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# Adopting SAS® Viya® into your Business: Data Success Tales from a Central Bank's Perspective

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## ABSTRACT

Data maturity is an essential element of a successful business. To support business growth and capacity, companies, like Eastern Caribbean Central Bank (ECCB) seek to adopt high performance, user-friendly data and analytical solutions as they outgrow tools such as Microsoft Excel.

This paper shows how ECCB matured from a legacy system primarily using Microsoft Excel for analytics and reporting purposes to a customized, self-service, robust system powered by SAS Viya. SAS Viya's ability to connect Python – an open-source interface – and REST APIs to the Cloud Analytics Services (CAS), along with web-based analytics and reporting capabilities, was an optimal analytical solution that supported ECCB's vision for growth and complex business process.

In this paper, we will walk you through the business issues that inspired the change, the specific techniques we used to solve the data issues, and how they integrated the solution into their processes. All solutions have their wins and losses – so we will share the practices that worked well and those that could have gone better.

## OVERVIEW OF EASTERN CARIBBEAN CENTRAL BANK FROM THE BUSINESS PERSPECTIVE

### WHAT IS THE EASTERN CARIBBEAN CENTRAL BANK?

The Eastern Caribbean Central Bank (ECCB) is the monetary authority for a currency union with a quasi-currency board arrangement. Based on the Eastern Caribbean Central Bank Agreement Act 1983, the ECCB has the power 'to issue and manage currency, to safeguard its international value, to promote monetary stability and a sound financial structure and to further the economic development of the territories of the Participating Governments.' There are eight member countries, six of which are independent, while two are territories of the United Kingdom. The ECCB was established on October 1, 1983 following an agreement signed on July 5, 1983 between the Government of Antigua and Barbuda, the Commonwealth of Dominica, Grenada, Montserrat, Saint Christopher (Saint Kitts) and Nevis, Saint Lucia and Saint Vincent and the Grenadines. Anguilla became a member of the Bank on 1 April 1987.

The Eastern Caribbean Central Bank Agreement Act 1983 includes the following purposes as laid out in Article 4:

- To regulate the availability of money and credit.
- To promote and maintain monetary stability.

- To provide credit and exchange conditions and a sound financial structure conducive to the balanced growth and development of the economies of the territories of the Participating Governments.

- To actively promote through means consistent with its other objectives the economic development of the territories of the Participating Governments.

The ECCB has as its main target the maintenance of a competitive fixed exchange rate. It has in fact maintained such a fixed rate to the US dollar of EC$2.70 to US$1 over the last 43 years.

### HOW DOES ECCB FULFILL ITS MANDATE?

The Board of Directors is responsible for policy and general administration of the ECCB. However, the highest decision-making body of the ECCB is the Monetary Council, which is comprised of a Minister of Government from each of the participating governments. The Monetary Council and the Board of Directors meet on a regular basis to receive updates on monetary and credit conditions and to give directives on such policy matters. "Nothing is more important for monetary policy than good statistics," says the first President of the European Monetary Institute, Alexandre Lamfalussy, in the foreword of the publication "Statistical Needs of the Monetary Union" (1996).

Statistics are a critical input for the Bank to effectively fulfill its monetary policy and financial stability mandates. The ECCB therefore collects macroeconomic statistics, such as national accounts, external sector statistics, monetary and financial statistics and government financial statistics, on a regular basis from all of its member countries. These statistics must be of the highest quality and collected on a timely basis to support the Bank in executing its functions.

## THE PURPOSE OF THE STATISTICAL SOLUTION

Over the past 10 years, there has been exponential growth in data demands for both financial and economic data. During that time, however, there was little progress made in technological advancements with respect to data management. Consequently, technology became outdated and manual processes resulted in increased operational and reputational risks.

In 2013, the ECCB began exploring options for a new statistical enterprise solution (SES) to house data submitted by various providers, such as commercial banks, statistical offices and other government agencies. SAS was selected as ECCB’s SES choice and their digital transformation began by automating manual processes and expanding their statistical and reporting capabilities. In order to meet the demands of the ECCB's consumers, the solution was designed, developed and implemented as a statistical system covering the collection, processing, storage and the dissemination of data by leveraging SAS’ data integration and business intelligence platforms.

In 2019, Version 2 of the SES solution was released which modernized the existing platform by introducing an array of technologies integrated through the SAS® Viya® platform. This enabled a seamless workflow across the main functional needs of ECCB and their partners. While SAS9 and SAS Viya are the hub of the solution, other open source technologies, such as JavaScript, Angular, JSON, Python, and rest APIs, are leveraged to support the user experience and external data integration and reporting requirements. Figure 18 provides a

high level architectural diagram of the solution and how the data interfaces with the variance components.

Data for the solution is stored in SAS, PostgreSQL tables, and CAS. The solution supports internal and external consumers in both interactive, batch, and streaming to third parties such as the International Monetary Fund (IMF). The end result is an innovative and scalable solution that seamlessly integrates SAS and non-SAS tools to solve the data collection, transformation, submission, reporting and analytical tasks for the ECCB.

## HOW THE SOLUTION IS BEING USED

Timely, quality data is vital to the success of the ECCB and the SES. As such, the solution provides innovative ways of performing both real-time and batch data management processes and techniques to ensure the validity and integrity of the data.

The data management processes are broken into three phases: data upload/collection, data storage and processing, and data retrieval and reporting. These phases are discussed in more detail below.

## PHASE 1: DATA UPLOAD/COLLECTION

### OVERVIEW

Prior to the implementation of SAS, data providers would submit hardcopy (data) forms to the ECCB, via fax, mail, or email, which was not considered a secure way of collecting sensitive data. This resulted in a major shortcoming of the legacy system, which required a lot of manual intervention and resource time. Data validation took place after inputting the data in the system and was accessible to internal users only prior to completion. The ECCB also requires a way to manage over 75 types of economic and financial data forms containing thousands of indicators which the legacy system did not have the capacity to handle.

The new solution has offered the following benefits to ECCB and its users:

- Financial institutions and other data providers are able to submit data via a secure server using a user-friendly web-based interface.
- Data can be uploaded using Excel files so there is no additional burden placed on data providers in submitting data to the ECCB.
- Data is not uploaded to the database unless it passes various checks (including consistency in data within and across forms – e.g., loans by economic sector on one form should equal total loans on another form).
- Set criteria for large changes in data periods have allowed ECCB to collect ‘variance’ explanations as part of the upload process. Data are not uploaded to the data warehouse unless these ‘variance’ explanations are provided.
- Variance explanations can be uploaded for sections that were inadequately reported.
- Qualitative/categorical data were previously not available to the users other than on the forms. The new solution stores the information and makes it available to the users through SAS Viya.
- The Excel files uploaded by the data providers are archived automatically in an organized system.

- Email alerts have been generated to send reminders of upcoming due dates, late notice for outstanding data, and successful and unsuccessful submissions of data (with reasons).
- The system was designed to have ‘watchers’ during the upload process; that is, supervisors receive progress notifications of their staff uploading data.

## IMPLEMENTATION

The SES is designed to limit only system-approved data from being staged in the system for further processing. This was accomplished through the development of a modern web-based data collection interface that drives real-time business rule evaluation and feedback as data is submitted by users and before being ingested into the system. The process provides feedback to the end user as it performs complex quality checks on the submitted financial and economic data. Only then does it store the data in the data warehouse to achieve the benefits listed above.

The user interface (Figure 1) runs as an application from within SAS Viya and leverages the existing SAS security infrastructure. Allowing external (banks, credit unions, countries, non-banking financial institutions, etc.) and internal (ECCB employees) data providers to upload their financial and economic indicator data in groups with common characteristics, called forms.

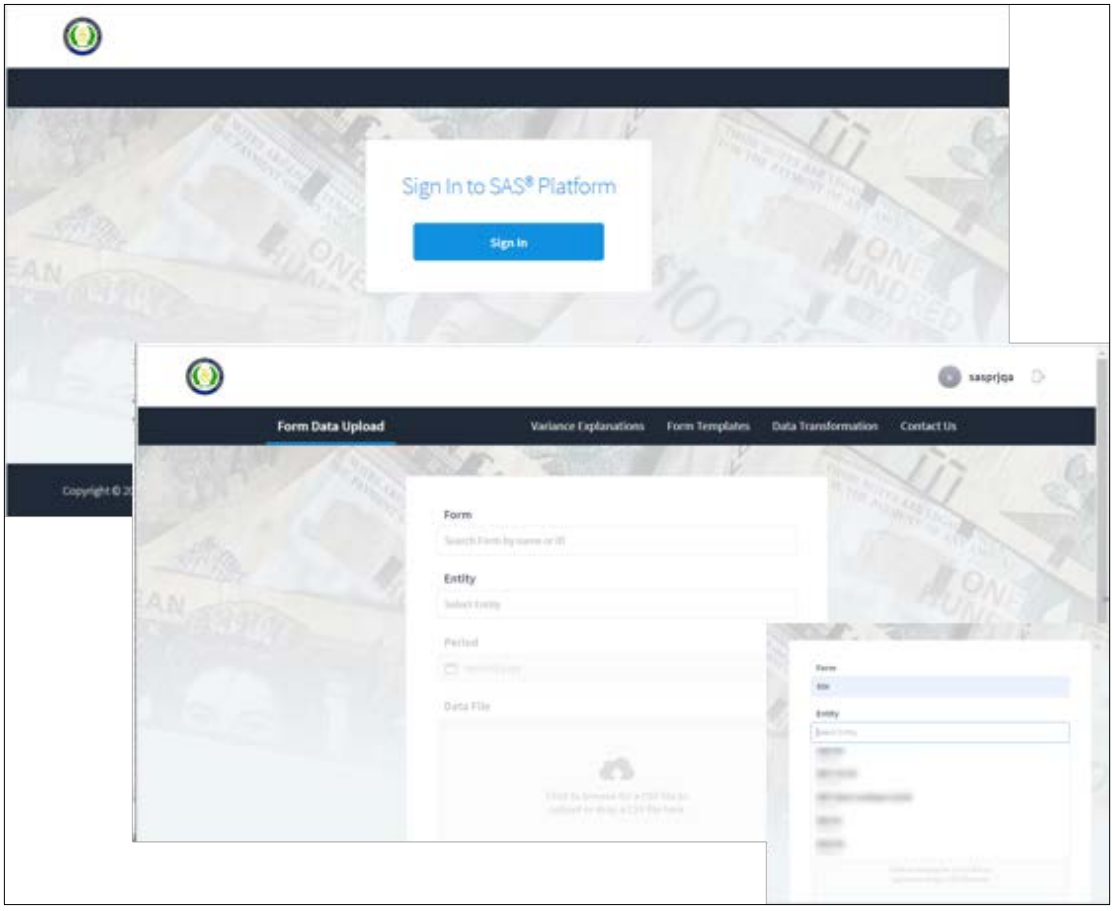



Figure 1. User Interface Screen

The user interface is written using the Node.js JavaScript framework and Angular. The application communicates with a SAS DataFlux Data management server through a RESTful API. Users input information into the UI and data is transformed into standardized JSON format before it is sent to the DataFlux server. Responses from this server are then parsed and drive the user experience as they progress through the upload process. The application performs extensive quality checks on the forms driven by definitions stored in PostgreSQL tables. In addition to confirming the data in the form being uploaded meets the expectations of what the user is selecting to upload, the system also applies data-level quality checks known as consistency and variance checks. Consistency checks are performed against indicator data either within a form or between forms, which are submitted at different times but require a dependency to exist between them.


Figure 2. Consistency Checks Screen

Variance checks validate that the value being submitted is above or below a criteria set by the ECCB between periods. If the criteria has been met, the user is required to provide explanations before the submission is accepted. The application manages the collection and storage of these explanations for audit purposes, as well as email notifications and interactive online feedback for successful and unsuccessful submissions.


Figure 3. Variance Checks Screen

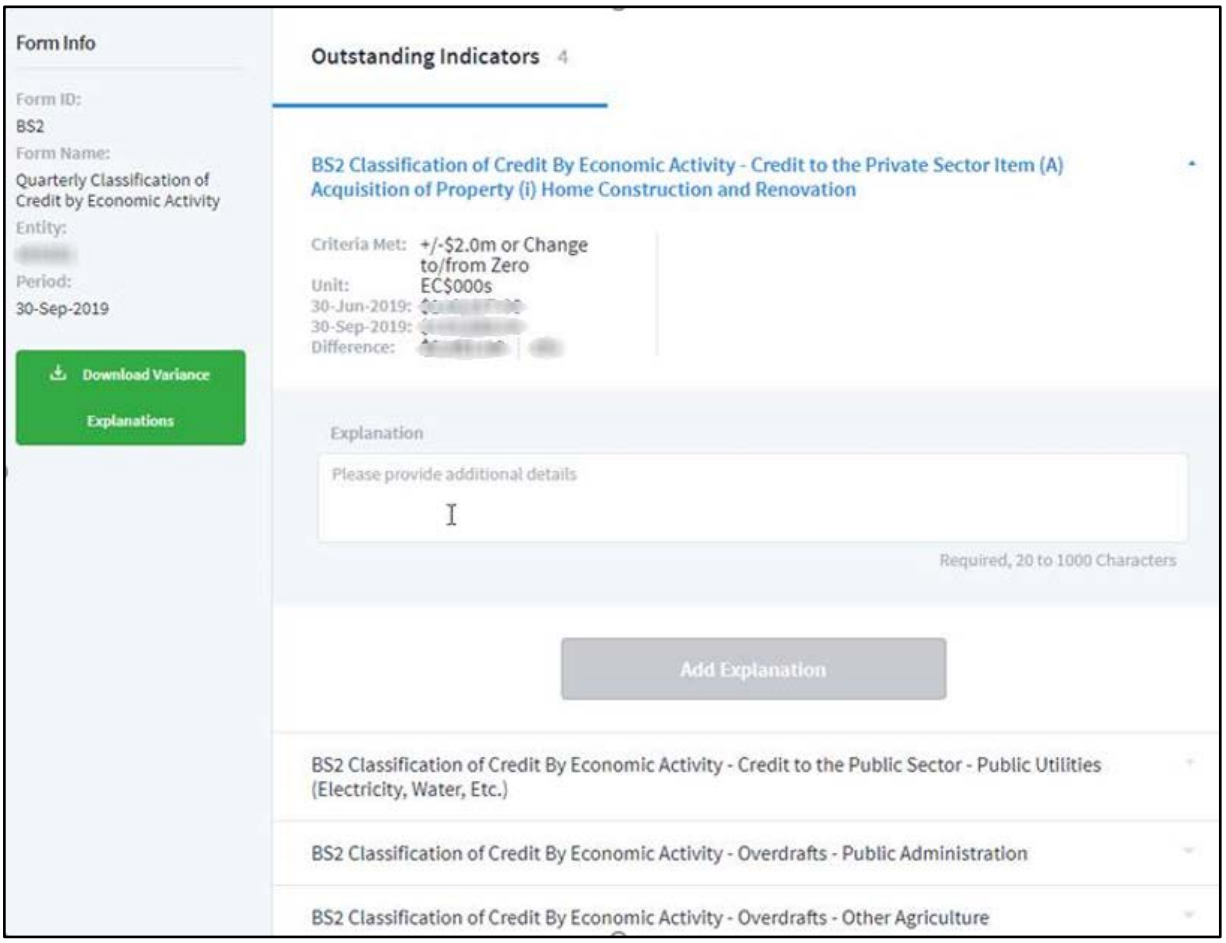



Figure 4. Variance Checks Explanation Screen

Due to the diverse user base for the system, security is a very important aspect of the system, and requires user authorization to different components of the system and row-level and column-level security. As such, roles defined within SAS Viya are used to provide permissions to submit or access data, reports, and restrict sensitive financial data. The same roles also control email notifications delivered to authorized users from either the data collection process or the daily forms submission management process discussed below.

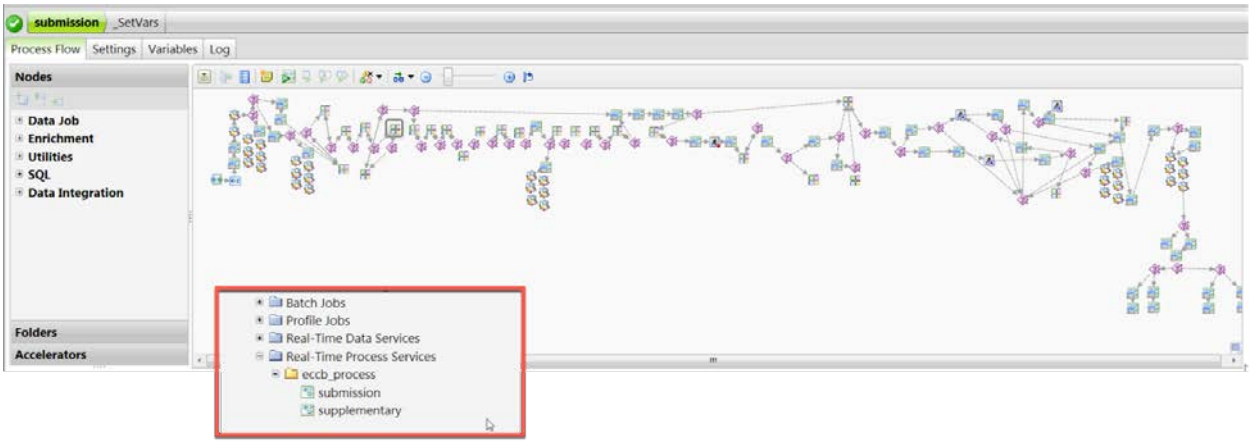



Figure 5. Data Quality Web Services

In addition to the real-time submission process, the data collection also leverages daily batch batch processes to manage the forms' due dates and submission status and sends reminder emails when appropriate to relevant parties based on their roles. Form submission status and the data produced by the data transformation process (as described in phase 2) are accessible in SAS Viya by statisticians, external data providers, and business analysts for reporting and analysis.

The process also performs maintenance activities, such as syncing the user table in the data warehouse to the user definitions in SAS Viya and sending email notifications for forms coming due and forms past due. The formulas for calculating form due dates and the email notification schedule were tightly linked to a country's defined workdays through a data-driven approach utilizing SAS user-defined calendars. A user-defined workday calendar is created for each country to aid in making calendar computations easier.

## PHASE 2: DATA STORAGE AND DATA PROCESSING

### OVERVIEW

While the legacy system could process data (create ratios, consolidate data, and collapse to lower frequencies), it was not done in the most efficient, or timely, way. The processing of the data is also part of the solution and is done after a data transformation run has been scheduled. A data transformation is the business logic to move the data from the staging area, which is updated through the data collection and form submission phase, into a data mart built on a star schema methodology. The data transformation scheduler has a user-friendly, web-based UI that is restricted to administrative users only.

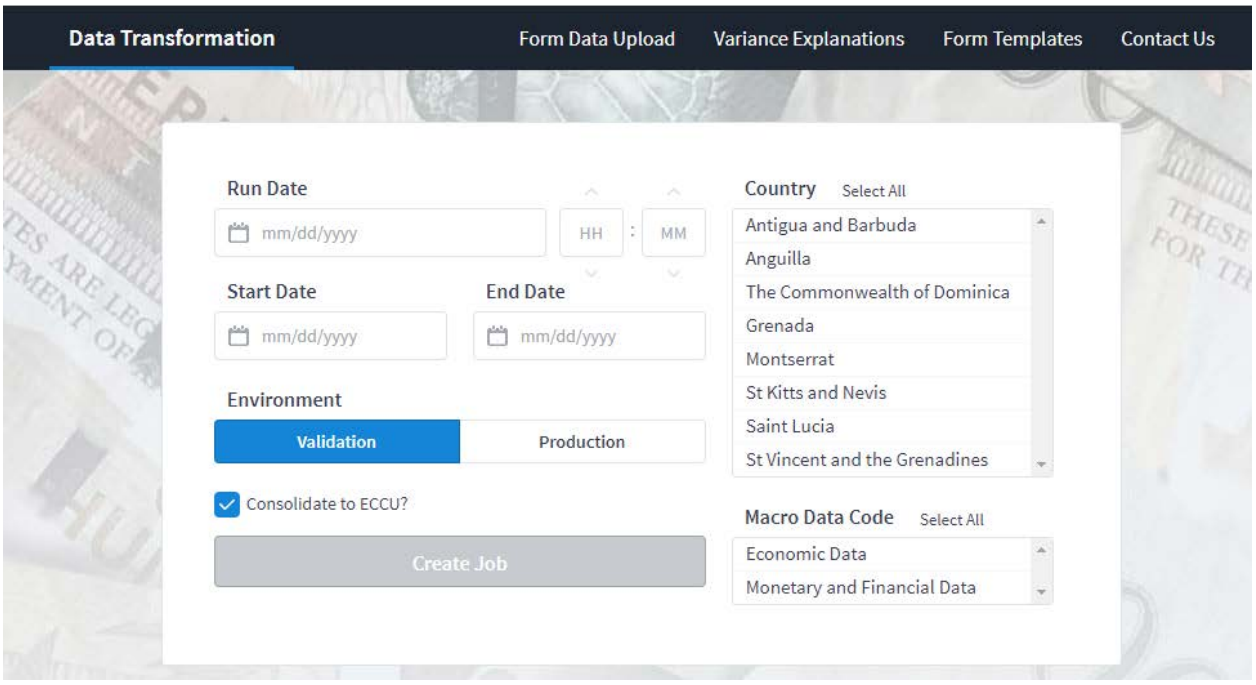



Figure 6. Data Transformation Screen

The scheduler contains various parameters that can be customized by the user to drive the type of data management process required. This includes the start and end dates for the data to load, countries, types of data (economic and/or financial), and data source to be updated (validation and/or production).

The data transformation performs the following tasks:

- Data submitted are processed through a data-driven system, managed and maintained by the ECCB, with pre-defined calculations (derives) as well as consolidated by country, the Eastern Caribbean Currency Union (ECCU) and custom groups (i.e. foreign banks vs. national banks).
- Data for all frequencies (from daily to annually) can be stored.
- Data are also available for various cumulating frequencies - monthly data stored as quarterly and annually for example based on type of data (stock (raw data where the value represents a single period for the base frequency) vs. flow (raw data which represents the value as of the period).
- While the data source keeps all of the data uploaded by a data provider, only the latest data are accessible to those retrieving the data.
- Two different data sources were created to allow for those responsible for validating the data to review them before sending them to the published/live data warehouse.

## IMPLEMENTATION

The data transformation (DT) component, as previously mentioned, is a batch process, which performs extensive computations on the source data. Unlike typical ETL (extract, transform, load) processes, the majority of the data management and quality tasks occur in the data collection phase. However, the process still leverages standard data warehouse modeling and implementation techniques to support slowly changing dimensions to prepare the data for the consumers to view various point in times.

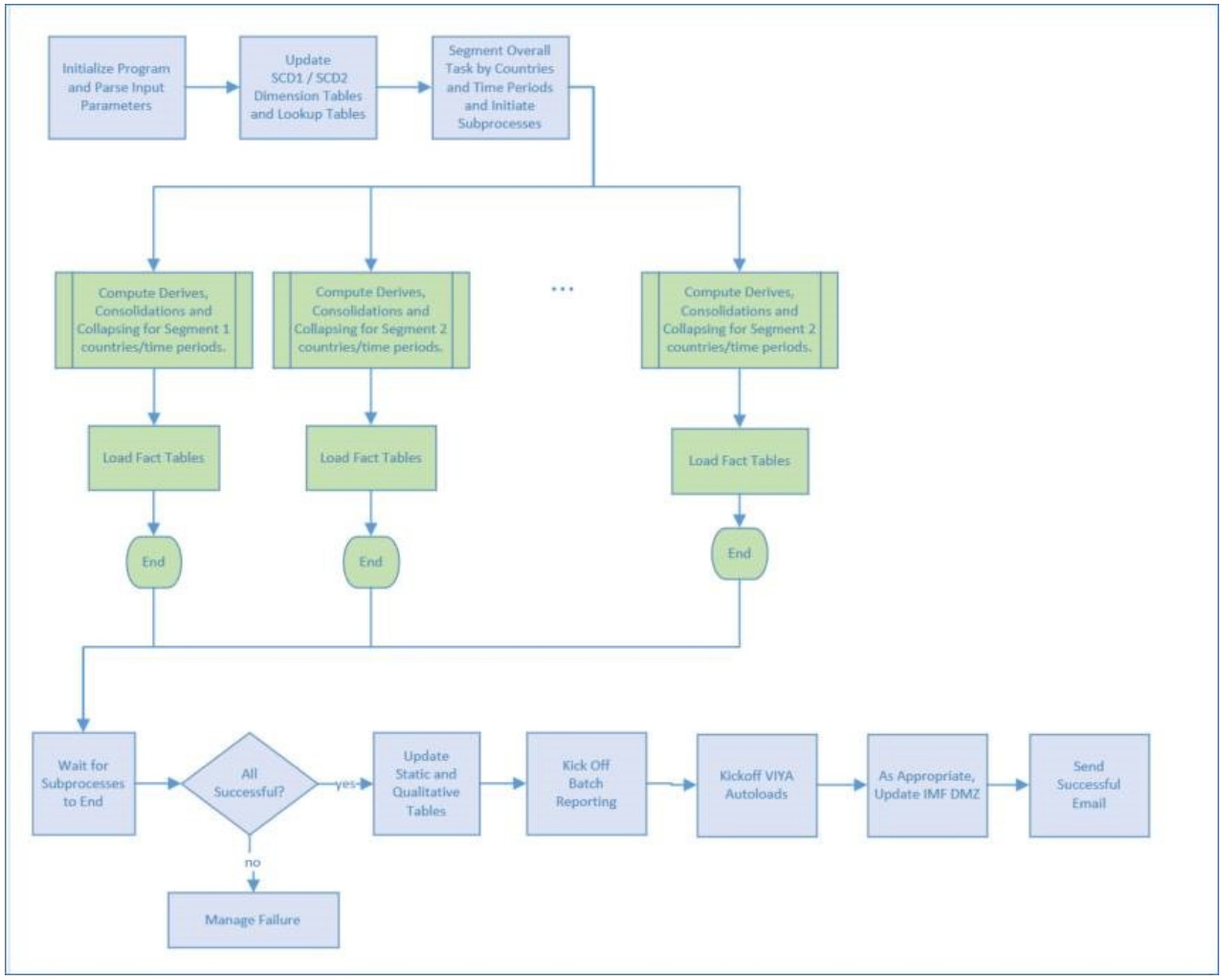



Figure 7. Data Transformation Process Workflow

The DT process controls the synchronization of data between the primary database, SAS® Cloud Analytics Services (CAS), and a database in the DMZ. The applicable system updates vary from one run to another, but are driven by the selected parameters when scheduling from the UI. For instance, selecting a validation run does not publish the data to the externally facing (DMZ) database but does publish as set of the CAS tables required for validating submitted data prior to a production publish.

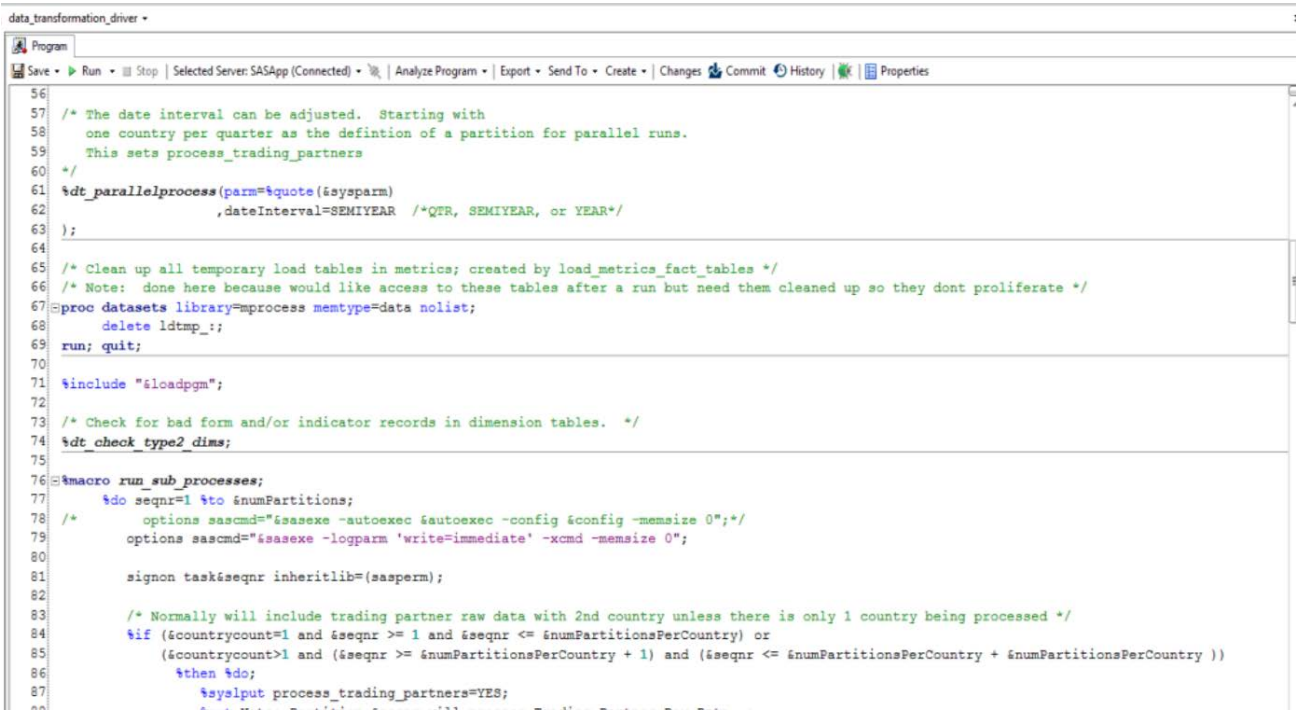



Figure 8. Data Transformation Driver Code

The transformation process that takes the submitted raw data is a very complex data-driven process, managed and maintained by the ECCB, that works with approximately 70,000 economic and financial indicators. Those indicators apply up to three formulas per indicator, across a possibility of five frequencies and three consolidation groups based on a roll-up from the entity submitting the data to the country and subsequently the ECCU, as demonstrated in the figure 9 below.

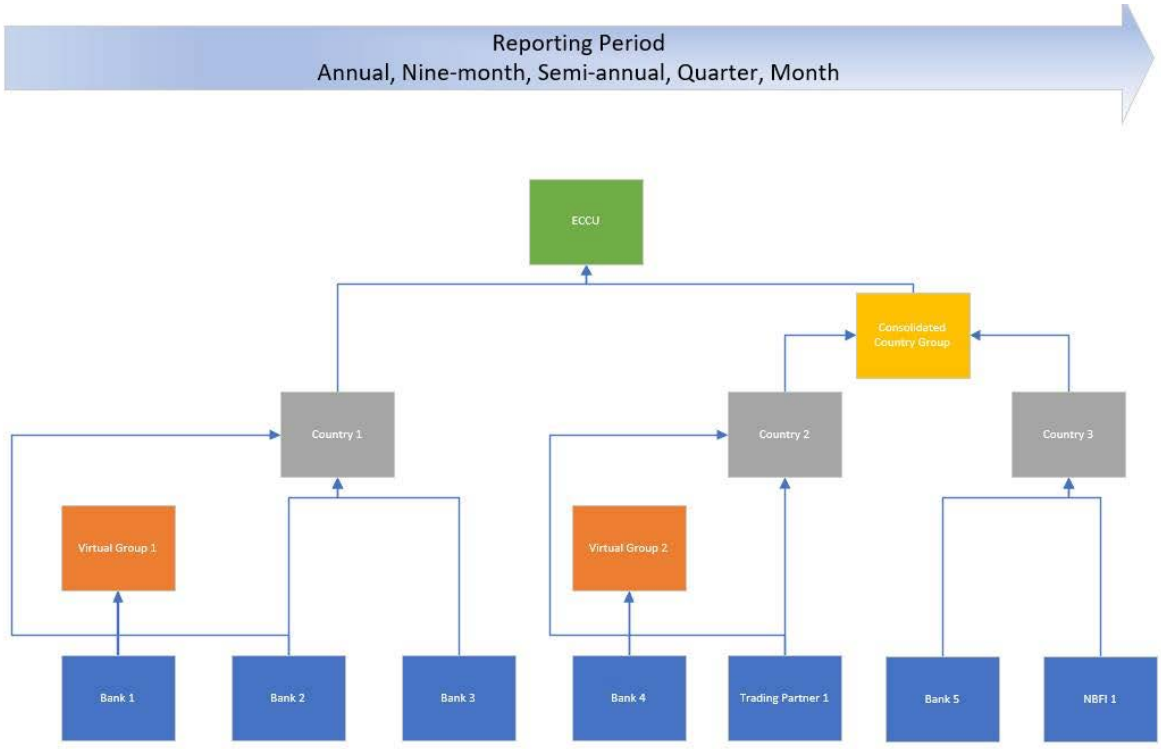
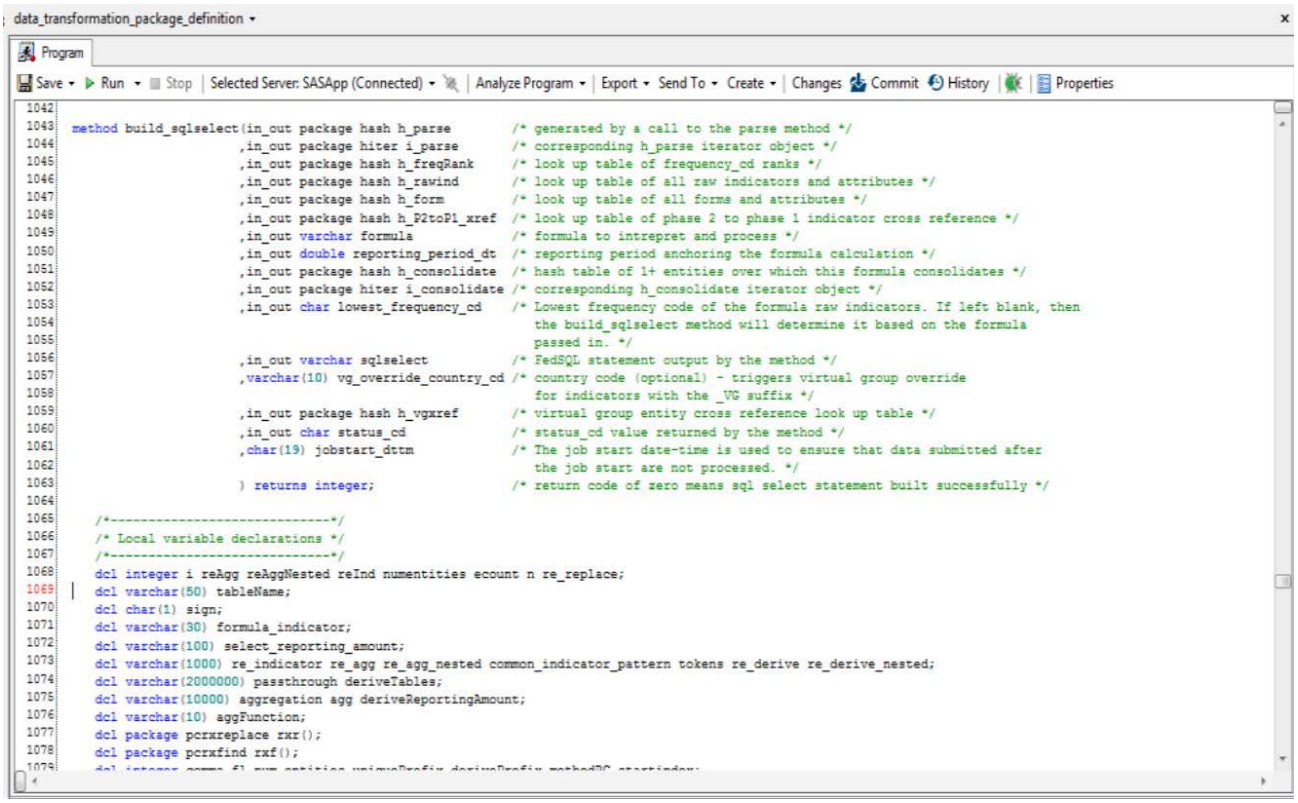



Figure 9. Data Transformation Consolidation Workflow

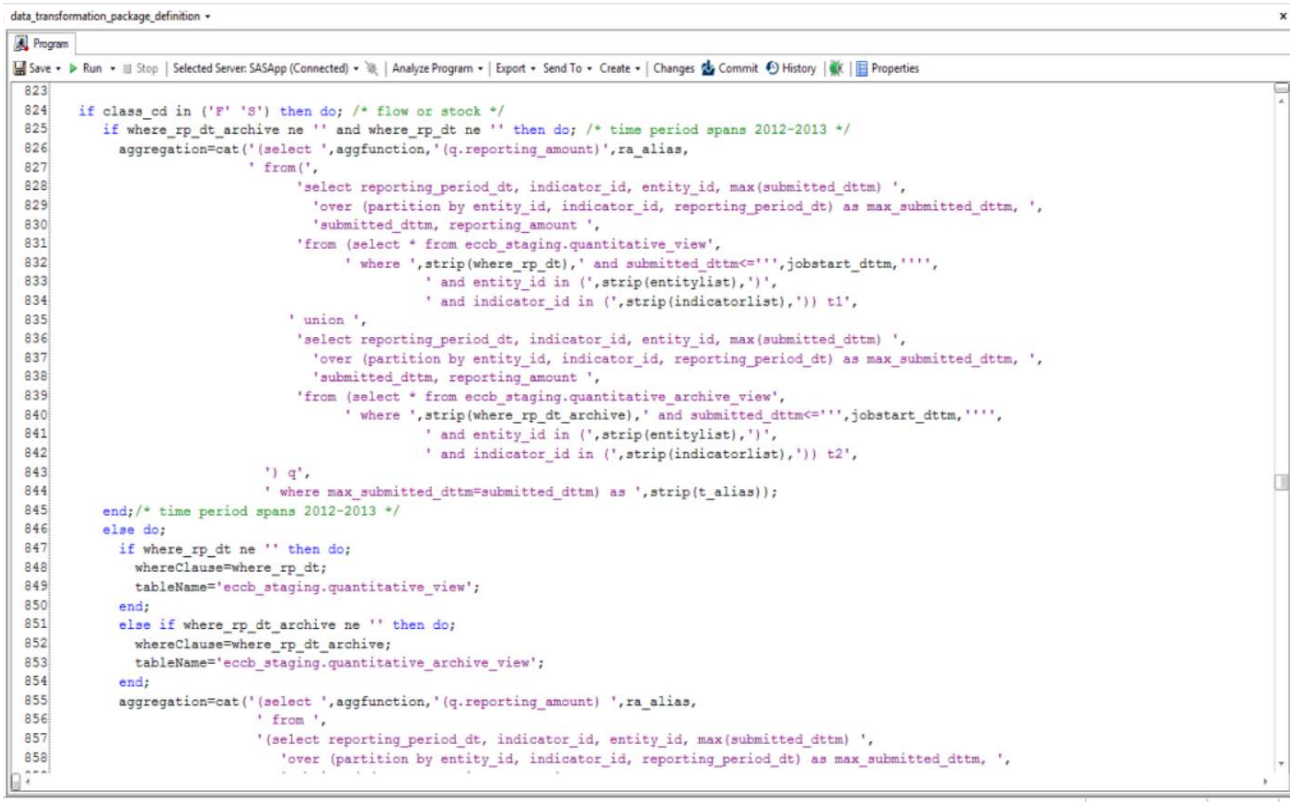
The formulas are managed through a table in the database that the DT code reads when performing the necessary calculations. The SAS code interprets the formulas and transforms them into FEDSQL using DS2.




```
method build_sqlselect(in_out package hash h_parse       /* generated by a call to the parse method */
                      ,in_out package hiter i_parse      /* corresponding h_parse iterator object */
                      ,in_out package hash h_freqRank    /* look up table of frequency_cd ranks */
                      ,in_out package hash h_rawind      /* look up table of all raw indicators and attributes */
                      ,in_out package hash h_form        /* look up table of all forms and attributes */
                      ,in_out package hash h_P2toP1_xref /* look up table of phase 2 to phase 1 indicator cross reference */
                      ,in_out varchar formula            /* formula to intrepret and process */
                      ,in_out double reporting_period_dt /* reporting period anchoring the formula calculation */
                      ,in_out package hash h_consolidate /* hash table of 1+ entities over which this formula consolidates */
                      ,in_out package hiter i_consolidate /* corresponding h_consolidate iterator object */
                      ,in_out char lowest_frequency_cd   /* Lowest frequency code of the formula raw indicators. If left blank, then
                                                            the build_sqlselect method will determine it based on the formula
                                                            passed in. */
                      ,in_out varchar sqlselect          /* FedSQL statement output by the method */
                      ,varchar(10) vg_override_country_cd /* country code (optional) - triggers virtual group override
                                                            for indicators with the _VG suffix */
                      ,in_out package hash h_vgxref      /* virtual group entity cross reference look up table */
                      ,in_out char status_cd             /* status_cd value returned by the method */
                      ,char(19) jobstart_dttm            /* The job start date-time is used to ensure that data submitted after
                                                            the job start are not processed. */
                      ) returns integer;                 /* return code of zero means sql select statement built successfully */

   /*------------------------------*/
   /* Local variable declarations */
   /*------------------------------*/
   dcl integer i reAgg reAggNested reInd numentities ecount n re_replace;
   dcl varchar(50) tableName;
   dcl char(1) sign;
   dcl varchar(30) formula_indicator;
   dcl varchar(100) select_reporting_amount;
   dcl varchar(1000) re_indicator re_agg re_agg_nested common_indicator_pattern tokens re_derive re_derive_nested;
   dcl varchar(2000000) passthrough deriveTables;
   dcl varchar(10000) aggregation agg deriveReportingAmount;
   dcl varchar(10) aggFunction;
   dcl package pcrxreplace rxr();
   dcl package pcrxfind rxf();
```

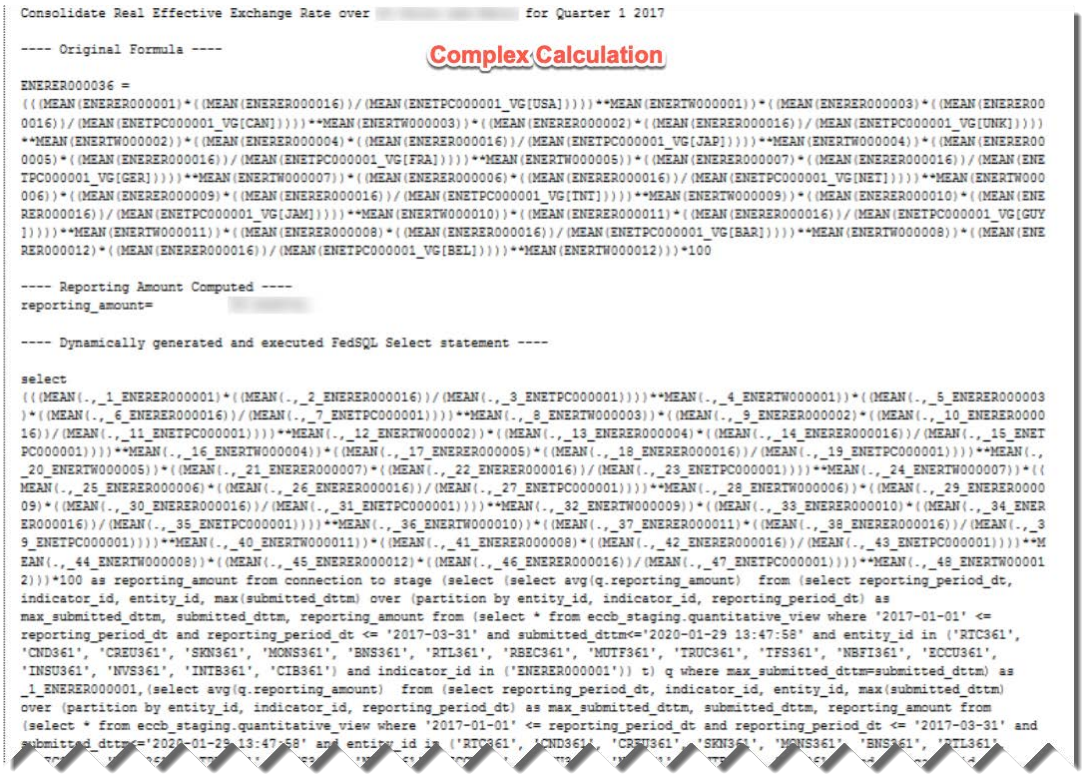
Figure 10. Data Transformation Package Definitions




```
if class_cd in ('F' 'S') then do; /* flow or stock */
   if where_rp_dt_archive ne '' and where_rp_dt ne '' then do; /* time period spans 2012-2013 */
     aggregation=cat('(select ',aggfunction,'(q.reporting_amount)',ra_alias,
                     ' from(',
                          'select reporting_period_dt, indicator_id, entity_id, max(submitted_dttm) ',
                            'over (partition by entity_id, indicator_id, reporting_period_dt) as max_submitted_dttm, ',
                            'submitted_dttm, reporting_amount ',
                          'from (select * from eccb_staging.quantitative_view',
                               ' where ',strip(where_rp_dt),' and submitted_dttm<=''',jobstart_dttm,'''',
                                        ' and entity_id in (',strip(entitylist),')',
                                        ' and indicator_id in (',strip(indicatorlist),')) t1',
                        ' union ',
                         'select reporting_period_dt, indicator_id, entity_id, max(submitted_dttm) ',
                           'over (partition by entity_id, indicator_id, reporting_period_dt) as max_submitted_dttm, ',
                           'submitted_dttm, reporting_amount ',
                         'from (select * from eccb_staging.quantitative_archive_view',
                               ' where ',strip(where_rp_dt_archive),' and submitted_dttm<=''',jobstart_dttm,'''',
                                        ' and entity_id in (',strip(entitylist),')',
                                        ' and indicator_id in (',strip(indicatorlist),')) t2',
                      ') q',
                      ' where max_submitted_dttm=submitted_dttm) as ',strip(t_alias));
   end;/* time period spans 2012-2013 */
   else do;
     if where_rp_dt ne '' then do;
       whereClause=where_rp_dt;
       tableName='eccb_staging.quantitative_view';
     end;
     else if where_rp_dt_archive ne '' then do;
       whereClause=where_rp_dt_archive;
       tableName='eccb_staging.quantitative_archive_view';
     end;
     aggregation=cat('(select ',aggfunction,'(q.reporting_amount) ',ra_alias,
                     ' from ',
                     '(select reporting_period_dt, indicator_id, entity_id, max(submitted_dttm) ',
                       'over (partition by entity_id, indicator_id, reporting_period_dt) as max_submitted_dttm, ',
```

Figure 11. Data Transformation Formula Builder

The formulas can be as simple as using basic statistical operators (SUM, MEAN, MAX, MIN, etc.) on a set of indicators. Or they can be as complex as a calculation that must take into account special grouping of entities and/or components of the formula requiring only a specific entity out of the subset as shown in the image below.




```
Consolidate Real Effective Exchange Rate over [redacted] for Quarter 1 2017

---- Original Formula ----

ENERER000036 =
(((MEAN(ENERER000001)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[USA]))))**MEAN(ENERTW000001))*((MEAN(ENERER000003)*((MEAN(ENERER00
0016))/(MEAN(ENETPC000001_VG[CAN]))))**MEAN(ENERTW000003))*((MEAN(ENERER000002)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[UNK])))))
**MEAN(ENERTW000002))*((MEAN(ENERER000004)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[JAP]))))**MEAN(ENERTW000004))*((MEAN(ENERER00
0005)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[FRA]))))**MEAN(ENERTW000005))*((MEAN(ENERER000007)*((MEAN(ENERER000016))/(MEAN(ENE
TPC000001_VG[GER]))))**MEAN(ENERTW000007))*((MEAN(ENERER000006)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[NET]))))**MEAN(ENERTW000
006))*((MEAN(ENERER000009)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[INT]))))**MEAN(ENERTW000009))*((MEAN(ENERER000010)*((MEAN(ENE
RER000016))/(MEAN(ENETPC000001_VG[JAM]))))**MEAN(ENERTW000010))*((MEAN(ENERER000011)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[GUY
]))))**MEAN(ENERTW000011))*((MEAN(ENERER000008)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[BAR]))))**MEAN(ENERTW000008))*((MEAN(ENE
RER000012)*((MEAN(ENERER000016))/(MEAN(ENETPC000001_VG[BEL]))))**MEAN(ENERTW000012)))*100

---- Reporting Amount Computed ----
reporting_amount= [redacted]

---- Dynamically generated and executed FedSQL Select statement ----

select
(((MEAN(._1_ENERER000001)*((MEAN(._2_ENERER000016))/(MEAN(._3_ENETPC000001))))**MEAN(._4_ENERTW000001))*((MEAN(._5_ENERER000003
)*((MEAN(._6_ENERER000016))/(MEAN(._7_ENETPC000001))))**MEAN(._8_ENERTW000003))*((MEAN(._9_ENERER000002)*((MEAN(._10_ENERER0000
16))/(MEAN(._11_ENETPC000001))))**MEAN(._12_ENERTW000002))*((MEAN(._13_ENERER000004)*((MEAN(._14_ENERER000016))/(MEAN(._15_ENET
PC000001))))**MEAN(._16_ENERTW000004))*((MEAN(._17_ENERER000005)*((MEAN(._18_ENERER000016))/(MEAN(._19_ENETPC000001))))**MEAN(._
20_ENERTW000005))*((MEAN(._21_ENERER000007)*((MEAN(._22_ENERER000016))/(MEAN(._23_ENETPC000001))))**MEAN(._24_ENERTW000007))*((
MEAN(._25_ENERER000006)*((MEAN(._26_ENERER000016))/(MEAN(._27_ENETPC000001))))**MEAN(._28_ENERTW000006))*((MEAN(._29_ENERER0000
09)*((MEAN(._30_ENERER000016))/(MEAN(._31_ENETPC000001))))**MEAN(._32_ENERTW000009))*((MEAN(._33_ENERER000010)*((MEAN(._34_ENER
ER000016))/(MEAN(._35_ENETPC000001))))**MEAN(._36_ENERTW000010))*((MEAN(._37_ENERER000011)*((MEAN(._38_ENERER000016))/(MEAN(._3
9_ENETPC000001))))**MEAN(._40_ENERTW000011))*((MEAN(._41_ENERER000008)*((MEAN(._42_ENERER000016))/(MEAN(._43_ENETPC000001))))**M
EAN(._44_ENERTW000008))*((MEAN(._45_ENERER000012)*((MEAN(._46_ENERER000016))/(MEAN(._47_ENETPC000001))))**MEAN(._48_ENERTW00001
2)))*100 as reporting_amount from connection to stage (select (select avg(q.reporting_amount)  from (select reporting_period_dt,
indicator_id, entity_id, max(submitted_dttm) over (partition by entity_id, indicator_id, reporting_period_dt) as
max_submitted_dttm, submitted_dttm, reporting_amount from (select * from eccb_staging.quantitative_view where '2017-01-01' <=
reporting_period_dt and reporting_period_dt <= '2017-03-31' and submitted_dttm<='2020-01-29 13:47:58' and entity_id in ('RTC361',
'CND361', 'CREU361', 'SKN361', 'MONS361', 'BNS361', 'RTL361', 'RBEC361', 'MUTF361', 'TRUC361', 'TFS361', 'NBFI361', 'ECCU361',
'INSU361', 'NVS361', 'INTB361', 'CIB361') and indicator_id in ('ENERER000001')) t) q where max_submitted_dttm=submitted_dttm) as
_1_ENERER000001,(select avg(q.reporting_amount)  from (select reporting_period_dt, indicator_id, entity_id, max(submitted_dttm)
over (partition by entity_id, indicator_id, reporting_period_dt) as max_submitted_dttm, submitted_dttm, reporting_amount from
(select * from eccb_staging.quantitative_view where '2017-01-01' <= reporting_period_dt and reporting_period_dt <= '2017-03-31' and
submitted_dttm<='2020-01-29 13:47:58' and entity_id in ('RTC361', 'CND361', 'CREU361', 'SKN361', 'MONS361', 'BNS361', 'RTL361',
```

Figure 12. Complex formula example

SAS 9.4 is the backbone of all the batch processing. The code was written to be a high-performing, data-driven, transformation process to enhance the data supplied by the providers through the aforementioned calculations, collapsing (frequency updates), and consolidating of the data into different groupings.

In order to meet the load time SLAs required by the batch process, the DT segments the data by country and time periods, which are executed in parallel via RSUBMIT (MP Connect). For performance, reusability, and to facilitate validation and continued enhancement of the DT process, it was written in DS2 with extensive use of the SQLSTMT, HASH, and user-written packages.

Upon completion of the production transformation activity, three processes are triggered:

- Refresh the data in CAS used in the Viya reports.
- Synchronize the data in the DMZ for the IMF.
- Produce a series of pre-defined batch reports generated as Excel workbooks that are used for various publications.

# PHASE 3: DATA RETRIEVAL AND REPORTING

## OVERVIEW

The DT process produces voluminous amounts of data that can be directly retrieved by various interested parties and stakeholders through the SAS platform. Users are able to analyze data by building queries in SAS Studio or on reports built in SAS Viya through the various supported SAS interfaces (SAS Add-in, SAS Visual Analytics, etc.), as well as a web service API developed for the IMF to retrieve data for their review and publications. The capabilities are driven by the various system roles and synchronization between the DT processes and the Viya platform.

Other benefits of the solution include:

- A wide variety of analytics already built-in to the software.
- Pre-defined reports built to incorporate annotations in the data (whether they are revised, preliminary, estimated or forecasted). This ensures the reports are 'camera-ready.' When a transformation run is complete a set of reports is created, called 'batch' reports.
- Data providers can access their own data using reports built through SAS Visual Analytics by accessing the SAS Drive.
- Data are accessible through various reports and dashboards that were created using SAS Visual Analytics - specifically designed/developed to meet the ECCB's needs. For example:

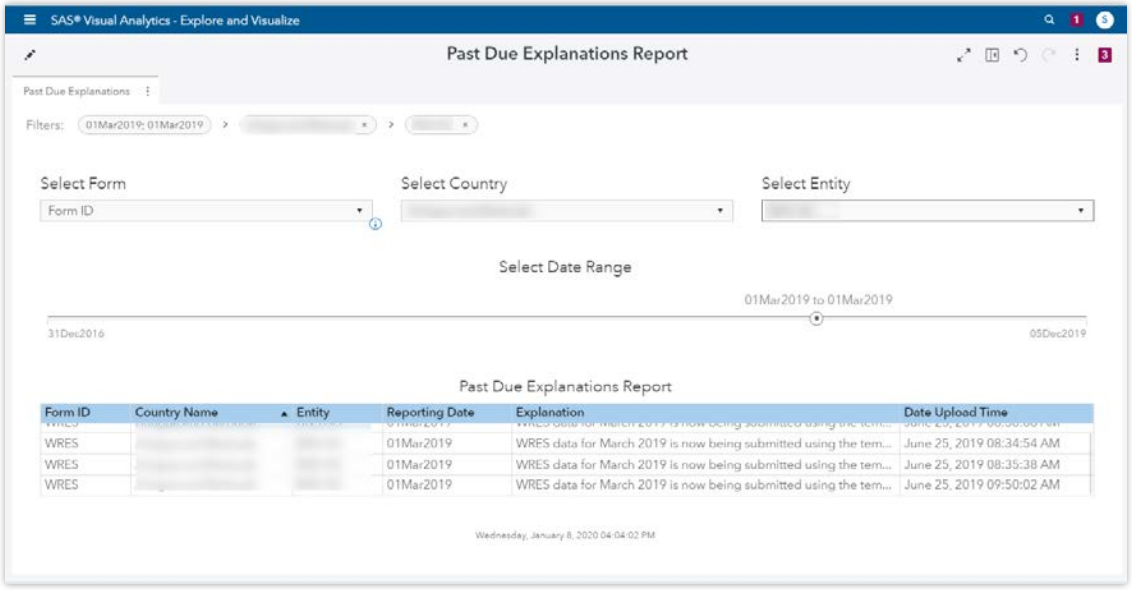



Figure 13. Past Due Explanations Report Screen Example

## IMPLEMENTATION

Reports come in the form of:

- Compliance, audit, and status reports from the transformation process
- Excel workbooks used for publications

- Pre-defined reports and dashboards surfaced through SAS Visual Analytics

In addition to automated reports and data, the system is available for authorized users to do ad hoc analytics and reporting using SAS Viya. Analytics are used for estimating future financial growth, predicting economic changes, text analytics for analyzing and to understand the explanations provided by data submitters for unanticipated changes, and enhanced modeling techniques to score the risk of the members.

The reporting and analytic components were built for internal and external clients, including but not limited to the public, data submitters, the ECCB, and the IMF. Each of these user types have different access methods to reports that are created as a result of the data generated through the first two phases of the data management processes.

The public has the ability to retrieve publications from the ECCB website. Data from the batch reports are used to generate the analysis and supplemental data in the publications.

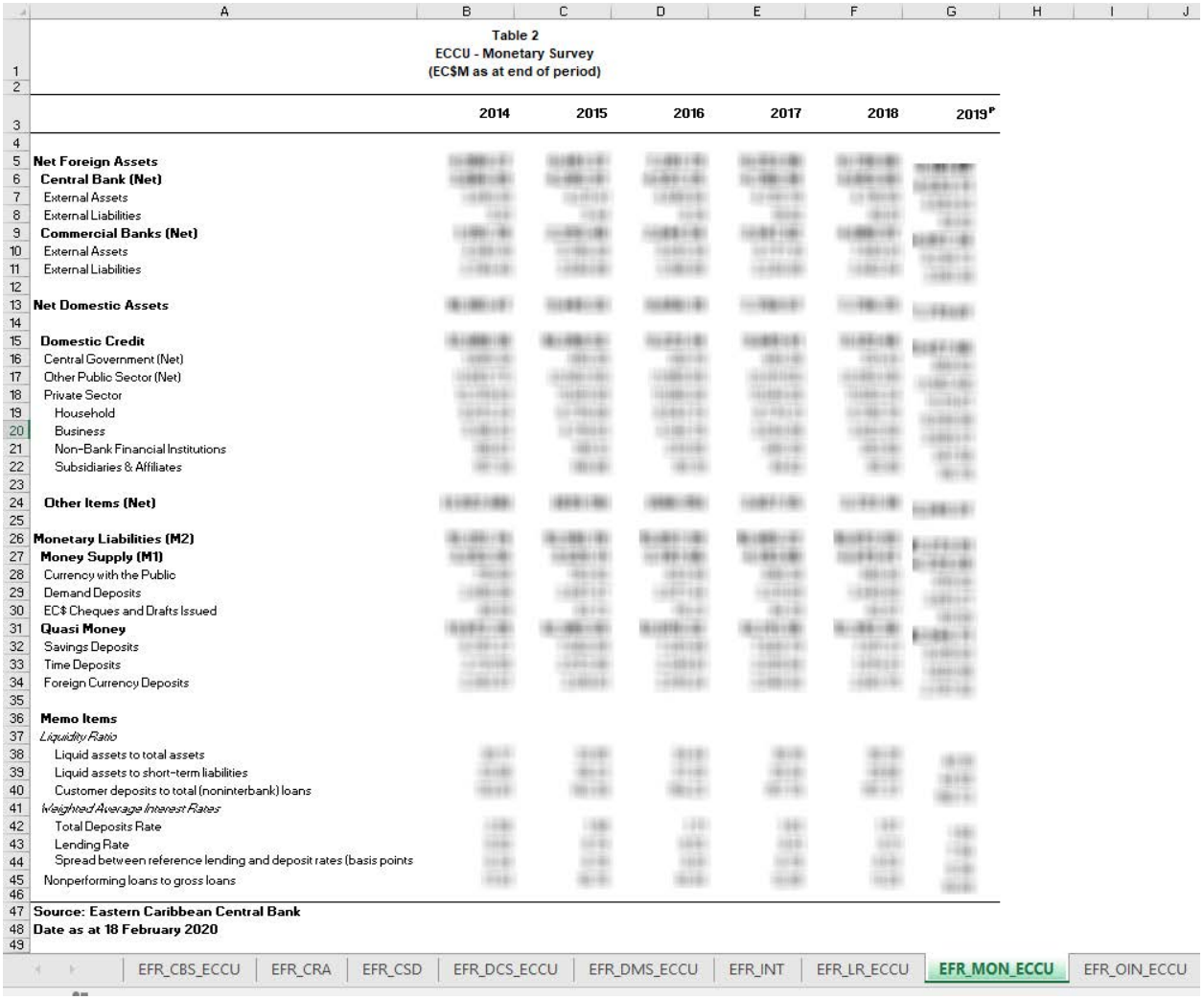


Table 2
ECCU - Monetary Survey
(EC$M as at end of period)

| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019[P] |
|---|---|---|---|---|---|---|
| **Net Foreign Assets** | | | | | | |
| **Central Bank (Net)** | | | | | | |
| External Assets | | | | | | |
| External Liabilities | | | | | | |
| **Commercial Banks (Net)** | | | | | | |
| External Assets | | | | | | |
| External Liabilities | | | | | | |
| **Net Domestic Assets** | | | | | | |
| **Domestic Credit** | | | | | | |
| Central Government (Net) | | | | | | |
| Other Public Sector (Net) | | | | | | |
| Private Sector | | | | | | |
| Household | | | | | | |
| Business | | | | | | |
| Non-Bank Financial Institutions | | | | | | |
| Subsidiaries & Affiliates | | | | | | |
| **Other Items (Net)** | | | | | | |
| **Monetary Liabilities (M2)** | | | | | | |
| **Money Supply (M1)** | | | | | | |
| Currency with the Public | | | | | | |
| Demand Deposits | | | | | | |
| EC$ Cheques and Drafts Issued | | | | | | |
| **Quasi Money** | | | | | | |
| Savings Deposits | | | | | | |
| Time Deposits | | | | | | |
| Foreign Currency Deposits | | | | | | |
| **Memo Items** | | | | | | |
| *Liquidity Ratio* | | | | | | |
| Liquid assets to total assets | | | | | | |
| Liquid assets to short-term liabilities | | | | | | |
| Customer deposits to total (noninterbank) loans | | | | | | |
| *Weighted Average Interest Rates* | | | | | | |
| Total Deposits Rate | | | | | | |
| Lending Rate | | | | | | |
| Spread between reference lending and deposit rates (basis points | | | | | | |
| Nonperforming loans to gross loans | | | | | | |

**Source: Eastern Caribbean Central Bank**
**Date as at 18 February 2020**

EFR_CBS_ECCU | EFR_CRA | EFR_CSD | EFR_DCS_ECCU | EFR_DMS_ECCU | EFR_INT | EFR_LR_ECCU | EFR_MON_ECCU | EFR_OIN_ECCU

Figure 14. Batch Report Example

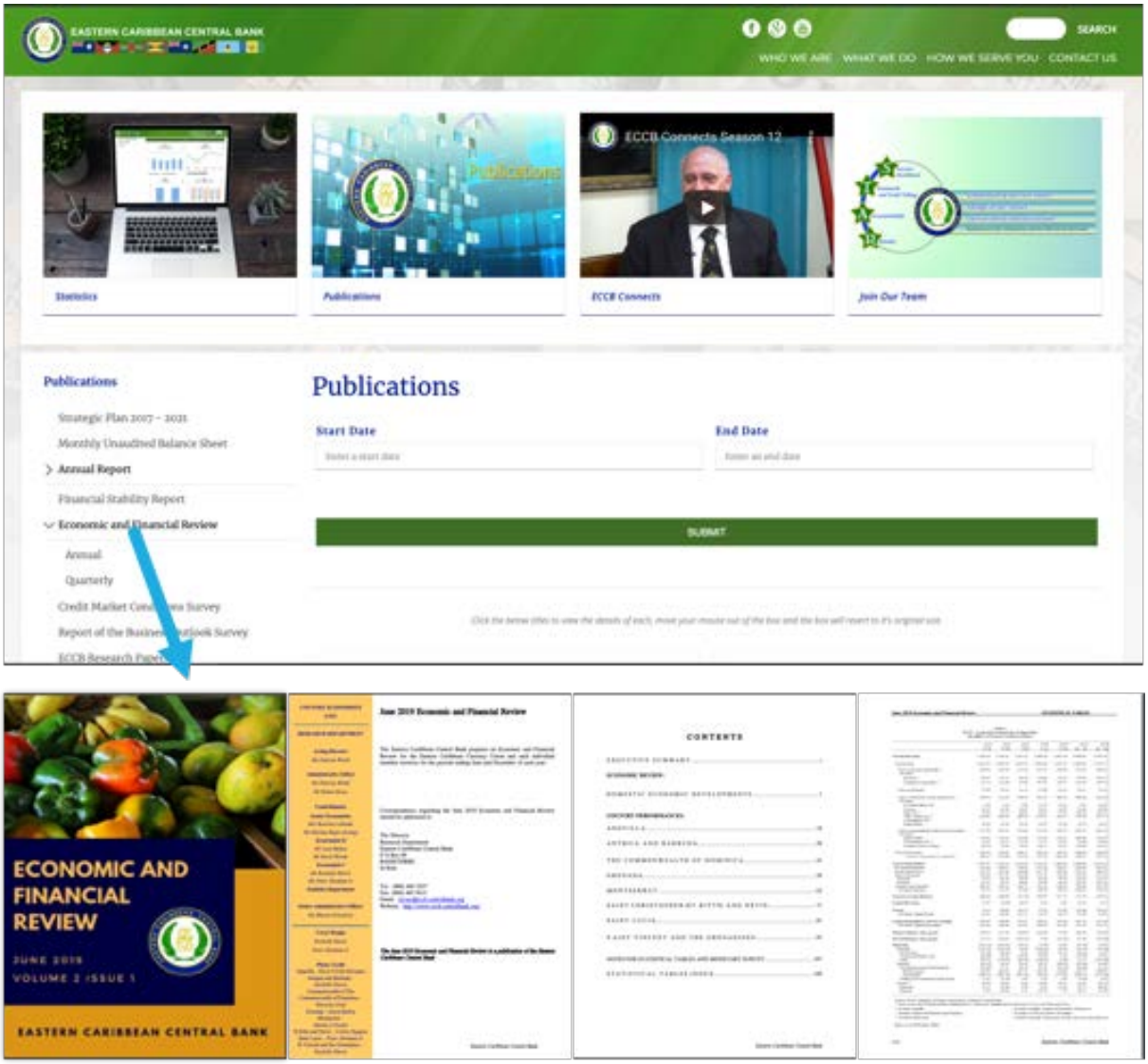



Figure 15. Public Access to Batch Reports

Data submitters have access to reports developed in SAS Visual Analytics. These reports are intended to drive compliance and auditing of the data submitted by the various entities. The ECCB also leverages these reports to review overall compliance with the system and audit the status of the data submission process through a set of pre-defined reports.

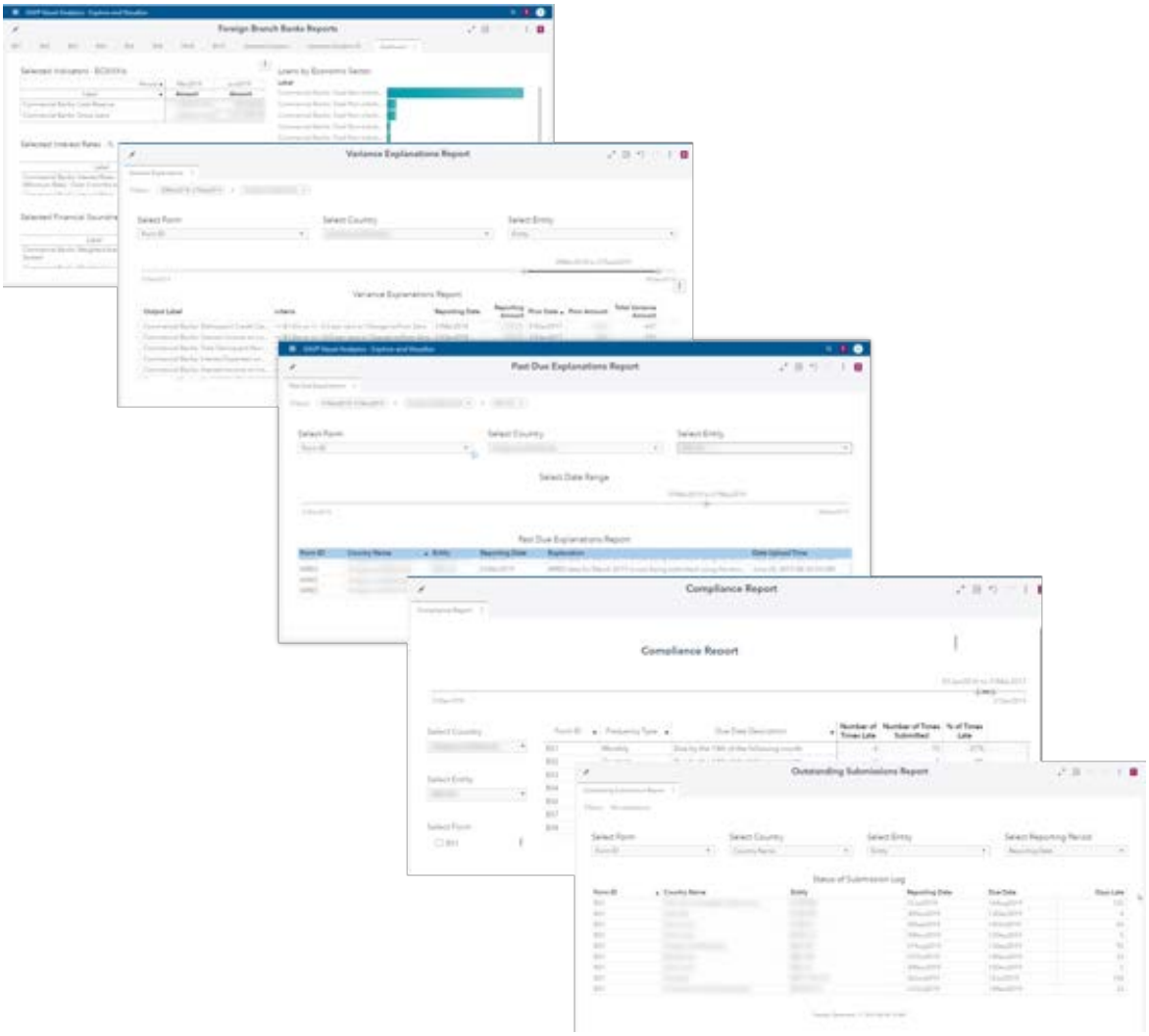



Figure 16. Pre-Defined Reports Examples

The ECCB also uses Visual Analytics for ad hoc reporting and data validation required for oversight, as well as forecasting and estimating future or missing data.

As part of their oversight requirements, the ECCB is required to submit specific reporting data to the International Monetary Fund (IMF). The IMF supports an Integrated Collection System (ICS) that leverages the Statistical Data and Metadata Exchange (SDMX) International Standard. As such, a RESTful API has been developed using Python to interface with the IMF collection service. This is accomplished through a secure service request handler running as a service in the DMZ that can accept and process data requests from authenticated external groups. This API gives the IMF the ability to request and retrieve data without the need for manual ECCB intervention. The content of the accessible data and reports is data driven and managed and maintained by the ECCB. The process for the integration between the ECCB and IMF is defined in figure 17 below.

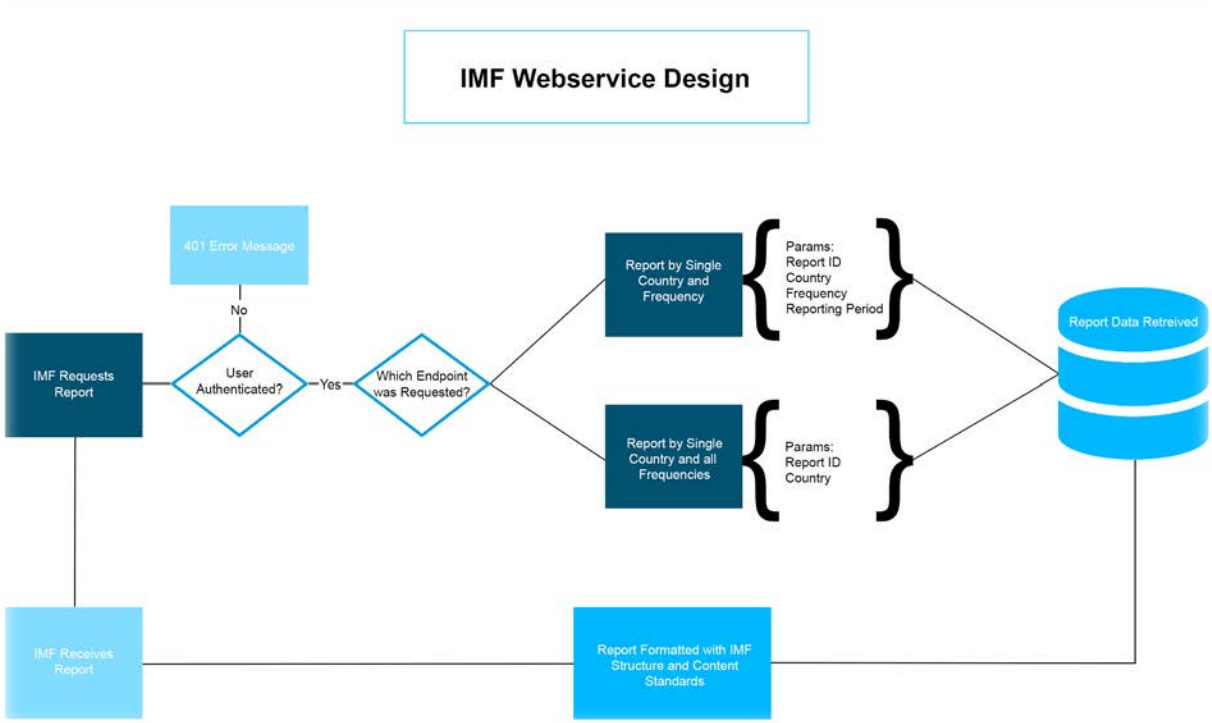



Figure 17. IMF Webservice Workflow

# ARCHITECTURE

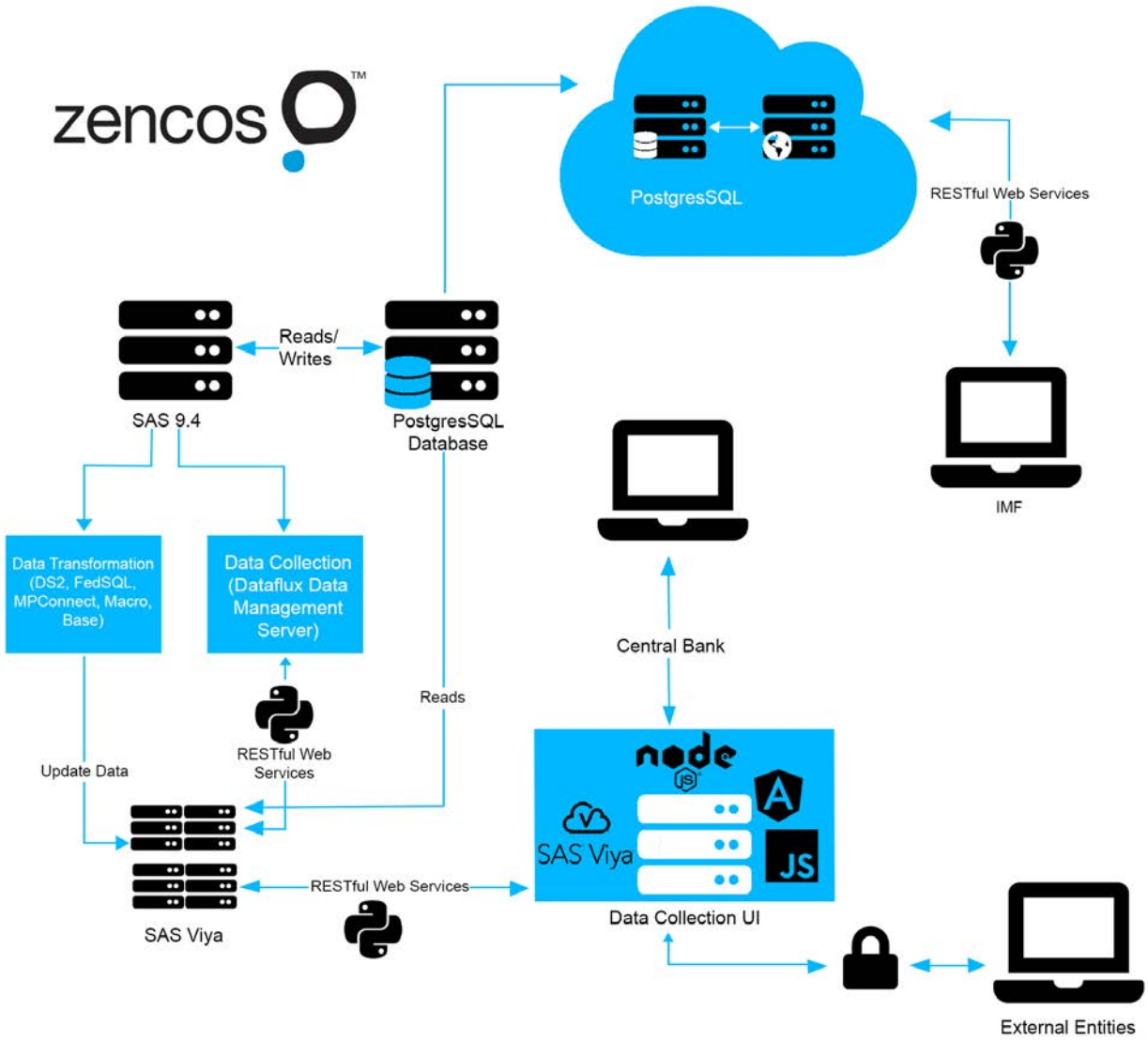



Figure 18. SES Architecture

## LESSONS LEARNED FROM THE IMPLEMENTATION AND DESIGN OF THE SOLUTION

Several lessons emerged for the team from the implementation of this project, including:

1. When undertaking a digital transformation, the project planning timeframe may require more time than other types of implementations. This type of project is a big change for organizations, and that change must be taken into account upfront. It is important to spend time engaging the user community to reduce churn and better manage the anticipated change.
2. As with any large project, ensuring a common language and understanding of specific requirements up front will save time in the end. More time should have been taken into account early on during requirements to "prototype" results to ensure alignment with the implementation team and customer. This can sometimes be difficult and conflict with maintaining the original defined, or proposed scope, but having solid change management procedures can help facilitate that process and reduce the time necessary in later project phases like user acceptance testing (UAT).
3. With a significant system change like this project had, testing across the broader user community in the bank should be accounted for sooner in the project and not in parallel with other solution build tasks and system testing.
4. Earlier preparation of manuals and other user adoption materials should have been prepared prior to going live and providing training to staff. This would have given staff an opportunity to better understand the system prior to the expectation of them using it.

## CONCLUSION

SAS® Viya® can be what you want to make of it. This project was built to allow many different types of users and stakeholders access to data that must be validated, consolidated, and of the highest quality, so the community can trust it. The Viya platform allowed us to not only interface with data providers in a mechanism that was new but also to leverage non-SAS open source technologies deployed on a single platform to deliver a scalable solution to the ECCB's stakeholders. Now we are able to provide data to the right people, at the right time, through various methods.

## CONTACT INFORMATION

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