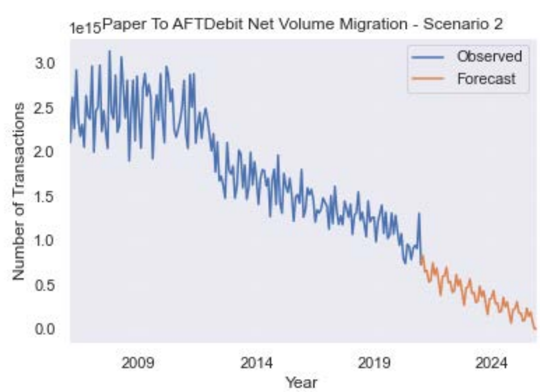



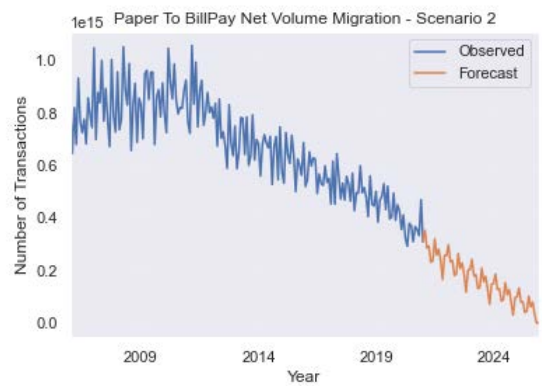



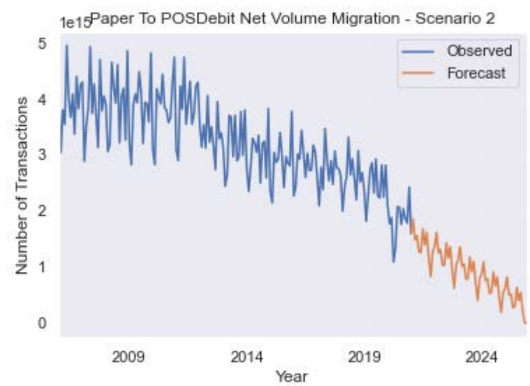

## Appendix 10. Sensitivity Analysis Scenario 2: Bias on Average Transaction Value

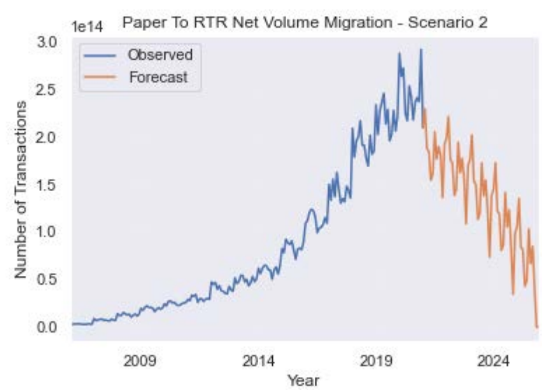
### Appendix 10.1. ACSS Net Migration

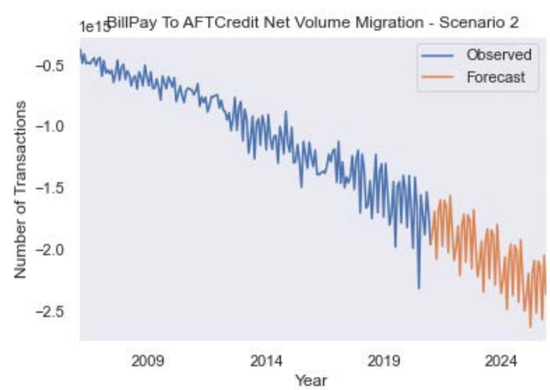


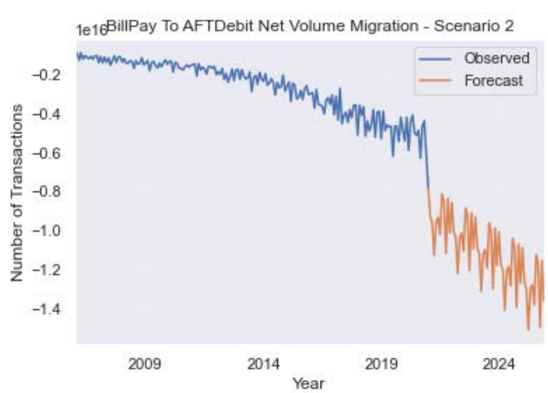



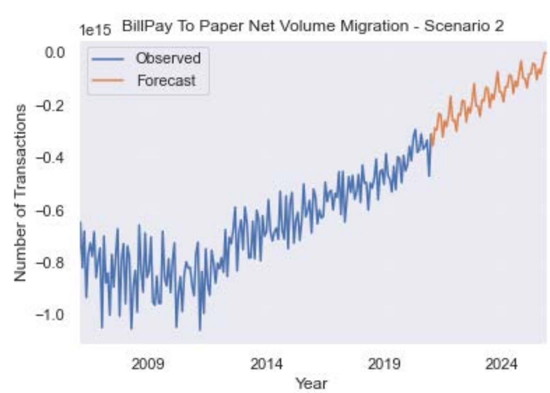

Paper To BillPay Net Volume Migration - Scenario 2
1e15
Observed
Forecast
Number of Transactions
Year

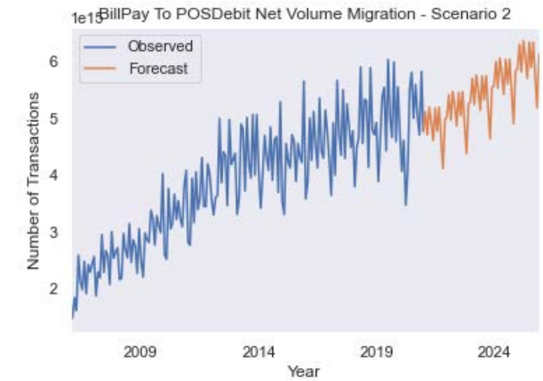

Paper To POSDebit Net Volume Migration - Scenario 2
1e15
Observed
Forecast
Number of Transactions
Year

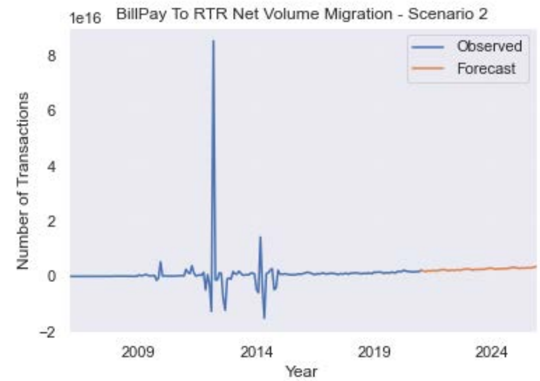

Paper To RTR Net Volume Migration - Scenario 2
1e14
Observed
Forecast
Number of Transactions
Year

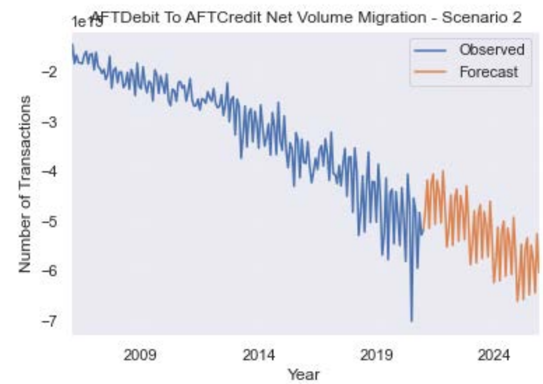

BillPay To AFTCredit Net Volume Migration - Scenario 2
1e15
Observed
Forecast
Number of Transactions
Year

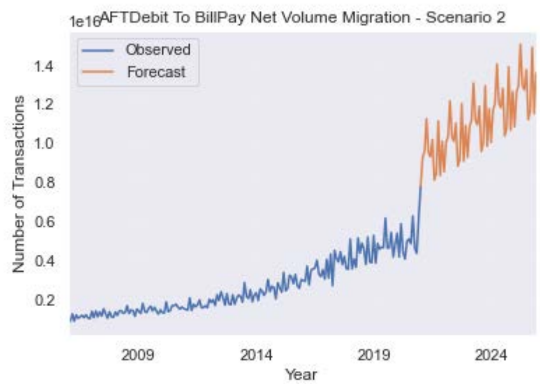

BillPay To AFTDebit Net Volume Migration - Scenario 2
1e16
Observed
Forecast
Number of Transactions
Year

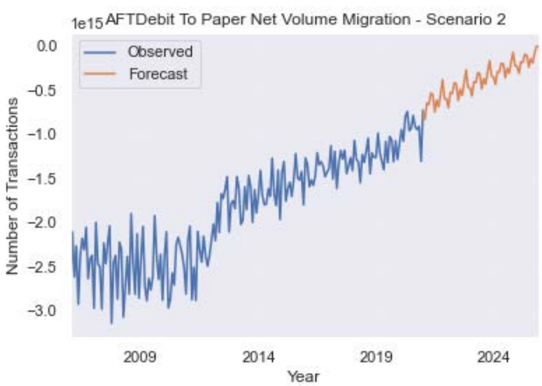

BillPay To Paper Net Volume Migration - Scenario 2
1e15
Observed
Forecast
Number of Transactions
Year

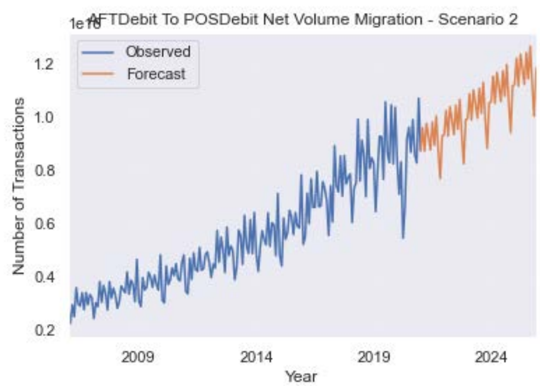

1e15
BillPay To POSDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year


1e16
BillPay To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year


1e15
AFTDebit To AFTCredit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year


1e16
AFTDebit To BillPay Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year


1e15
AFTDebit To Paper Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year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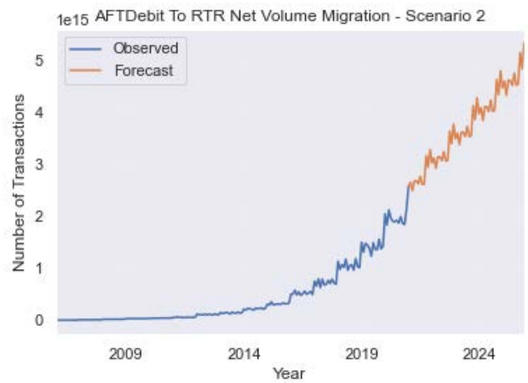
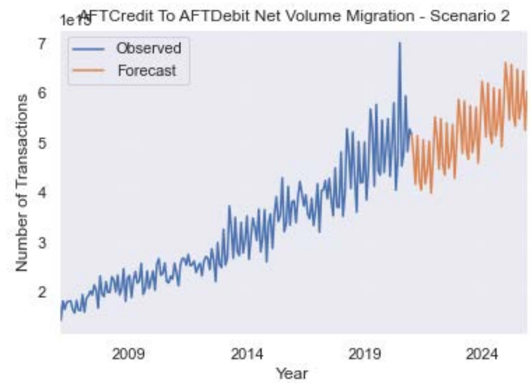
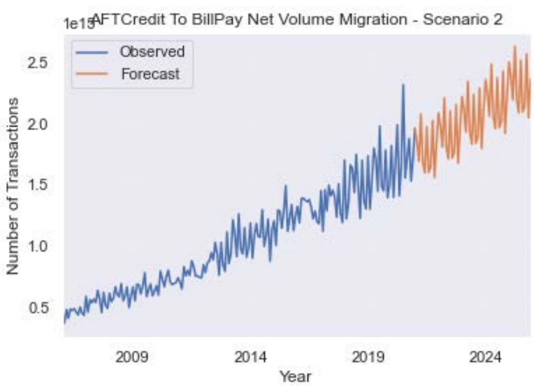
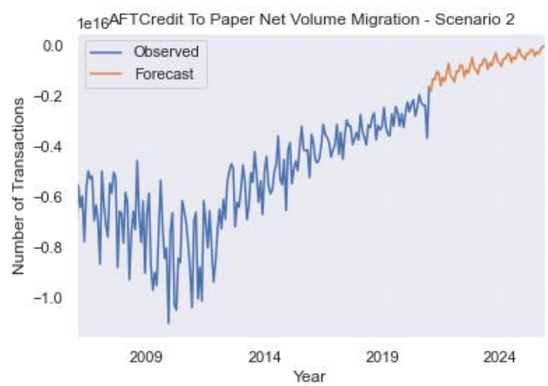
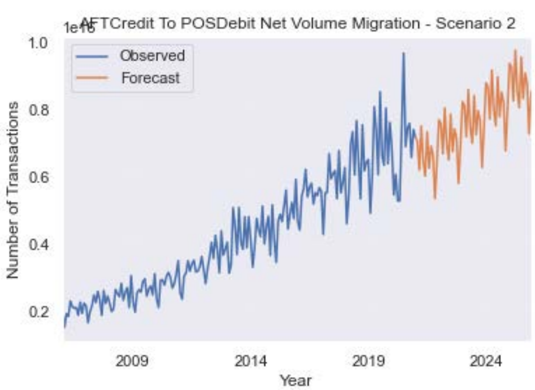
AFTDebit To POSDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
2009
2014
2019
2024
Year

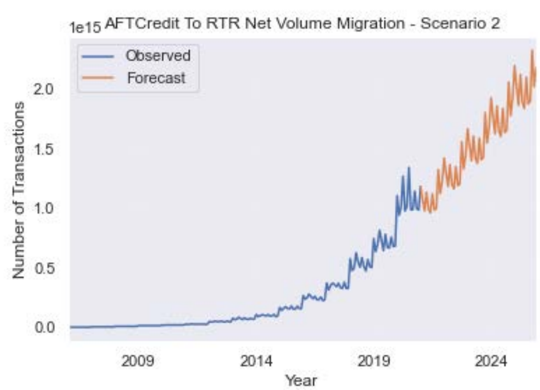

1e15 AFTDebit To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
0
1
2
3
4
5
2009
2014
2019
2024

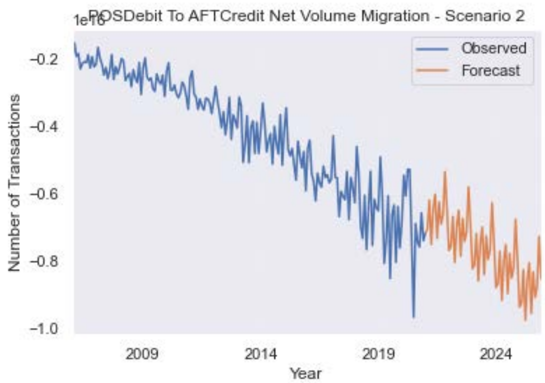

AFTCredit To AFTDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
2
3
4
5
6
7
2009
2014
2019
2024

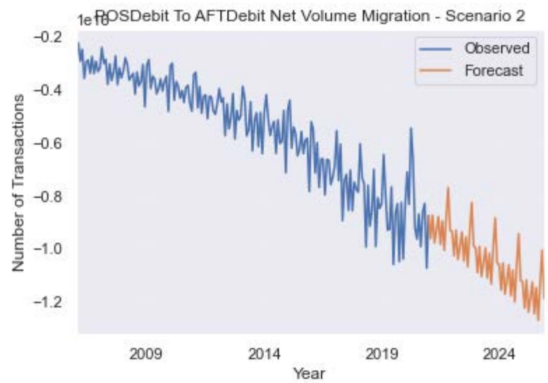

AFTCredit To BillPay Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
0.5
1.0
1.5
2.0
2.5
2009
2014
2019
2024

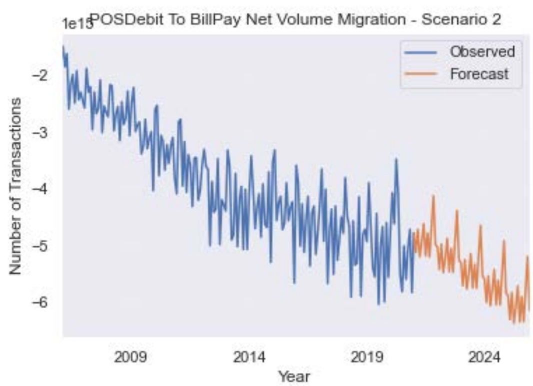

1e16 AFTCredit To Paper Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
2009
2014
2019
2024

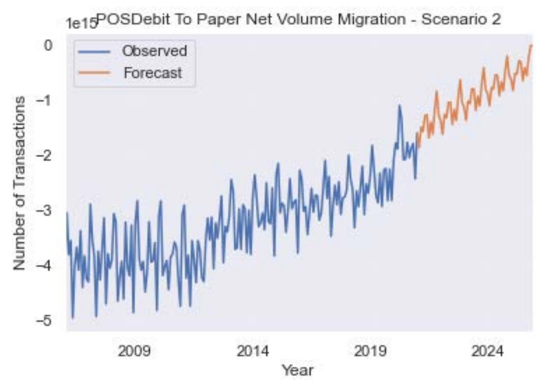

AFTCredit To POSDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
0.2
0.4
0.6
0.8
1.0
2009
2014
2019
2024

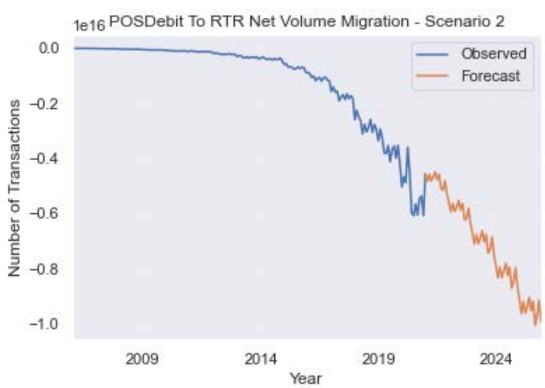

1e15 AFTCredit To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year
0.0
0.5
1.0
1.5
2.0
2009
2014
2019
2024


1e16
POSDebit To AFTCredit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
−0.2
−0.4
−0.6
−0.8
−1.0
2009
2014
2019
2024
Year

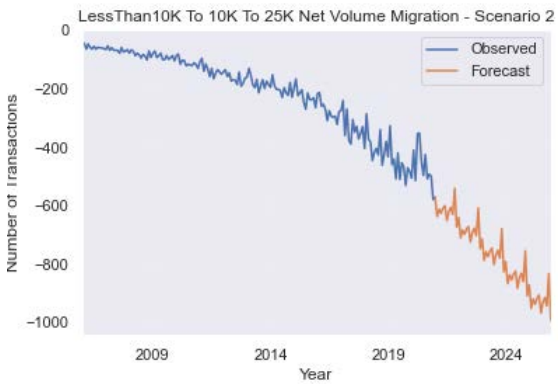

1e16
POSDebit To AFTDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
−0.2
−0.4
−0.6
−0.8
−1.0
−1.2
2009
2014
2019
2024
Year

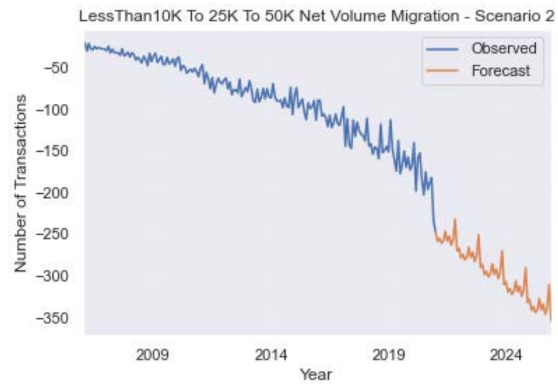

1e15
POSDebit To BillPay Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
−2
−3
−4
−5
−6
2009
2014
2019
2024
Year

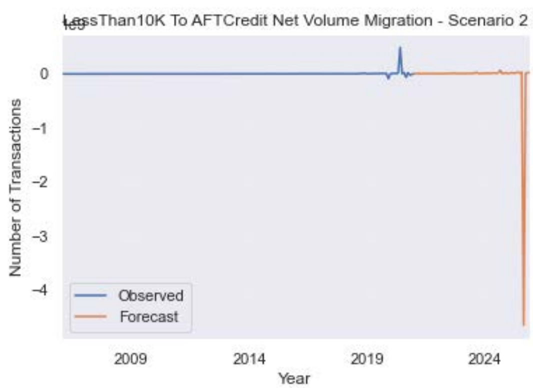

1e15
POSDebit To Paper Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
0
−1
−2
−3
−4
−5
2009
2014
2019
2024
Year

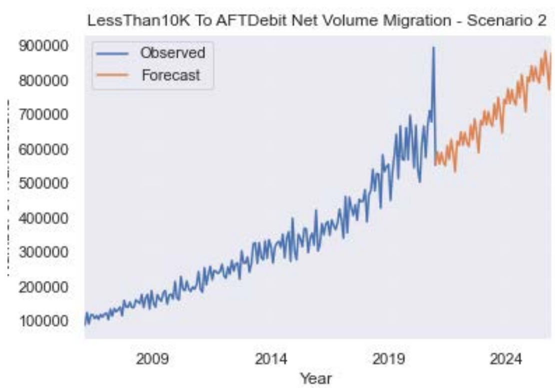

1e16
POSDebit To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
2009
2014
2019
2024
Year

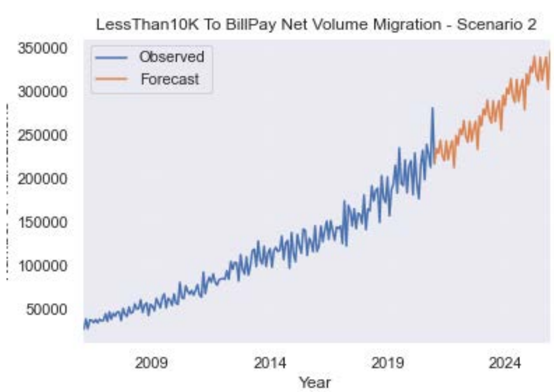
## Appendix 10.2. LVTS Net Migration

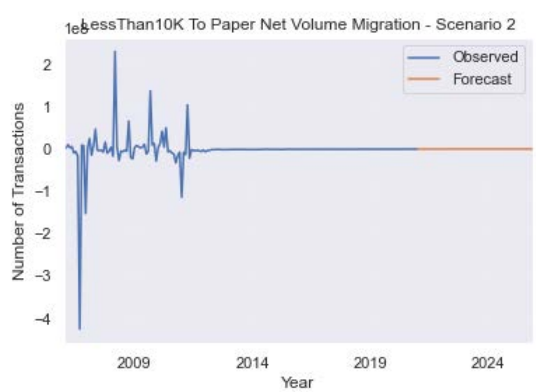


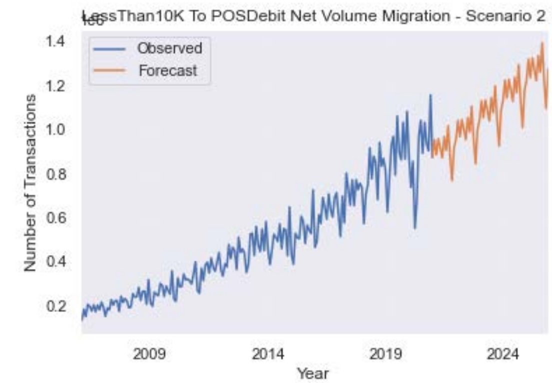



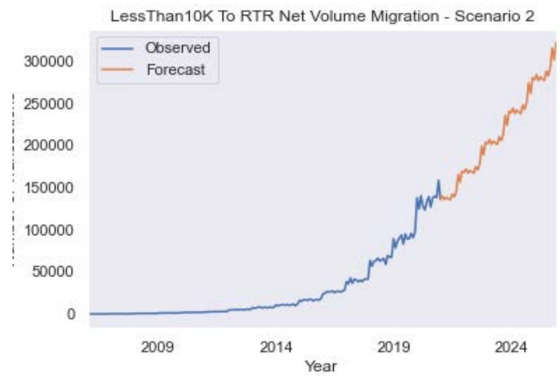



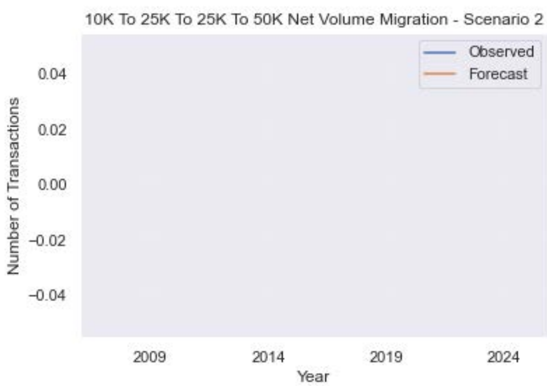



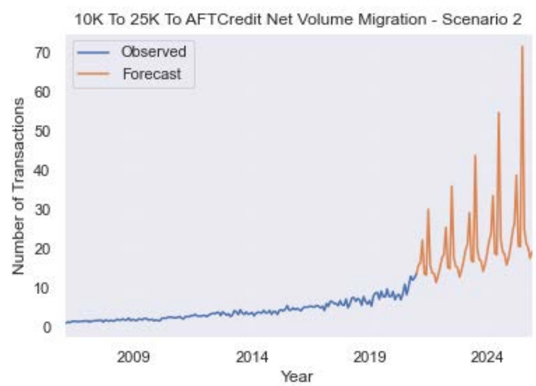



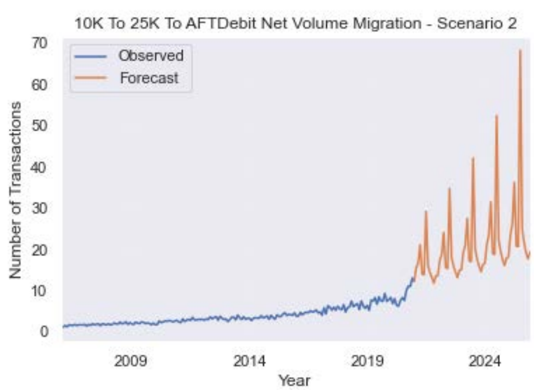



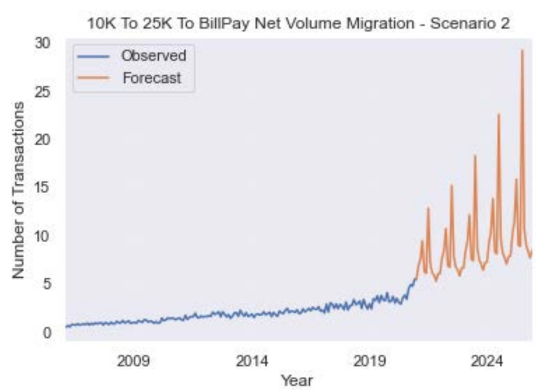

LessThan10K To POSDebit Net Volume Migration - Scenario 2
1e6
Observed
Forecast
Number of Transactions
Year

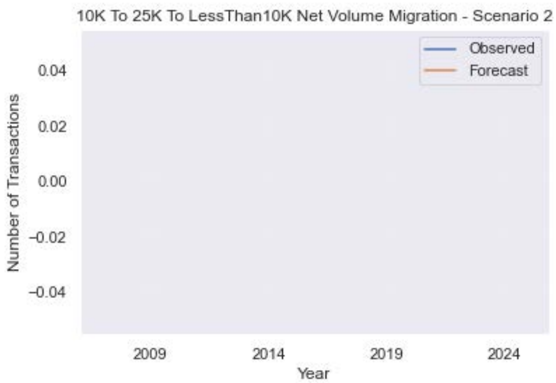

LessThan10K To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Year

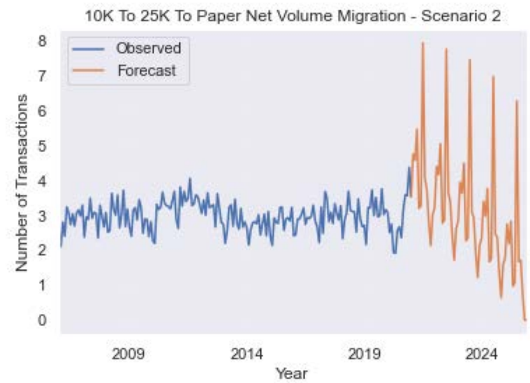

10K To 25K To 25K To 50K Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year

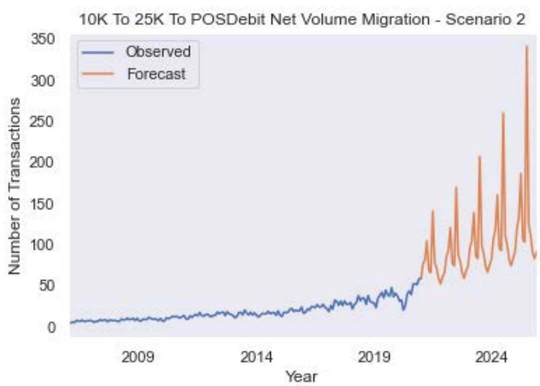

10K To 25K To AFTCredit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year

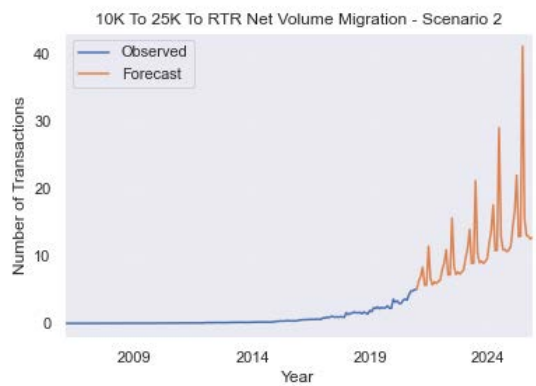

10K To 25K To AFTDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year

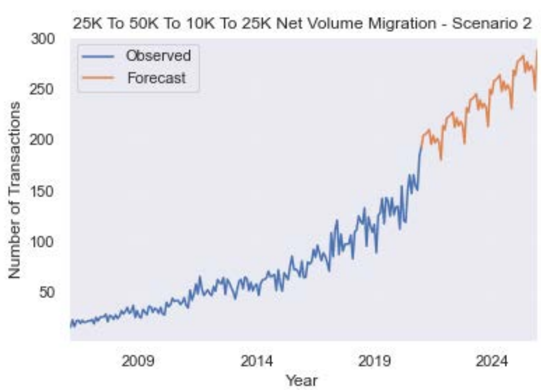

10K To 25K To BillPay Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
Year

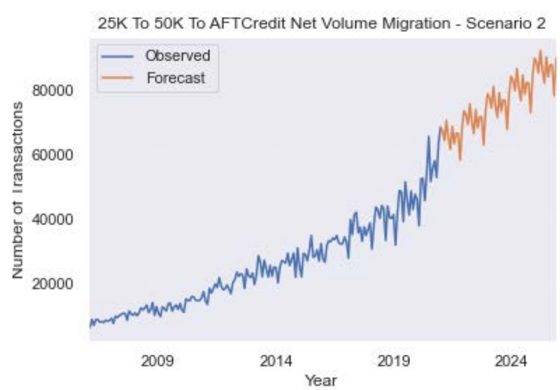

10K To 25K To LessThan10K Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
0.04
0.02
0.00
−0.02
−0.04
2009
2014
2019
2024
Year

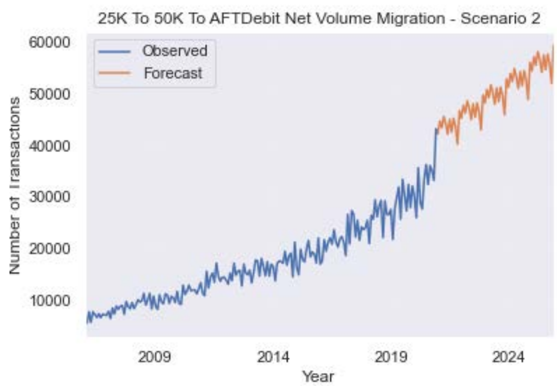

10K To 25K To Paper Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
8
7
6
5
4
3
2
1
0
2009
2014
2019
2024
Year

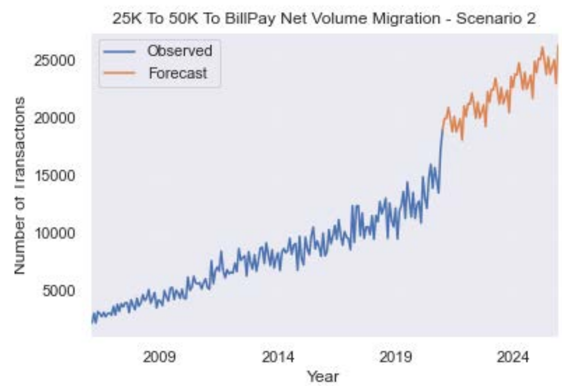

10K To 25K To POSDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
350
300
250
200
150
100
50
0
2009
2014
2019
2024
Year

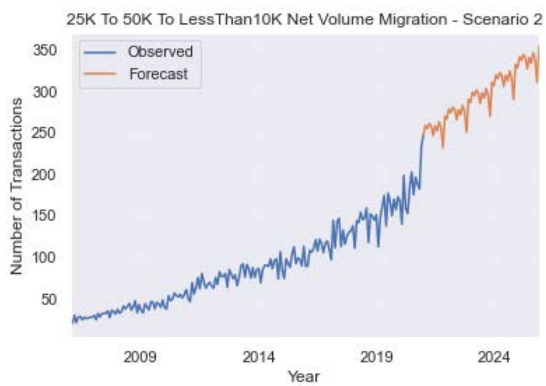

10K To 25K To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
40
30
20
10
0
2009
2014
2019
2024
Year

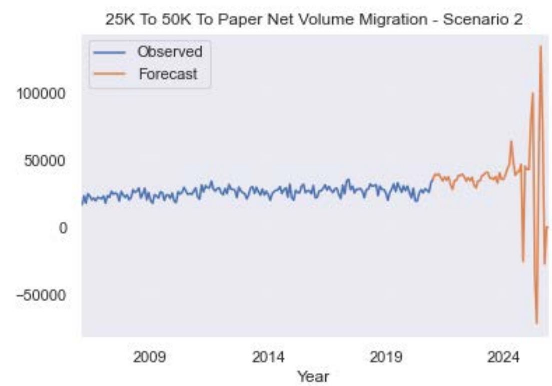

25K To 50K To 10K To 25K Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
300
250
200
150
100
50
2009
2014
2019
2024
Year

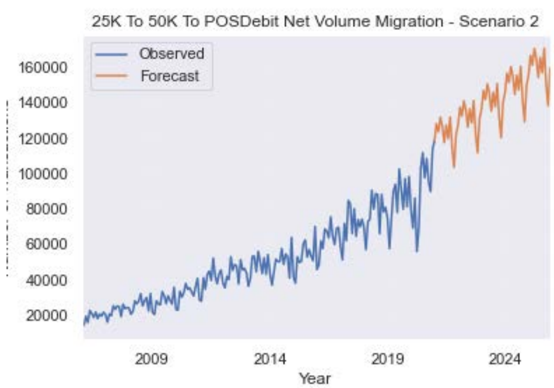

25K To 50K To AFTCredit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
80000
60000
40000
20000
2009
2014
2019
2024
Year

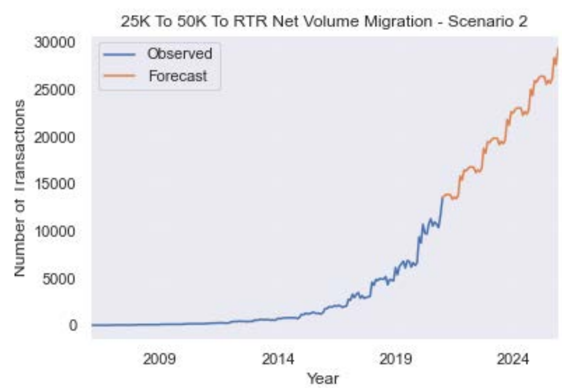

25K To 50K To AFTDebit Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
60000
50000
40000
30000
20000
10000
2009
2014
2019
2024
Year


25K To 50K To BillPay Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
25000
20000
15000
10000
5000
2009
2014
2019
2024
Year


25K To 50K To LessThan10K Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
350
300
250
200
150
100
50
2009
2014
2019
2024
Year


25K To 50K To Paper Net Volume Migration - Scenario 2
Observed
Forecast
100000
50000
0
−50000
2009
2014
2019
2024
Year


25K To 50K To POSDebit Net Volume Migration - Scenario 2
Observed
Forecast
160000
140000
120000
100000
80000
60000
40000
20000
2009
2014
2019
2024
Year


25K To 50K To RTR Net Volume Migration - Scenario 2
Observed
Forecast
Number of Transactions
30000
25000
20000
15000
10000
5000
0
2009
2014
2019
2024
Year