

# CX-Analytics Profit Forecasting Model

## Functional Specifications

Version 5

30 June 2012



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# 1. Introduction and Purpose

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This document summarizes the functional design of the CX-Profit Forecasting Model (PFM) system, and includes the following sections:

- Input parameters required by the CX-PFM system
- Design methodology and key considerations of the CX-PFM system
- Outputs of the CX-PFM system
- Operational workflows illustrating needed actions to utilize the CX-PFM system effectively
- Notes and other assumptions

## 2. Definitions

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### 2.1 Model Key Terms

- 2.1.1 **Account Level Constant (ALC)** – Any value which varies across individual accounts but does not vary across the model’s time horizon.
- 2.1.2 **Account Level Variable (ALV)** – Any value which changes across individual accounts and across the model’s time horizon. Account-level variables can be forecast or inputs to the model as specified in this document. Typically, ALVs are standardized to account’s limit (balance) or limit available (spend).
- 2.1.3 **Account Level Variable Input (ALV Input)** – Any input to the model which changes over the life of the forecast at the account-level. Cash APR is an example of an ALV Input.
- 2.1.4 **Activity Vector** – A CX-Analytics defined normalized curve representing account activity over time, utilized to define the underlying behaviour of a Primary ALV.
- 2.1.5 **MOB** – Months on Book
- 2.1.6 **Dependent ALVs** – ALVs which utilize some combination of other ALVs, PLIs and/or ALCs to produce a P&L output of the model. For example, cash fees are dependent ALVs based on cash turnover and the cash fee rate.
- 2.1.7 **Historic Data** – Up to 12 months of series input data extending from the most recent calendar month backwards. It is presumed there are no ‘gaps’ in the data
- 2.1.8 **Historic Data Term** – The number of months fore which data are available historically for an account.
- 2.1.9 **Portfolio-Level Input (PLI)** – Any input which can be applied to the entire portfolio. For example, the cost of funds rate is a portfolio level variable.
- 2.1.10 **Primary ALVs** – Those ALVs that are calculated fundamentally from ALCs and regression coefficients applied to Activity Vectors.

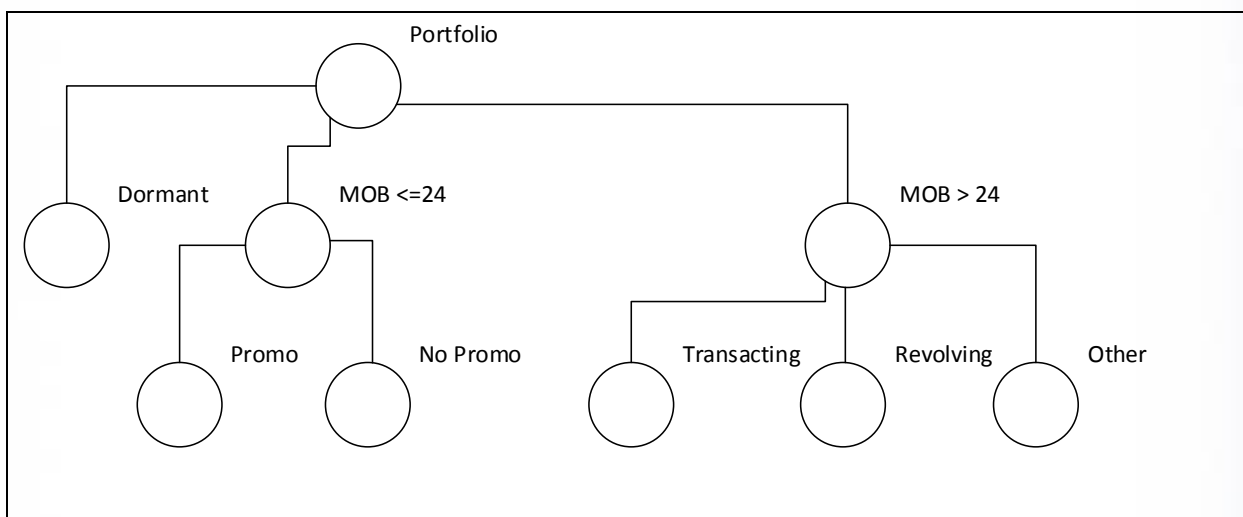
# 3. Functional Workflow

The functional workflow defines the behavior of the system and the processes drive the functionality of the system.

The CX-PFM system is designed to effectively model the profitability of the Client card portfolio. The separation of work into distinct steps simplifies the individual components of the model. The system workflow is comprised of the following steps:

## 3.1 High-level segmentation

The CX-PFM system initially performs a high-level, business based segmentation of accounts. This segmentation is based on an experience-based, discretionary grouping of accounts by key characteristics. Typically, CX-Analytics classifies accounts using a hierarchical approach based on account age and behavior.



**Figure 1. Indicative segmentation.**

The segmentation above reflects a typical approach, although client requirements and account attributes, such as APR assigned and product attributes will also drive the approach to segmentation. The end nodes reflect high-level segments.

## 3.2 Performance clustering

After segmentation, for each high-level segment performed in step 3.1, accounts are further categorized, for each primary ALV, into performance clusters. Within each high-level segment, accounts are clustered based on having similar month-over-month changes in the key primary ALVs. For example, accounts building merchandise balances will be separated from accounts paying off these balances. These will typically comprise two separate clusters.

# 3. Functional Workflow

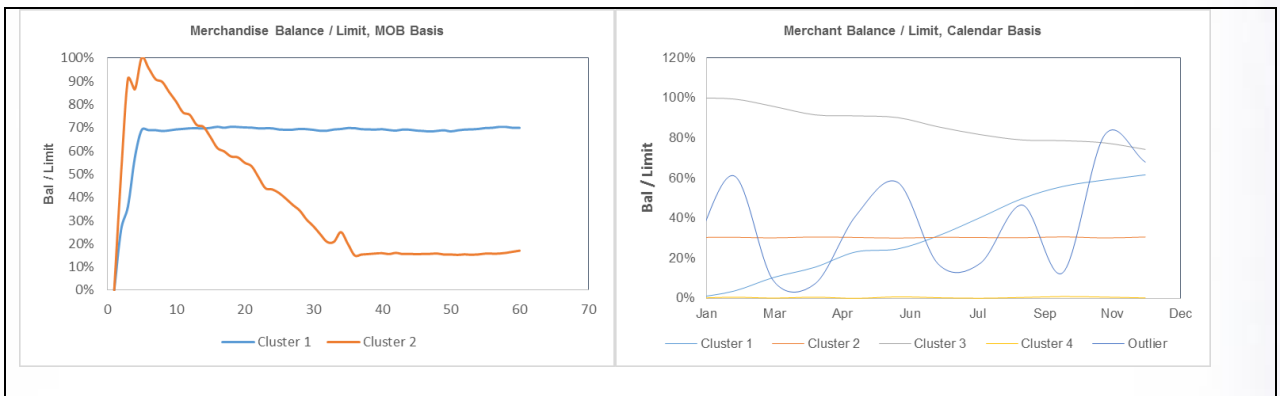
Accounts which exist in separate performance clusters across one key primary ALV may be part of the same performance cluster for another. Clusters within primary ALVs are independent of other ALVs for which performance clustering is performed.

The process of account/ALV level performance clustering is automated and is a proprietary algorithm developed by CX-Analytics.

## 3.3 Activity vector creation

After accounts are clustered, for each high-level segment and individual performance cluster, activity vectors are developed. These vectors are meant to reflect a typical account's performance within each performance cluster, for the primary ALV for which the cluster was developed.

Vectors for accounts younger than 24 months on book (MOB) are developed on a MOB basis. Vectors are formed starting with 0 months since open date as an anchor point. These vectors extend for 60 months of the account's history. Vectors for accounts with MOB > 24 are developed on a calendar basis. The typical account performance vector is a Jan-Dec, 12- month activity vector, meant to capture seasonality or calendar based trends.



**Figure 2. Vector development.**

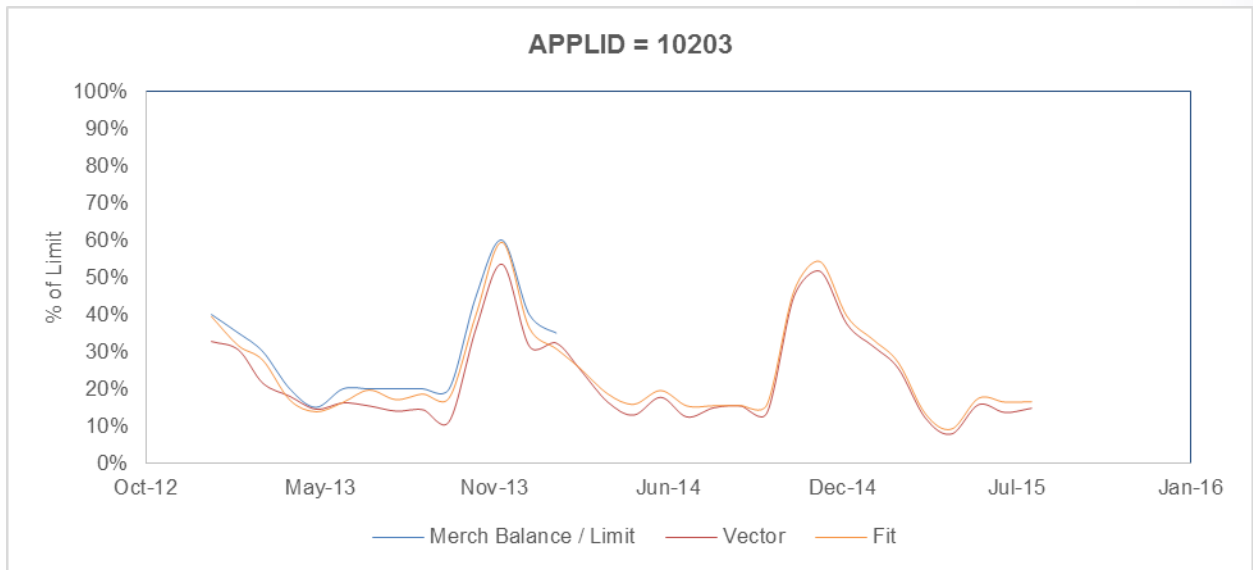
The above reflects examples of vectors developed by performance cluster. For illustrative purposes, both MOB and calendar based vectors are shown. These vectors are developed for the Merchandise Balance ALV, which has been standardized by dividing by the account's limit, to capture similar behavior without the effect of differing limits.

Vector creation is performed as a service by CX-Analytics, and utilizes both numerical methods and CX-Analytics experience with financial account performance. Vectors are typically updated quarterly or semi-annually, as account behavior is generally consistent over time.

# 3. Functional Workflow

## 3.4 Activity vector fitting

After vectors are developed, these vectors are fit to each individual account’s activity, for each primary ALV. The fitting process is meant to capture differences in scale between vectors and individual account’s performance. Vectors are assigned based on the initial performance cluster assigned for each primary ALV.



**Figure 3. Account-level vector fitting.**

The above plot illustrates the fitting process. Fitting accounts scales vectors to performance at the individual account level. This enables CX-PFM to produce a forecast at the account-level, and enables reporting across any set of measures, beyond the level of the original segmentation and clustering. Fitting also reduces the standard error of the forecast, which is evident in the example above.

All primary ALVs are fit to the individual account level. Typically this includes all relevant balances and spend categories and any additional client defined driver of profit. Fitting is an automated, numerical process executed by CX-Analytics, and is typically performed with the same frequency as the execution of CX-PFM.

## 3.5 Forecast

After primary ALVs are fit, primary ALVs can be scaled back to absolute values (for example, converting balance / limit vectors to total balance, based on an account’s limit at the end of period). Furthermore, dependent ALVs, such as all key income line items, can be derived using account-level constants.

# 3. Functional Workflow

CX 505: Primary Variable Results													CX-An	
Filename: Activity Client: Nationwide Building Society Execution Date: September 23, 2012 File Period: Oct2010-Jun2012 Validation Period: Apr2010-Jun2012														
Forecast Results (000s)														
Variable		JAN11	FEB11	MAR11	APR11	MAY11	JUN11	JUL11	AUG11	SEP11	OCT11	NOV11	DEC11	2011 YTD
Month-end Balance	Actual	£952,304	£959,680	£1,005,214	£1,074,945	£1,118,897	£1,151,751	£1,166,779	£1,192,789	£1,164,532	£1,193,391	£1,213,103	£1,242,098	£13,485,400
	Forecast	£956,714	£950,147	£992,525	£1,052,755	£1,110,793	£1,138,112	£1,158,533	£1,180,542	£1,195,140	£1,200,999	£1,209,039	£1,221,748	£13,386,040
	Error	-45%	1.00%	(1.26%)	(2.06%)	(5.46%)	(1.19%)	(0.77%)	(1.03%)	0.5%	0.37%	(4.81%)	(1.64%)	(1.64%)
Total ADB	Actual	£946,834	£949,899	£951,329	£997,201	£1,060,514	£1,109,943	£1,148,479	£1,187,904	£1,187,320	£1,193,997	£1,199,532	£1,213,745	£13,129,000
	Forecast	£955,993	£946,187	£1,002,794	£1,045,221	£1,107,899	£1,142,007	£1,177,556	£1,198,933	£1,215,832	£1,219,337	£1,224,223	£1,241,918	£13,477,880
	Error	0.48%	(3.88%)	5.42%	-4.82%	-4.46%	2.98%	2.53%	2.69%	2.37%	2.12%	2.06%	2.32%	2.60%
Total Turnover	Actual	£282,247	£231,589	£286,071	£281,870	£289,171	£284,962	£280,840	£310,024	£281,559	£281,151	£292,452	£313,701	£3,345,650
	Forecast	£281,324	£233,388	£286,260	£283,875	£288,552	£285,365	£282,555	£308,397	£285,608	£285,795	£295,530	£313,251	£3,359,010
	Error	(3.86%)	-7.77%	0.74%	-7.62%	(2.14%)	1.41%	0.11%	(5.25%)	1.44%	1.65%	1.05%	(1.43%)	4.26%
Revolving Purchase ADB	Actual	£485,423	£497,084	£488,451	£494,959	£492,001	£495,230	£499,906	£508,287	£512,327	£521,007	£531,022	£535,276	£6,072,840
	Forecast	£483,393	£485,786	£491,030	£496,078	£502,455	£507,043	£511,693	£515,202	£521,810	£526,467	£538,781	£548,385	£6,131,110
	Error	(4.18%)	(2.27%)	(1.49%)	2.29%	2.36%	2.39%	1.36%	1.85%	1.61%	1.36%	2.49%	1.86%	
Cash ADB	Actual	£29,222	£28,710	£28,276	£27,760	£28,321	£28,308	£28,569	£29,441	£29,940	£29,977	£29,036	£28,017	£345,920
	Forecast	£29,330	£28,059	£28,448	£29,148	£28,969	£28,973	£29,322	£29,775	£29,404	£28,573	£27,997	£27,739	£340,740
	Error	382%	1.31%	0.11%	4.35%	-2.24%	-3.36%	1.61%	1.13%	1.13%	(1.73%)	(4.85%)	(3.92%)	(9.92%)

Figure 4. Portfolio Activity and Profit and Loss Report.

The above report snapshot illustrates CX-PFM’s portfolio level Activity and P&L report, which includes both forecast and actual values for both primary and dependent ALVs at the portfolio level, and produces a measure for profit as an output.

## 3.6 Validation

CX-Analytics scrutinizes all CX-PFM output, including the following key metrics:

- Account-level standard error
- Tests for heteroscedasticity in primary ALV forecast
- Accuracy of forecast against 3 months of portfolio-level holdout data

In addition to internal validation, CX-Analytics typically performs a quarterly review with client management, both to verify and prove accuracy and to discuss next steps



# 3. Functional Workflow

## 3.7 Functional Architecture Diagram

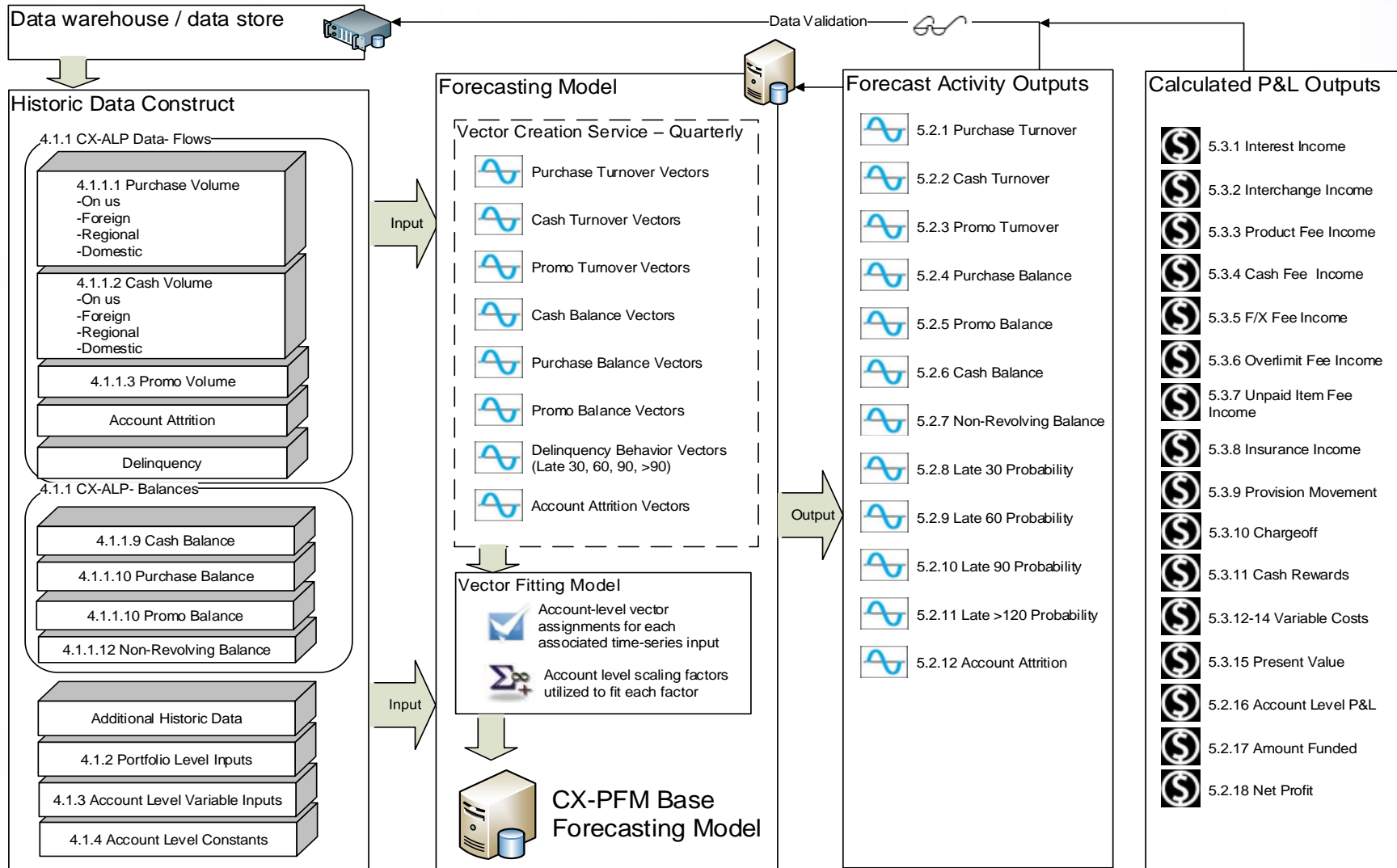


Figure 5. Functional architecture diagram.

# 4. Inputs

The input parameters for the CX-Profit Forecasting Model are derived from available data within the analytical environment and the CX-Account Level Profit (ALP) data. These input parameters are illustrated in the table below.

## 4.1 CX-Profit Forecasting Model Data Inputs

Required CX-PFM Data Inputs	
CX-PFM Input	Associated CX-ALP® or TSYS Analytics Field
<b>4.1.1 Historic Data</b>	
4.1.1.1 Month-End Purchase Volume	0.2.1 On-Us Purchase Amount
	0.2.3 Domestic Purchase Amount
	0.2.5 Foreign Purchase Amount
	0.2.7 Regional Purchase Amount
4.1.1.2 Month-End Cash Volume	0.2.2 On-Us Cash Amount
	0.2.4 Domestic Cash Amount
	0.2.6 Foreign Cash Amount
	0.2.8 Regional Cash Amount
4.1.1.3 Month-End Promo Volume	0.2.11 Balance Transfer Amount
4.1.1.4 Days Past Due at Month End	0.4.6 Days Past Due Count
4.1.1.5 Cycle Cash Balance	0.5.3 Cash Balance at Cycle
4.1.1.6 Cycle Purchase Balance	0.5.4 Purchase Balance at Cycle
4.1.1.7 Cycle Promotional Balance	0.5.5 Promo Balance at Cycle
4.1.1.8 Cycle Non-Revolver Balance	Sum of CX-ALP 0.5.17-36, Based on Client need
4.1.1.9 Triad Score	ACCOUNT.TRIAD_SCORE
4.1.1.10 Months on Book	0.11.2 Months on Book
4.1.1.11 Credit Limit	0.1.9 Total Credit Limit
4.1.1.12 Cash Limit	0.1.10 Cash Limit
4.1.1.13 TCAT Level APR	0.13.8-0.13.37 TCAT Level APR
4.1.1.14 Observation Month	0.11.11 Observation Month
4.1.3.15 Servicing/Operations Costs per Volume	Derived from CX-ALP 4.1-4.7
4.1.3.16 Variable Technology Costs per Volume	Derived from CX-ALP 4.9
4.1.3.17 Variable Fraud Costs per Volume	Derived from CX-ALP 4.8
<b>4.1.2 Account Level Constants</b>	
4.1.2.1 Postal Code	ACCOUNT.ZIP
4.1.2.2 Country	ACCOUNT.COUNTRY
4.1.2.3 Birth Date	ACCOUNT.BIRTH_DT
4.1.2.5 Employee Indicator	ACCOUNT.EMPLOYEE_CD
4.1.2.6 Prescreening Score	ACCOUNT.PRE_SCR
4.1.2.7 Recovery Flag	ACCOUNT.STF_RECOVERY
4.1.2.8 Foreclosure Flag	ACCOUNT.STC_FORECLSR
4.1.2.9 Product	0.10.2 Product Code
4.1.2.10 Revolving/Transacting Status	0.1.12 – 0.1.14 Revolving/Transacting/Dormant
4.1.2.11 Profit	CXALP.PRETAXOPPROFIT

# 4. Inputs

CX-PFM Input	Associated CX-ALP® or TSYS Analytics Field
4.1.2.12 Channel	0.9.1 Response Channel
4.1.2.13 Close Date	TA.CLOSE_DT
<b>4.1.3 Portfolio Level Inputs</b>	
4.1.3.1 Cost of Funds	To be delivered by Client (when required)
4.1.3.2 Impairment Rate Structure	To be delivered by Client (when required)
4.1.3.3 MOB v. Calendar Threshold	To be delivered by Client (when required)
4.1.3.4 Rate of Discount for NPV	To be delivered by Client (when required)
<b>4.1.4 Account-Level Variable Inputs</b>	
4.1.4.1 Cash Fee Rate	To be delivered by Client
4.1.4.2 F/X Fee Rate	To be delivered by Client
4.1.4.3 Payment Protection Insurance Rate	To be delivered by Client
4.1.4.4 Overlimit Fee Rate	To be delivered by Client
4.1.4.5 Late Fee Rate	To be delivered by Client
4.1.4.6 Cash Rewards Rate	To be delivered by Client
<b>4.1.5 New Campaign Inputs</b>	
4.1.5.1 Calendar Month to Begin Forecast	To be delivered by Client upon addition of New Accounts/Campaign
4.1.5.2 Expected Cash Balance Behaviour	
4.1.5.3 Exepected Purchase Balance Behaviour	
4.1.5.4 Expected Promo Balance Behaviour	
4.1.5.5 Expected Non-Revolving Balance Behaviour	
4.1.5.6 Expected Cash Balance	
4.1.5.7 Vectors for Promo Turnover	
4.1.5.8 Expected Delinquency Behaviour	
4.1.5.9 Expected Cash Limit	
4.1.5.10 Expected Credit Limit	
4.1.5.11 Number of Expected Additional Avtive Accounts	

## 4.2 Metadata Dependency

To successfully execute the forecasting model as a service, CX-Analytics requires the monthly provision of account-level metadata to CX-Analytics. These metadata are defined by the following criteria:

- Data contains a surrogate key for APPLID
- Data contains no PII
- Data contains records for the entire portfolio for the following tables:
  - TA6950.CX\_ALP
  - TA6950.CX\_ACCOUNT
  - TA6950.CX\_TRANS\_BALANCE

CX-Analytics can begin development of forecasting model activity vectors only upon the completion of this necessary prerequisite.

# 4. Inputs

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## 4.3 New Account Campaign Inputs

The CX-PFM system can also forecast new business, provided a detailed set of new business assumptions are provided as inputs. New campaign inputs are detailed in section 4.1.5. Furthermore, various anomalies such as the inclusion of introductory offer periods, promotional rewards and other product attributes must be modeled by CX-Analytics in a discretionary way with input from the client.

## 4.4 Input Frequencies and Timings

The following frequencies and timings for inputs are necessary to run the model:

- Historic Data Input – This is sourced monthly from CX-ALP at month-end
- Account Level Constants – This is sourced monthly from CX-ALP at month-end
- Portfolio Level Inputs – These are delivered by client annually
- Account-Level Variable Inputs – These are delivered by client quarterly
- New Account Campaign Inputs – These are delivered by client quarterly

# 5. Outputs

Output is provided in the formats described below:

## 5.1 Forms of Output

CX-Analytics provides **three outputs** from the CX-PFM solution: (1) data and (2) a quarterly management advisory and (3) bespoke reports. Outputs are typically delivered as a service.

- 5.1.1 **Forecasted Account-Level Data** –The CX-PFM solution provides forecasted data for up to 36 months beyond the current month. Data output consists of all forecasted elements listed in Section 5.2 and all Calculated Outputs listed in Section 5.3.
- 5.1.2 **CX-Analytics Quarterly Advisory** – In addition to providing forecasted data, CX-Analytics analyzes the CX-PFM forecast and draws conclusions leveraging industry expertise and thorough analysis. This service utilizes the output of the CX-PFM solution to provide strategic and operational consulting. In addition, a review of previous forecasting to provide for the ongoing modeling and improvement of Activity Vectors is generally included with this service.
- 5.1.3 **Quarterly report pack** – In addition to providing quarterly advisory, CX-Analytics typically delivers a quarterly report pack, including segment and cluster level validation, a forecast P&L at the account level, and a set of diagnostics used for model validation.

## 5.2 Primary ALV Outputs

The CX-PFM system produces the forecasted outputs corresponding to the various time-series data provided through the CX-ALP® platform. After vector fitting, the following vectors will serve as the primary output of the CX-PFM system, and all cost and revenue outputs are derived using these vectors:

CX-PFM Primary ALVs	
Output ID	Output Description
5.2.1	Purchase Turnover
5.2.2	Cash Turnover
5.2.3	Promo Turnover
5.2.4	Purchase Balance
5.2.5	Promo Balance
5.2.6	Cash Balance
5.2.7	Non-Revolving Balance
5.2.8	Late 30 Probability
5.2.9	Late 60 Probability
5.2.10	Late 90 Probability
5.2.11	Late >120 Probability
5.2.12	Account Attrition

# 5. Outputs

## 5.3 Dependent ALV Outputs

The system then utilizes the explicitly forecasted time-series vectors to project the key metrics defining the operations of the business. These metrics are calculated using account-level constants or portfolio-level constants

CX-PFM Dependent ALVs	
Output ID	Output Description
5.3.1	Interest income
5.3.2	Interchange income
5.3.3	Product fee income
5.3.4	Cash fee income
5.3.5	F/X Fee income
5.3.6	Overlimit fee income
5.3.7	Unpaid item fee income
5.3.8	Expected value of Impairment cost at account-level
5.3.9	Expected value of charge off
5.3.10	Cash rewards
5.3.11	Variable servicing operations costs
5.3.12	Variable technology costs
5.3.13	Variable fraud costs
5.3.14	Net present value of the account (n = 36 periods)
5.3.15	Account level forecasted P&L (36 month time series projection)
5.3.16	Total cost of funds
5.3.17	Net Profit

## 5.4 Notes on Impairment Calculations

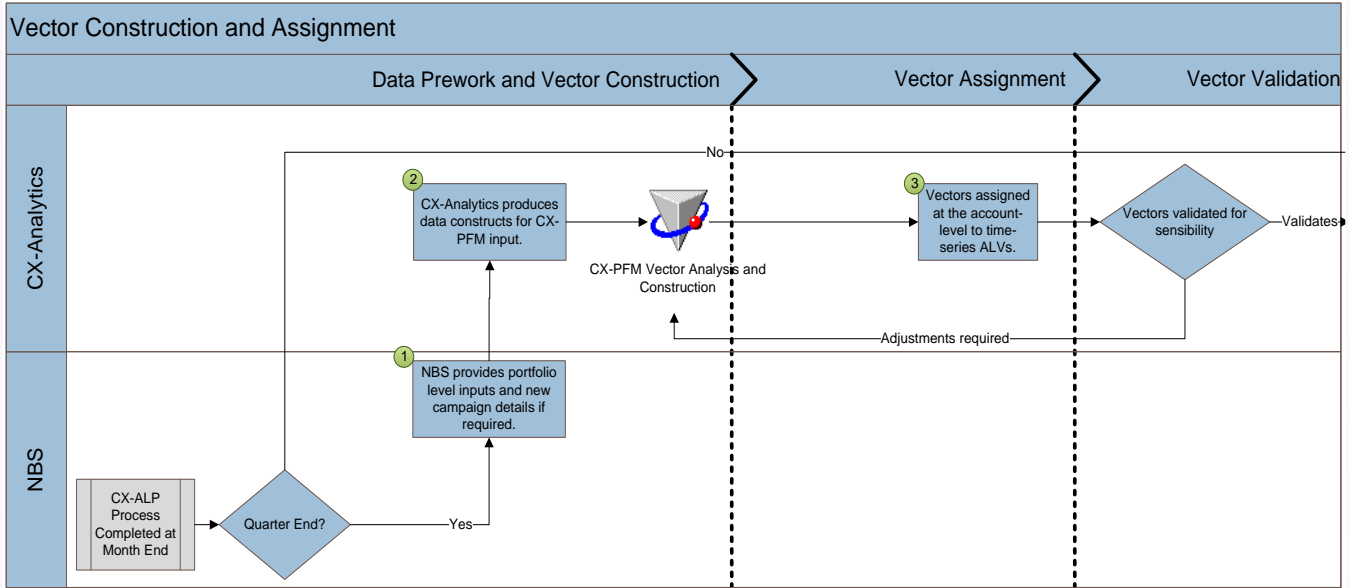
Delinquency calculations and the prediction that a specific account will be in a specific delinquency status at any given time in the future, produce an expected value (as opposed to a forecast of an exact delinquency state).

CX-PFM provides a calculation of an expected value of provision movement and charge off amount within a forecasted month. This expected value is a Dependent ALV which is calculated using the Primary ALVs representing delinquency. While TRIAD scores do play a role in provisioning, an average provision amount is calculated and inputted by client in the form of impairment rate structure, taking into account only the past due status, as TRIAD scores are not forecasted in the model.

# 6. Operational Workflows

The operational workflows provided include all core sets of activities required to utilize and interpret the CX-PFM solution.

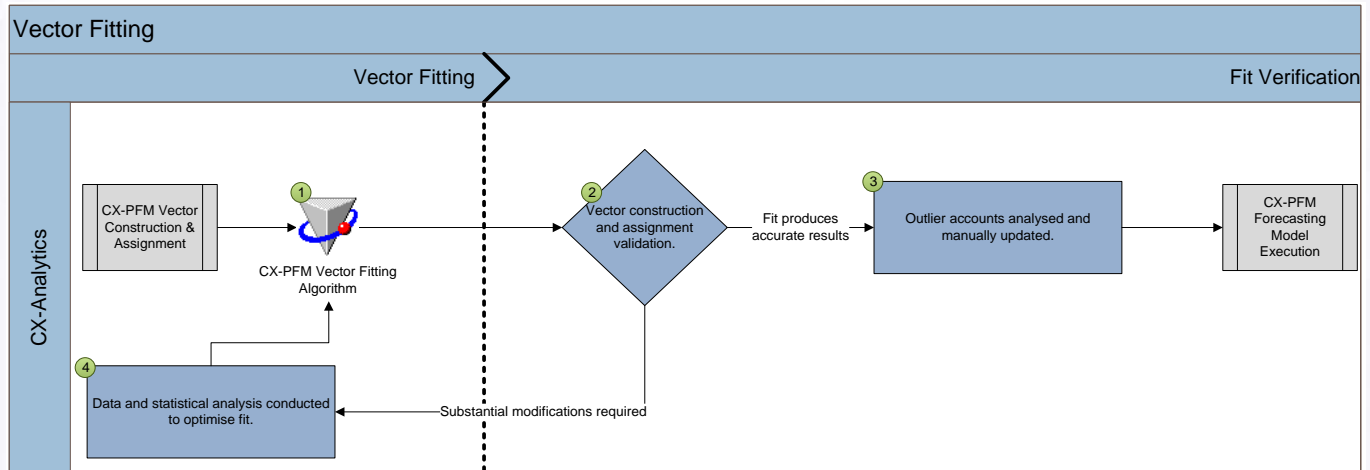
## 6.1 Vector Construction and Assignment



Vector Construction and Assignment					
Step	Process	Responsible Party	Input	Output	Time
6.1.1	Client provides account and portfolio level inputs, new campaign details if required	Client	CX-ALP® data, TA data	Client portfolio input file	10 days
6.1.2	CX-Analytics produces data constructs	CX-Analytics	CX-ALP® data, TA data, client portfolio inputs	Data views	1 day
6.1.3	Vectors are assigned	CX-Analytics	CX-PFM data construct, client portfolio inputs	CX-PFM vectors	4 days

# 6. Operational Workflows

## 6.2 Vector Fitting

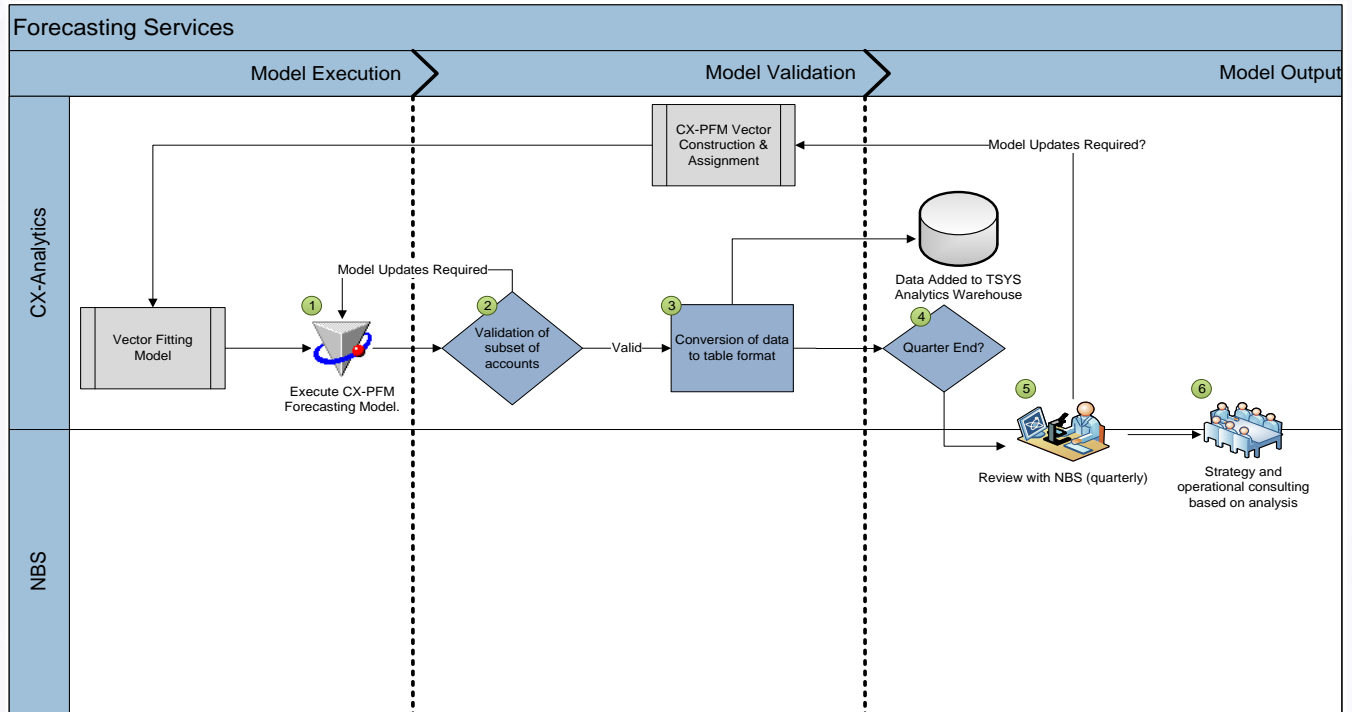


Vector Fitting					
Step	Process	Responsible Party	Input	Output	Time
6.2.1	CX-PFM vector fitting algorithm	CX-Analytics	CX-PFM data construct, CX-PFM vectors	CX-PFM data construct with fitted vectors	1 day
6.2.2	Vector construction and assignment validation (occurs once per quarter at maximum)	CX-Analytics	CX-PFM data construct with fitted vectors	Updated vectors	15 days day
6.2.3	Outlier account analysis	CX-Analytics	CX-PFM data construct with fitted vectors		2 days
6.2.4	Fit optimisation	CX-Analytics	CX-PFM data construct with fitted vectors	Updated vector fitting algorithm	1 day



# 6. Operational Workflows

## 6.3 Forecasting Services



Vector Fitting					
Step	Process	Responsible Party	Input	Output	Time
6.3.1	Execute CX-PFM Forecasting Model	CX-Analytics	CX-PFM data construct with fitted vectors, client portfolio level inputs	CX-PFM forecasted data set	
6.3.2	Validation	CX-Analytics	CX-PFM forecasted data set	Validated CX-PFM forecasted data set	
6.3.3	Data Conversion	CX-Analytics	Validated CX-PFM Forecasted data set	CX-PFM forecasted data set made available in TA	
6.3.4	Quarter End	N/A	N/A	N/A	
6.3.5	Review with client	CX-Analytics	Validated CX-PFM forecasted data set		
6.3.6	Strategy and Operations Business Consulting (can occur once per quarter at maximum)	CX-Analytics	Forecasting Model quarterly review deck, Detailed forecast analysis		

# 7. Notes

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## 7.1 Macro-Economic Considerations

The incorporation of macro-economic data into forecasts of account risk and profitability has long been on most lenders' wish-lists. However, developing an empirically-based model that would do so has – to our knowledge – never been successfully accomplished. There are several reasons for this failure:

- (1) Historical account performance data have not existed over a sufficiently long time horizon to allow their inclusion in econometric models, which generally require time series data measured in decades in order to cover relevant changes in business and other economic cycles;
- (2) The relationships among macro-economic factors and consumer credit performance is extremely complex and may vary from time to time;
- (3) Consumer credit performance itself may be a leading indicator for certain macro-economic events (for example, the present mortgage crisis has been driven in part by the higher-than-forecast delinquency among mortgage loans, which in turn affected the performance of securitised assets, etc.

Even if macro-economic indicators could be identified that would assist in forecasting account risk and profitability, it would be necessary to forecast the occurrence of these leading indicators themselves – something that economists and businesses have not been terribly successful in doing in the past.

Having acknowledged all of the above, it still may be beneficial to allow an account profitability forecast to be influenced by a lender's own assessment of the future economy and its probably effect on credit risk and profitability. Therefore, the solution will incorporate macro economics as follows:

- The risk and impairment assumptions are derived from a client's Risk Management team, which allows updates at an F-Segment and Behaviour Segment level on a monthly basis. To the extent client's future risk assessments include affects of macroeconomic changes, these will be incorporated.
- The portfolio level inputs for the forecasting system will allow adjustments (percentage-based) of turnover and balance calculations in the model on a calendar month basis. The inputs are supplied by the business user.
- New account segments are separately modeled thereby allowing specific assumptions for account originated in a specific, future period.
- The Scenario-analysis capability of CX-ALP® allows a client's to model changes to actual, historic results based on changes in up to three key performance assumptions concurrently. Utilising this CX-ALP® function, a client could create scenarios where unit credit losses, balances and turnover were changed and then utilise the output to adjust inputs to the forecasting system.

# 7. Notes

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The proposed forecasting system contains no direct input of macroeconomic data and does not explicitly forecast future performance of any variable based on changes to macroeconomic data.

## 7.2 Forecast period

It is recommended that the forecast period be 36 months into the future. Forecasts of lengths beyond 36 months are difficult to justify and are lower in accuracy, but have been previously implemented based on client requests.