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DATA VALIDATION MODELS OF REGULATORY REPORTING DATASETS ON THE EXAMPLE OF FORBEARANCE CROSS-TIME CLASSIFICATION IN ECB ASSET QUALITY REVIEW

Master's thesis

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MAKSERASKUSTEGA KREDIIDILEPINGUTE VALIDEERIMISE MUDELID REGULATIIVRAPORTEERIMISES EUROOPA KESKPANGA ASSET QUALITY REVIEW NÄITEL

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Author's declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

This Master's thesis describes the data-heavy nature of regulatory reporting and ECBs' practices for data validation as well as gives an overview of the existing technological challenges in financial institutions. The author is focusing on the data validation processes aimed at improving regulatory reporting and risk assessment performance aspects. The purpose of the thesis is to define harmonised validation rules for the forbearance status assignment that would be applicable for all banks under the ECB direct supervision due to the common set of regulations used to derive the final set of validation rules. Forbearance validation rules are derived through the validation cycle process based on the existing forbearance validation rules defined by the ECB in scope of the Asset Quality Review (AQR) exercise. The hypothesis states that existing forbearance validation rules provided by the ECB are not sufficient for the identification of the potentially forborne portfolio.

The first validation cycle has proved that the hypothesis of this Master's thesis is true. The second validation cycle was performed to define and validate the final list of forbearance cross-time validation rules. During the second validation cycle it was discovered that forbearance status assignment validaiton rules are applicable only for cases, when forbearance measure was granted between analysed R1 and R0 reference dates.

The final set of forbearance cross-time validaiton rules defined in scope of this Master's thesis could be used by significant financial institutions under the ECB direct supervision to improve their NPL and forbearance data validaiton process or by the regulators to validate if data submitted by institutions is compliant with the official regulations.

This thesis is written in English and is 46 pages long, including 5 chapters, 4 figures and 24 tables.

Annotatsioon

Makseraskustega krediidilepingute valideerimise mudelid regulatiivraporteerimises Euroopa Keskpanga *Asset Quality Review* näitel

Käesolev lõputöö kirjeldab regulatiivraporteerimise olemust ja Euroopa Keskpanga pangandusjärelvalve süsteemi, rõhutades selle kitsaskohti, mis on eelkõige seotud IT infrastruktuuri ja andmete kvaliteediga.

Lõputöö eesmärk on defineerida ühtne reeglestik, mis aitaks valideerida makseraskustega krediidilepingud kõikides olulistes Euroopa Liidu pankades, mis kuuluvad Euroopa Keskpanga otsese järelvalve alla. Makseraskustega krediidilepingute valideerimise reeglid on tuletatud läbi valideerimise tsükli, mille aluseks on Euroopa Keskpanga *Asset Quality Review* harjutuse raames defineeritud makseraskustega krediidilepingute valideerimise reeglid. Käesoleva lõputöö hüpotees: olemasolevad Euroopa Keskpanga reeglid ei ole piisavad potentsiaalse makseraskustega krediidilepingute tuvastamiseks.

Lõputöö raames on autor viinud läbi valideerimise tsükli Euroopa Keskpanga poolt defineeritud reeglitele, mille tulemusena sai kinnitatud töö hüpotees. Teise valideerimise tsükli raames on autor pakkunud reeglitele muudatused, mis tuginevad ametlikkude allikate uurimisele, ning valideerinud lõpliku makseraskustega krediidilepingute reeglistikku mida saab kasutada kõikides olulistes Euroopa Liidu pankades.

Lõputöö on kirjutatud inglise keeles ning sisaldab teksti 46 leheküljel, 5 peatükki, 4 joonist, 24 tabelit.

List of abbreviations and terms

AQR	*Asset Quality Review*	
	A detailed review of the financial conditions of the financial institution according to the officially published European Central Bank guidelines and methodologies [1].	
BASEL III	International regulatory framework aimed to enhance the supervision and risk management of banks [2].	
BCBS 239	*Basel Committee on Banking Supervision's standard number 239*	
	Principles of risk data aggregation capabilities and risk reporting practices to ensure banks' ability to aggregate and analyse accurate risk data in timely manner [25].	
EBA	*European Banking Authority*	
	The agency responsible for implementing rules to regulate and supervise banking across all EU countries [3].	
ECB	*European Central Bank*	
	A central bank of the European countries which have adopted the euro [4].	
ETL	*Extract, Transform, Load*	
	A process in which data is extracted, transformed and loaded from multiple sources to a final destination [5].	
EU	*European Union*	
IFRS	*The International Financial Reporting Standards*	
ITS	*Implementing Technical Standards*	
	The act regulating uniform regulatory reporting requirements, including reporting templates and guidelines [6].	
LTV	*Loan to value*	
	The ratio used to express the outstanding loan amount to the value of an asset by the following formula: exposure amount divided by the allocated collateral amount [1].	
NCA	*National Competent Authority*	
	A public authority which is empowered to supervise financial institutions as part of the supervisory system [7].	

NPL	*Non-performing loans*
	Loans with delay in payments of 90 days or more [8].
SSM	*Single Supervisory Mechanism*
	An institutional framework that allows the European Central Bank (ECB) to supervise the most important banks and banking groups in Europe according to a common standard [9].
XBRL	*Extensible Business Reporting Language*
	Technical format used for financial data exchange between banks and regulators [10].

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1 Introduction

The banking sector faces many regulatory obligations due to a wide variety of potential risks related to the different fields of its activities and an impact on regional economy being in the role of the financial intermediary. In light of the data-heavy nature of regulatory reporting and cyclicality of economic crises, financial institutions should be focusing on the importance of data validation process to assess their individual vulnerabilities and to meet regulatory compliance [11].

1.1 Problem Background

The financial crisis of 2008 showed a strong interdependency between people, the financial sector and the economic environment across the single market area. The crisis highlighted the need for unified regulations and supervision of the financial sector to increase financial integrity and stability in the single market area [9]. As a response to the difficulties faced and in support of more efficient recovery and prevention of further crises, the Single Supervisory Mechanism (SSM) was established. The SSM is an institutional framework that allows the European Central Bank (ECB) to supervise the most important banks and banking groups in Europe according to a common standard.

The single supervisory approach has transformed banks' technological requirements and has highlighted the critical role of data and analytics in the banking sector, focusing on improvement of data accuracy and comparability [12]. Increased supervision has significantly affected financial institutions - a lot of banks were not ready for amplified demand of required data and changes to be applied for internal processes and policies to ensure compliance with the high standards set by the ECB.

One of the main negative outcomes of the 2008 crisis on banks' assets portfolio was an increase of non-performing loans (NPL) or, in other words, the situation when customers are not able to repay the loan for more than 90 days [13], [14]. Since SSM was established, the ECB has prioritised the monitoring of the NPL portfolio and efficient post-crisis management [15]. One of the strategies of the NPL management is

granting forbearance measures, aimed at returning exposures to sustainable repayment. A forbearance measure or the modification of contract terms and conditions is a specific instrument, that should be applied only to the customers' in financial difficulties. Potential abuse of forbearance measures may be led by unclear methodology or, in particular, be provoked by disguising banks' actual performance status expressed on the balance sheet [16].

Considering the COVID-19 pandemic, this topic has received renewed attention [17]. In 2020, the ECB introduced further official measures to help prevent customers from becoming non-performing and to alleviate the impact from credit loss for the banks [18]. However, it is very likely that the expiration of the measures at the end of the year will lead again to an increase of NPLs and will require significant focus from impacted banks' portfolios. To ensure an efficient monitoring of the portfolio from the credit risk perspective, it is essential to have a clear overview of the banks' data ensuring high data quality assurance.

1.2 Purpose of the Thesis

Due to establishment of unified regulations and standards under the SSM, financial institutions have faced different technological challenges in the regulatory reporting area, primarily related to the IT infrastructure and data quality. As the result, the quality and transparency of the submitted regulatory reports are continuously subject to comprehensive review.

This Master's thesis describes the data-heavy nature of regulatory reporting and ECBs' practices for data validation as well as gives an overview of the existing technological challenges in financial institutions. The author is focusing on the data validation processes aimed at improving regulatory reporting and risk assessment performance aspects.

The purpose of the thesis is to define harmonised validation rules for the forbearance status assignment that would be applicable for all banks under the ECB direct supervision due to the common set of regulations used to derive the final set of validation rules. Forbearance validation rules are derived through the validation cycle process based on the existing forbearance validation rules defined by the ECB in scope

of the Asset Quality Review (AQR) exercise. The hypothesis states that existing forbearance validation rules provided by the ECB are not sufficient for the identification of the potentially forborne portfolio.

The master's thesis is focusing on defining validation rules for the forbearance dataset due to its business and compliance importance and methodological complexity. Forbearance validation rules defined in this thesis could be used by the banks' regulatory reporting departments or by the regulators to assess the status of the official NPL and forbearance methodology application in the banks under the ECB direct supervision, in case of unsatisfactory results questions about the data quality or methodological incompliance must be raised.

1.3 Method

This Master's thesis is focusing on the importance of data validation models existence in the regulatory reporting area. Regulatory reporting departments are end-users of the banks' data collected from the different source systems and transformed by the various calculations (e.g. impairments calculation, forbearance status). Data validation is an important step to be performed on the final output data, that helps to assess if data is representing an expected and valid result. Validation process aims to answer if something is done in a correct way. Accurate and valid underlying validation rules are the core element of an efficient validation process. Insufficiently defined rules will return misleading results, making the whole validation process useless.

The data validation cycle methodology, used in this thesis, consists of four processes: design, implementation, execution and review [19]. Used methodology is borrowed from the European Statistical System approach on statistical data validation. From the perspective of this thesis, the author is validating forbearance validation rules based on the sampled dataset, that has been confirmed as fully compliant from the regulatory and data quality perspective. In scope of the first validation cycle, the author is taking the ECB defined forbearance validation rules, describing the regulatory and business background of each rule, providing data requirements and structural view of the validation implementation process, setting up the metrics and reviewing the result of the executed test. In scope of the second validation cycle, the author is proposing adjustments for the ECB-defined forbearance validation rules based on the official

documentation review and analysis of the regulations, finding possible dependencies and testing them on the sampled dataset.

1.4 Overview of the Thesis

This thesis is divided into three primary chapters. The first primary chapter includes an overview of the unified approach of regulatory reporting and ECBs' practices for data validation as well as describes the existing technological challenges in financial institutions. The second primary chapter is focusing on the forbearance definition prior to the main practical part of this thesis – Defining Data Validation Rules for the Forbearance Dataset. In scope of the third primary chapter, the author is testing the ECB defined forbearance validation rules and proposing adjustments based on the official documentation review and analysis of the regulations.

2 Regulatory Reporting Overview and Related Technological Challenges

This chapter describes the data-heavy nature of regulatory reporting and ECBs' practices for data validation as well as gives an overview of the existing technological challenges in financial institutions.

2.1 Regulatory Reporting Overview

The Single Supervisory Mechanism (SSM), established in 2014, is an institutional framework that allows ECB to supervise the most important banks and banking groups in Europe [20]. A total of 115 significant banks, as of the 1st January 2021, are directly supervised by the ECB, while the non-significant credit institutions continue to be supervised by the national competent authorities (NCAs) [21]. A single supervisory approach is intended to supervise all its members according to a common standard, that should increase transparency of the banking sector in the euro area.

In order to fulfil supervisory obligations, financial institutions are required to provide all relevant information on regular and ad-hoc basis. Information required on a regular basis should be submitted according to the applicable reporting requirements framework version regulated by Implementing Technical Standards (ITS) on Supervisory Reporting by the European Banking Authority (EBA). Regular reporting requirements are set for own funds and financial information, represented by the different reporting packages (e.g. financial information - FINREP, capital adequacy information - COREP, liquidity modules - LCR) [20]. In addition to ensuring the supervisory review of individual banking group, aggregated supervisory reports, provided by the financial institutions, are used for preparing ECB Consolidated Banking Data – a key dataset for macroprudential and banking data analyses [22].

Due to the potential impact of fundamental banks performance on the regional economy, it is essential not only to collect data for the overall performance assessment,

but to challenge banks' data quality. In scope of data quality assessment, the ECB has launched regular presented data validation controls as well as has allocated a significant part of the preconditional Comprehensive Assessment exercise to be focused on the data integrity of the supervised financial institutions.

2.1.1 Regular Checks

As previously mentioned, financial institutions are obliged to submit regulatory reports on a regular basis according to the latest version of the EBA reporting framework regulated by the ITS. Each version of the reporting framework contains a list of validation rules described by the Data Point Model in the format of an XBRL taxonomy. XBRL or Extensible Business Reporting Language is the technical format used for financial data exchange between banks and regulators [10].

Validation rules are defined using XBRL assertations or unique code that represent specific validation rules, including hierarchy, sign, general and enumerated values checks.

- Hierarchy or dimensional aggregation checks describe the relationship between the total and breakdown values [10]. For example, v0798_h rule is expressed as $\{r670\} = +\{r680\} + \{r690\}$ for column (010) of table F 02.00.
- Sign checks that are referring to the validation of positive or negative values respectively [10]. For example, v2060_s rule is expressed as $\{F\ 01.03\} <= 0$ for rows (240;260) and column (010).
- General value checks that are performed to ensure consistency between the different data point within one or through different sheets of the reporting package [10]. For example, v0783_m rule is expressed as $\{F\ 01.03, r310, c010\} = \{F\ 01.01, r380, c010\}$.
- Enumerated value checks that control if data is presented in the right format representing allowed values [10].

Defined validation rules help to assess the completeness and accuracy of the generated reports as data is presented in an aggregated view format. Rules described by the ITS are performed by the NCAs and the ECB during the validation of the submitted regulatory reports.

2.1.2 ECB Comprehensive Assessment

One of the most detailed compliance and overall health-check exercises, first launched in 2013 prior to SSM establishing, is the Comprehensive Assessment (CA), comprised of the Asset Quality Review (AQR) and Stress Test [23]. The purpose of the AQR is to perform a detailed review of the financial conditions, according to the officially published ECB guidelines and methodologies, and to increase transparency of the balance sheet of the financial institution that is likely to become obligor to the ECB direct supervision or on ad hoc basis due to exceptional circumstances [20], [24]. The AQR aims to enhance the banking asset portfolio quality, including internally applied policies, standards and data quality [1].

The AQR exercise consists of two phases: portfolio selection and the actual detailed review of a subset of the banks' most significant assets. The ECB, with close cooperation with the NCAs, should identify the riskiest portfolio to be reviewed in the second phase of AQR [25].
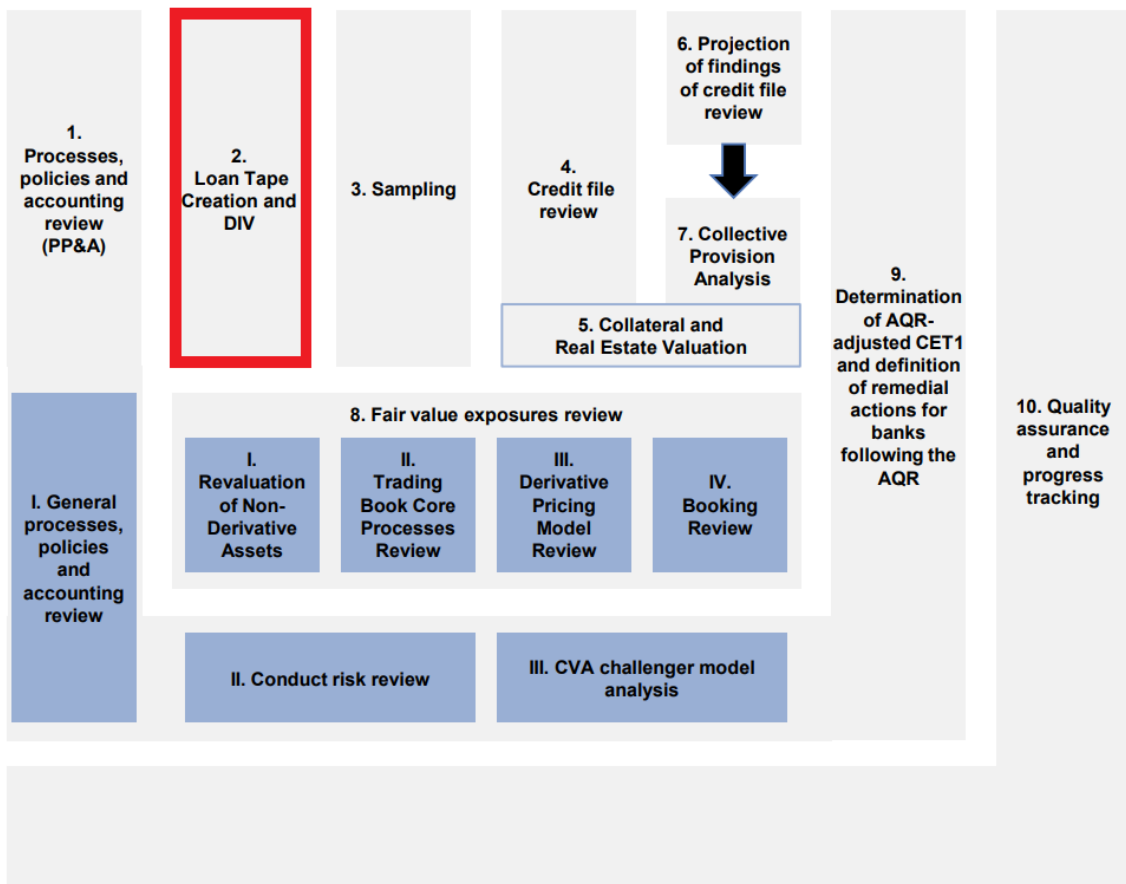
Figure 1. Schematic overview of the AQR Phase 2 methodology [1].

Phase two is the actual execution of the controls, review of the processes, policies, accounting and selected portfolio exposures based on the banks' prepared data (Figure 1). A significant part of the AQR Phase 2 is the second workblock:

- Loan tape creation - a core dataset that contains the basic accounting information (e.g. classification of financial instrument, provisioning, collateral information) for the portfolios selected in Phase 1 on a contract level;

- Data Integrity Validation (DIV) - process that helps to assess quality of the submitted Loan Tape.

The DIV process consists of prescribed data validation rules for reconciliation, field-specific, cross-field, sense and cross-time check [1].

- Reconciliation checks are performed to ensure that data provided by the Loan Tape is consistent with the data available in the source system. Reconciliation process may include an audit of the whole dataflow and interviews with related counterparties. Basic reconciliation checks might be performed on the number of lines and total figures in the submitted dataset [1].

- Field-specific checks are performed across single fields in the Loan Tape dataset. Tests include such basic validations as duplication of unique fields, application of the allowed values, format and sign [1].

- Cross-field validations are more specific and are performed to ensure consistency between different fields. For example, value of the exact collateral should be the same for each entry [1].

- Sense checks are semi-manual controls for assessing the distribution of the data. Sense checks could be considered as an evaluative validation what includes such checks as redundancy of "other" and "not defined" values, very low or high amounts and repeated values where limits and list of allowed values are not specified [1].

- Cross-time validation rules are performed to analyse different snapshot dates: reference date and one year before the AQR reference date, that allows to perform analysis through time to assess the consistency of presented data. On the example of forbearance, missing forbearance status for the customers with visible signs of financial difficulties and concessions granted could be treated as

a sign of potential data quality issues or issues in internal policies and processes of the bank, that should require an in-depth investigation [1].

Despite the complexity of the AQR validation rules, results of the performed controls give a clear overview of the actual data integrity status in the financial institution. Some of the checks should be introduced in a regular data validation process or initiate a creation of the data validation framework.

2.2 Technological Challenges in the Regulatory Reporting Area

The single supervisory approach has transformed banks' technological requirements and has highlighted the critical role of data and analytics in the banking sector, focusing on improvement of data accuracy and comparability [12], [26]. Increased supervision has significantly affected financial institutions - a lot of banks were not ready for amplified demand of required data and changes to be applied for internal processes and policies to ensure compliance with high standards set by the ECB [27].

The common approach has harmonized different reporting components, that previously were focused on individual business area reports. Financial institutions should also have started to concentrate on better overview of internal processes and policies. According to a KPMG survey, in addition to compliance challenges, new regulations, especially Basel III and IFRS, have affected the business and operating model of the banks [28].

2.2.1 IT Infrastructure

Financial crises have shown that banks' information technology was not able to support increased demand of risk data to be collected and processed in an adequate period of time ensuring data accuracy [29].

In 2013, the Basel Committee developed principles of risk data aggregation capabilities and risk reporting practices (the BCBS 239 principles) to ensure bank's ability to aggregate and analyse accurate risk data in timely manner [29]. The BCBS 239 principles are covering four main topics: overarching governance and infrastructure, risk data aggregation capabilities, risk reporting practices and supervisory review, tools and cooperation [29]. According to the latest Thematic Review report, performed on

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2019 data, banks have made noticeable progress in the implementation of the principles of risk data aggregation capabilities and risk reporting practices compared to the outcome of the 2017 data review, when all sampled significant banks results were deemed not fully compliant [30], [31]. Despite the progress, many IT infrastructure challenges remain unsolved (Figure 2). Comparing the progress in implementation of each principle, data architecture and IT infrastructure principle has the highest materially non-compliant rating ratio according to the 2019-year results – 27,27% (9 banks out of 33) are materially non-compliant. Statistics on the final results from the data architecture and IT infrastructure principles perspective is highlighted in red border in the Figure 2.
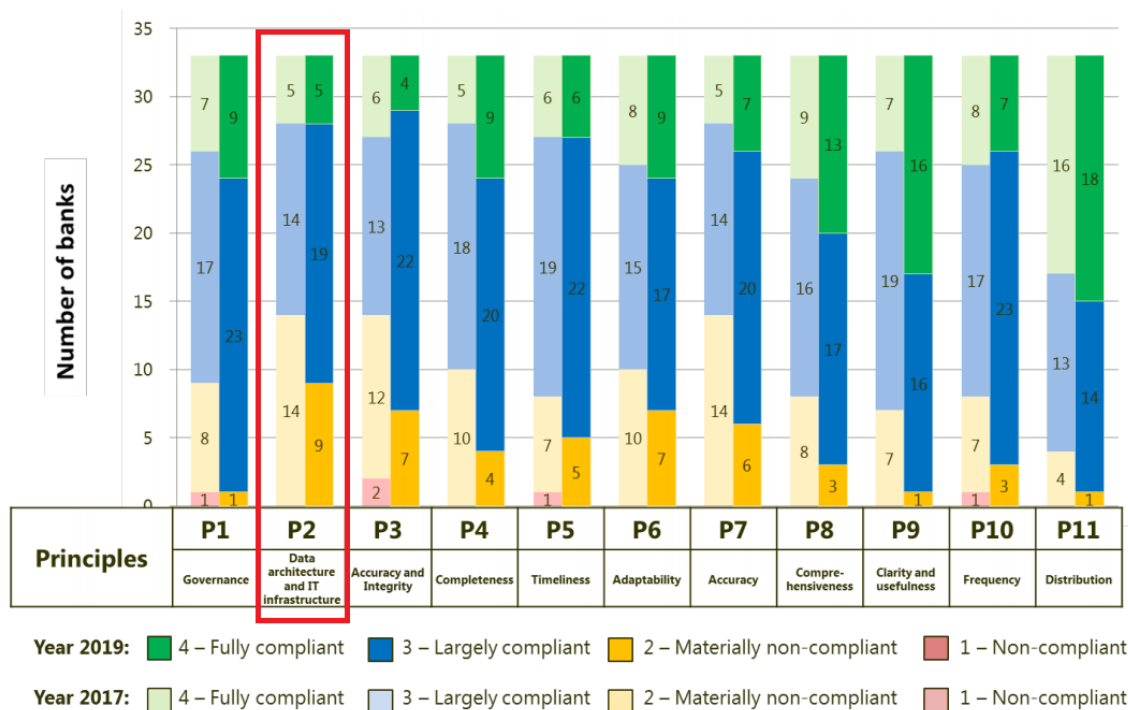
Figure 2. Comparison of compliance results of Thematic Review results in 2017 and 2019 [30].

The most problematic topics described by the IT infrastructure and data architecture principle are:

- IT legacy systems and disparate data warehouses, absence of single data source, that is not allowing to collect, store, analyse and reconcile data in accordance with uniform standards [30], [32];
- many interdependencies in IT projects that remain unhandled [30];

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- not aligned data dictionaries, data taxonomy and architecture across different branches and subsidiaries of the same banking group [30].

Lack of IT infrastructure is usually offset by manual workarounds, provoking probability of human mistakes, not aligned and not automatically reconciled outcome as data is being processed by different people and departments sometimes using different data sources, as well as inconsistent reporting requirements through different reporting periods. As a result, time and effort is being spent on manual data aggregation, reconciliation and adjustments activities, while analysis for better risk management and decision making is left out of scope [33].

2.2.2 Data Quality

Quality data is crucial for the evaluation of performance and appropriate decision-making process of any organization, however in the banking sector poor data quality has an impact on risk management and regulatory compliance. Quality of underlying data plays a key role not only for banks' internal processes management, but also for the ECB, who uses provided aggregated reports for macroprudential and banking data analyses which in turn is published for the general public in EU [22].

Issues identified and measured by the ECB based on the submitted aggregated reports are usually referring to the deeper problems related to the data quality issues faced by the financial institutions. Possible data quality challenges could be described using the data quality characteristics. It should be also noted that IT infrastructure challenges, described in paragraph 2.2.1 of this thesis, have a direct impact on the data quality.

- Availability and accessibility characteristics are about the ability of use the data for the particular needs [34]. Restrictions on data availability and accessibility may be triggered by the inadequacy of used technologies what are not supporting the business needs.
- Granularity characteristic refers to the level of detail at which data is available [34]. Granularity level could be defined by the internal and external reporting requirements or any other business needs. Financial institution should be more flexible in the implementation of the more detailed data requirements for the data to be collected.

- Accuracy expresses the correctness of the value meaning that value should represent the truth [34]. Incorrectly inserted values can cause a misleading result. The most common reason for inaccurate data is incorrect input caused by human mistakes on different levels: incorrect input by the front-line manager in the source system, not valid calculation logic introduced by the analyst and mistakes in data transformation rules by the developers. Regular audit, continuous testing and restrictions set by the system may minimise a possibility of inaccurate data.

- Reliability characteristic describes the data consistency across the different systems, meaning that the same data collected by different systems could not be contradicting [34]. The availability of a single data source used, for example, for reporting, could minimise the possibility of inconsistent underlying data used by different reports packages and could simplify the process of reports reconciliation.

- Currentness characteristic refers to the age of the data [34]. Considering the complexity and long chains of the variety of different source systems and ETL processes, the data available for the analysis could already be deprecated. It is critically important to deliver data to the end-users in an adequate period of time.

Dependency between the IT infrastructure and data quality can be proven by the ISO 25012 standard system-dependent data quality characteristics, partly covered by the data characteristics described above [35].

All the technological challenges described in the scope of paragraph 2.2 are caused by the need for immediate financial and human resources investment in the IT infrastructure, data and reporting processes, while the benefit may be realised only over the long-term.

2.3 Future of Regulatory Data

It can be concluded that data remains a critical factor for banks and regulators. Quality data is essential for moving forward in a digital data driven environment. Concerns related to data quality, data manipulation, existing room of interpretation as well as the complexity and cost of regulatory reporting frameworks implementation for the financial institutions, provoke a new regulatory agenda.

The scope of the data quality assessment performed by the ECB is limited by the current reporting process approach, during which institutions are submitting reports providing aggregated figures. The ECB is not able to assess the detailed quality of the submitted reports based on the data quality standards, therefore some internal dimensions for identifying potential data quality issues were introduced:

- punctuality, that is assessed by the verification of the reports submission deadline and measures the percentage of missing or delayed reports [36];
- accuracy, that is measured based on the predefined templates and data point [36];
- completeness, that is assessed through the predefined validation rules on the templates and data point [36];
- plausibility, that is measured through the open issues that are waiting for the explanation and additional investigation by the financial institutions [36].

According to the Aggregated Data Quality statistics of the second quarter of 2020, data quality of the submitted reports has worsened [37]. Such decrease in data quality metrics could be conditioned by the implementation of the new EBA regulatory reporting framework in the second quarter of 2020, what among other included the final changes on the reporting of non-performing and forborne exposures (Table 1).

Table 1. ECB Aggregated Data Quality Table [37].

Dimension	Metric	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2
Submission and punctuality	Number of reporting institutions	114	116	116	115	114
	Number of expected reports	912	928	928	919	912
	% of missing and delayed reports	0,55	0,11	1,29	3,37	2,85
Completeness	% of missing templates	0,45	0,10	0,34	0,26	0,96
	% of missing data points	5,83	4,98	5,57	3,29	3,65

Dimension	Metric	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2
Accuracy	% of failing validation rules	0,07	0,03	0,04	0,05	0,16
	% of reporting institutions submitting reports with at least one failing validation rule	48,25	28,45	46,55	52,17	71,05
Plausibility	% of issues awaiting explanation	15,20	26,20	< 5	7,8	68,7

In comparison between 2019 Q4 and 2020 Q2, data quality statistics is showing an increase in missing templates, delayed reports and failing validation rules percentage. As well as 68,7% of identified issues are still awaiting explanation and further investigation by reporting institution is required.

However, it should be also noticed, that values presented by the aggregated report may not necessarily refer to the data quality issues in the financial institution, but also to the limited timeframe set by the ECB, potential incompleteness of the ECB templates and validation rules. Presented statistics are used to highlight the issues existing in the current regulatory reporting process.

Long term regulatory agenda is focusing on automated data processing and data quality enhancement to reduce the cost of regulatory reporting and ensure the transparency of submitted regulatory reports [38], [39]. Considering the SSM long-term approach, financial institutions should prioritise IT infrastructure topics: existence of a single data source, data collection, storing, analysis and data reconciliation and validation possibilities.

3 Forbearance Definition

Forbearance means measures granted for a customer in financial difficulties to prevent them from reaching non-performing status or to support the process of exiting the non-performing criteria. The concept of financial difficulties is related to the financial characteristics of a particular customer and the predicted inability to meet their financial commitments in the future [8]. The non-performing status indicates the customers' actualised inability to fulfil his or her financial commitments to the credit institution. Therefore, according to the ECB guideline, forbearance is the modification of the terms and conditions of the contract that would not have been granted if the customer was not experiencing financial difficulties and with the specific purpose to prevent him or her from becoming unable to meet financial commitments [8]. European Banking Authority (EBA) recommends that forbearance measures should be granted when customer meets the following criteria:

- formal evidence of temporary liquidity constraints such as income decrease, loss of job;
- excellent credit behaviour prior to financial difficulties;
- willingness to cooperate with the financial institution [8].

EBA has also introduced a set of potential forbearance measures, in other words, concessions granted to the customer in financial difficulties (Table 2). Forbearance measures are aimed at resolving the presence of arrears on the exposure [8]. The main evidence of the concession is more favourable terms and conditions comparing to normal market conditions or conditions granted for customers with the same risk profile.

Table 2. EBA proposed possible forbearance measures [8].

ID	Forbearance measure	Short description
FM01	Interest only	Short-term measure. Customer has to pay only interest during the defined period up to 24 months. After the measure ends, repayment schedule is being revised.

ID	Forbearance measure	Short description
FM02	Principal payment reduction	Short-term measure. Customer has to pay full interest and reduced principal payments during the defined period up to 24 months. After the measure ends, repayment schedule is being revised.
FM03	Full grace	Short-term measure. The delay of principal and interest payments is agreed for defined period. After the measure ends, repayment schedule is being revised.
FM04	Interest and/or arrears capitalisation	Short-term measure. The addition of unpaid interest and/or arrears to the outstanding principal amount of the exposure.
FM05	Interest rate reduction	Long- or short-term measure. Permanent or temporary reduction in interest rate. An interest rate reduction below market conditions is allowed.
FM06	Maturity extension	Long-term measure. Extension of the exposures' maturity date considering the life cycle of the allocated collateral, which allows to spread the repayments over a longer period.
FM07	Additional collateral	Long-term measure used in combination with any other forbearance measure. Additional collateral attraction is aimed to secure the higher risk exposure.
FM08	Disposure of secured asset	Long -term measure. Sale of the collateral used to secure the asset.
FM09	Rescheduled payments	Long -term measure. The change of the existing repayment schedule to more favourable repayment program.
FM10	Currency conversion	Long -term measure. Alignment of the currency between exposure and customers' cash flow.
FM11	Other alteration of contract conditions	Long -term measure. Any other change in the terms and conditions of the contract not listed above.
FM12	Refinancing	Short-term measure. The process of granting a new exposure instead of continuing payments on existing one. Refinance is usually made to reduce an interest rate or contractual payments schedule.
FM13	Debt consolidation	Long -term measure used to consolidate multiple exposures into limited number of exposures.
FM14	Debt forgiveness	Long -term measure. Partial or full debt cancellation.

As previously mentioned, forbearance can be granted for performing or already non-performing customers, therefore management of forbearance is dependent on the customer performance status but is being managed on individual exposure level (Figure 3). The exposure of non-performing customer should remain in non-performing forborne status at least for one year after forbearance measure was granted. Forbearance status can be exited only after a one year probation period under performing status: forbearance measures do not lead to reclassification to non-performing, therefore probation starts after forbearance measure end (e.g. end of grace period), or customer is reclassified to performing after non-performing, which means in total at least two years in forborne status.
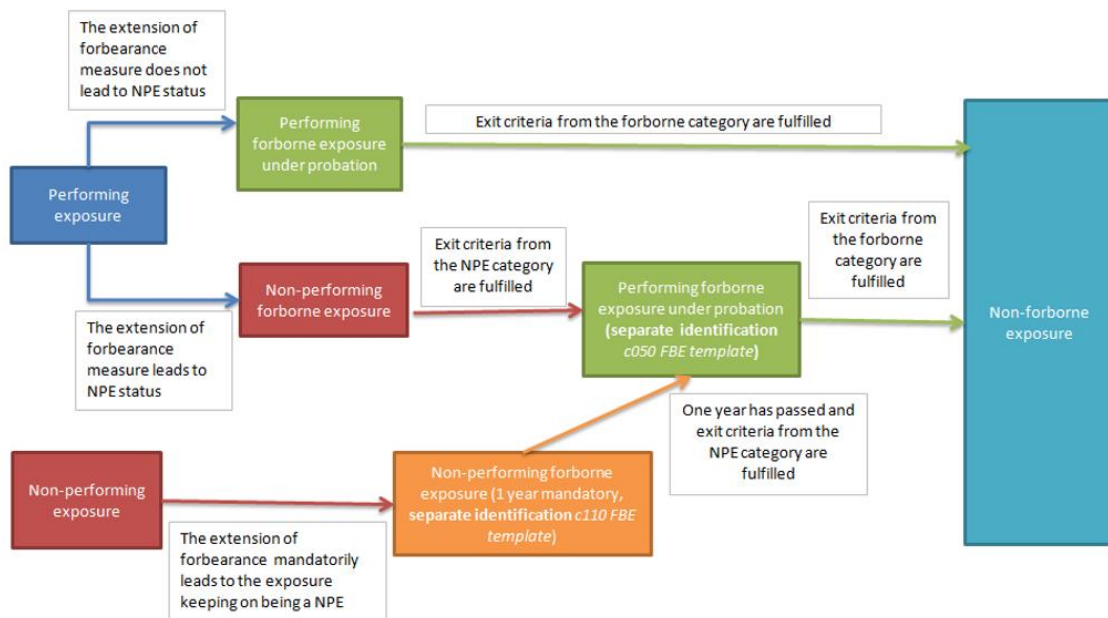
Figure 3. Forbearance lifecycle [40].

Forbearance and NPL management are a key topic for credit risk and have a direct impact on the banks' financial statement. Financial institutions are obliged to calculate loss caused by customers not repaying the money they owe [41]. Impairment (credit loss) value is dependent on the asset quality: the higher the risk of default, the higher impairments are calculated and deducted from the asset's purchase cost, meaning that the institution's financial statement is expressing lower figures on its balance sheet.

4 Defining Data Validation Rules for Forbearance Dataset

Complete, accurate and correct validation rules are the core components of the data validation process. Validation rules should verify if data meets the standards – insufficiently defined rules will return insufficient results, making the whole validation process useless.

The scope of the validation rules definition covered in this Master thesis is limited to the forbearance topic. The ECB proposes a set of validation rules to identify contracts potentially missing forbearance status, however the hypothesis of this thesis states that existing forbearance validation rules, provided by the ECB in scope of the AQR, are not sufficient for the identification of the potentially forborne portfolio.

In scope of the performed analysis, existing AQR forbearance validation rules are applied to the sampled dataset. Returned results are analysed from the validation rules context perspective. Validation rules analysis is based on the documentation, standards, policies and methodologies established under the SSM. The review of the validation results is an input of the adjustments of the AQR validation rules. The final adjusted list of validation results is validated against the same sampled dataset used in the first validation cycle.

All significant financial institutions under the ECBs direct supervision have a common set of regulations, policies and standards to be implemented in their processes, meaning that the unified set of validation rules defined in this Masters' thesis is applicable to the consolidated financial dataset of any significant EU institution.

4.1 Validation Process Cycle

The data validation cycle methodology, used in this thesis, consists of four processes: design, implementation, execution and review (Figure 4) [19]. Used methodology is borrowed from the European Statistical System approach on statistical data validation. From the perspective of this thesis, the author is validating forbearance validation rules

based on a sampled dataset, that has been confirmed as a fully compliant from regulatory and data quality perspective.

Figure 4. Data validation process lifecycle [19].

The first phase of the cycle is the data validation process design, during which experts are defining validation rules based on their professional knowledge and available information [19]. In scope of this thesis, existing forbearance cross-time validation rules defined by the AQR exercise are taken as a basis for the first validation cycle. Based on the rules, data requirements and validation structure are described in the next implementation phase.

Implementation phase is focusing on deriving data requirements to enable an execution of the validation rules testing and review [19]. During the implementation phase structure of the validation process logic and possible interdependencies are described from the technical point of view.

The next, execution phase is an actual test of the dataset or validation rules described in the design phase [19]. In scope of this thesis sampled dataset or sampled portfolio is considered as fully compliant with the EBA/GL/2018/06 guideline, therefore the aim of

the execution phase is to return validation rules accuracy results. Execution phase contains the results presentation according to the described logic in the previous implementation phase [19]. Business review and further analyses of the results is done during the final phase of the first validation cycle, called the review phase. The output of the review phase is an input for the new validation cycle. On example of the current thesis, validation results of the AQR cross-time validation rules performed during the first validation cycle are an input for the second validation cycle, where the author is proposing and adjustments according to the official standards and policies launched under SSM.

Quality data is a key factor of effective risk management and regulatory compliance of the financial institution. High quality can be achieved by clear business requirements and appropriate IT support. As a result, clear and transparent data will support comprehensive analysis and decision-making process.

4.2 Sampled Portfolio

As the main purpose of this thesis is to define forbearance validation rules through the two validation cycles, it is needed to describe a dataset on which validation rules would be tested. The sampled dataset contains 53 568 rows of the basic financial information presented on the contract level – sampled portfolio. The 1,99% (1 064 contracts) of the sampled portfolio is considered as forborne at the R1 reference date and fully compliant with the EBA/GL/2018/06 guideline according to the credit review.

The sampled portfolio consists of two subsets, each subset represents a specific date for which analysis should be performed:

- R1 – most recent reference date;
- R0 – reference date in the past.

In scope of performed analysis,

- R1 - 30.06.2020 reference date;
- R0 - 30.06.2019 reference date.

Validation rules are tested on the merged dataset or sampled portfolio, where R1 and R0 reference dates are consolidated into one sampled portfolio. Detailed data requirements are described in the implementation phase of each validation cycle. Underlying sampled portfolio is the same for each validation cycle, however data requirements may differ according to the requirements triggered by the validation rules described in design phase of each cycle.

4.3 First Cycle of Forbearance Rules Validation Process

The first cycle is aimed to validate if the official cross-time validation rules described in the AQR are sufficient for the identification of potentially forborne portfolio or not. During the first validation cycle cross-time validation rules are described from the business importance perspective, transformed to data and validation requirements, and executed on the sampled portfolio. As a conclusion of the first validation cycle, validation results are reviewed, and further improvements proposed.

4.3.1 Design

AQR Forbearance cross-time validation rules are based on definition of Forbearance as referred in Annex V to Commission Implementing Regulation (EU) No 680/2014 and shortly described in paragraph 3 of this thesis.

In scope of this thesis, AQR Forbearance cross-time validation rules are respectively derived into two parts to identify potential forbearance status (Table 3):

- customer and contract data should present signs of financial difficulties;
- contract data should present visible signs of concessions granted.

Validation rules are comparing the same attributes at two different points in time, where R1 is the most recent and R0 initial reference dates. In scope of performed analysis,

- R1 - 30.06.2020 reference date;
- R0 - 30.06.2019 reference date.

Table 3. ECB AQR forbearance cross-time validation rules.

Type ID	Type	Rule ID	Rule	Field
S1	Sign of financial difficulties	F1	Customer is in the watch-list at R0 or R1 reference date.	WATCH_LIST
		F2	Exposure is credit-impaired at R0 or R1 reference data.	IFRS9_STAGE
		F3	Payments of exposure are past due at R0 or R1 reference date.	DPD
		F4	Loan-to-value amount is higher than 100% at R0 or R1 reference date.	LTV
S2	Sign of concession	C1	Allocated collateral amount increase at R1 reference date.	COL_ALLOC
		C2	Interest rate decrease at R1 reference date.	INT_RATE
		C3	Maturity date extension at R1 reference date.	MATURITY

S1 – Sign of financial difficulties rules are related to the risk attributes that are dependent on the banks' internal risk models and accounting requirements (e.g. number of days past due).

- **F1 WATCH_LIST** - early warning or watch list status is assigned for the large exposure customers in order to identify potential non-performing status of the customer at possibly early stage. Watch list status should be triggered by internal data analyses and data received from the external sources (e.g. tax office, register of court decisions). Watch list status is not directly referring to the financial difficulties of the customer but is a precaution for closer monitoring in case of uncertainty of the customer's future development [42]. Validation rule states that customer could be in a watch list at any reference date as according to the EBA/GL/2018/06 regulation, customer should be identified as a watch list customer three months prior to forbearance [8].

- **F2 IFRS9_STAGE** - credit-impaired definition, is a classification of financial instruments according to International Financial Reporting Standard 9 [43]. The standard defines a three-stage model for identification of changes in credit quality since assets' initial recognition. Non-performing credit-impaired financial assets should be classified under stage 3. Validation rule states that

customers' financial difficulties could be identified based on credit-impaired exposure status at any analysed reference date.

- **F3 DPD** - past due validation rule refers to a count of days from the date when payments should have been made. The AQR states that the worst past due status of all customers' exposure should be assessed. However, filter of exact number of days past due to be considered is not specified.
- **F4 LTV** - loan to value is a ratio used to express the outstanding loan amount to the value of an asset by the following formula: exposure amount divided by the allocated collateral amount [1]. Rule states that loan to value ratio higher than 100% is a sign of financial difficulties for mortgage customer or corporate customer with commercial real estate, shipping or aviation sector of activity.

S2 - Sign of concession rules are derived from the EBA proposed potential forbearance measures to be applied by financial institutions described in paragraph 5.1 of this thesis [8].

- **C1 COL_ALLOC** – allocated collateral amount is the value of the collateral that can under specified conditions be used to cover the customers' exposure in case of repayment difficulties. According to the guideline, the financial institution may ask for additional collateral from the customer to improve loan to value ratio and ensure that higher risk exposure is covered. The measure is used in combination with viable forbearance measures aimed at helping the customer in case of temporary financial difficulties [8].
- **C2 INT_RATE** – Bank may consider an interest rate reduction measure to reduce the monthly repayment obligation for the customer, as high interest rate is one of the most common reasons for customers' distress [8].
- **C3 MATURITY** – Maturity date extension measure aims to allow the repayments to be spread over a longer period than originally stated by the terms and conditions of the contract, also resulting in the reduction of the monthly repayment obligation. Measure can be granted in a combination with payment reduction related measures (e.g. interest only, reduced payments, grace period).

If any of the described rules under S1 sign of financial difficulties and S2 concessions granted rules group is true, then exposure is treated as forborne according to the initial

methodology. In case rules have identified contract as potentially forborne, but there is no forbearance status in the sampled portfolio, validation is treated as failed and further analysis is required.

4.3.2 Implementation

Validation rules, described in the design phase, and additional reference data are used to derive data requirements. Two reference dates, where R1 30.06.2020 is the most recent reference date and R0 30.06.2019 reference date in the past, are merged into one sampled portfolio (Table 4). Data requirements are logically derived into two parts: reference data and data required by the AQR cross-time validation rules. Validation rules defined in design phase and data requirements are described for MS SQL Server.

Table 4. Data requirements for the first validation cycle.

Type	Attribute	Datatype	Description	Possible values
Reference data	CONTRACT_ID	nvarchar (50)	Contract identification number	
	CUSTOMER_ID	nvarchar (50)	Customer identification number	
	R1_IS_FORBORNE	bit	Identifies if exposure is forborne or not	1 – yes 0 – no
Data requirements defined by validation rules	R1_WATCH_LIST	bit	Identifies if customer is in a watch list	1 – yes 0 – no
	R0_WATCH_LIST			
	R1_IFRS9_STAGE	int	Stage identificatory according to IFRS9	1 – stage 1 2 – stage 2 3 – stage 3
	R0_IFRS9_STAGE			
	R1_DPD	int	Count of days past due	
	R0_DPD			
	R1_LTV	numeric (12,4)	Loan-to-value ratio	
	R0_LTV			
	R1_COL_ALLOC	numeric (12,4)	Allocated collateral amount	
	R0_COL_ALLOC			
	R1_INT_RATE	numeric (12,4)	Interest rate	
	R0_INT_RATE			
	R1_MATURITY	datetime	Maturity date	
	R0_MATURITY			

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For better readiness validation results are derived into 4 levels: underlying validation rules are grouped by signs of financial difficulties and concession granted (Table 5, 6). Signs of both groups are unified into one check if contract has an evidence of being forborne (P_FB), the actual forbearance status in provided sampled portfolio is compared against returned status by the validation rules (Table 7).

The main logic is derived from the AQR cross-time forbearance validation rules. Rules from F1 to F4 are describing potential signs of financial difficulties and rules from C1 to C3 are describing potential concessions granted (Table 5). Granular rules are grouped into S1 and S2 groups accordingly (Table 6).

Table 5. Underlying validation requirements for the first validation cycle – level 4.

ID	Data type	Logic description
F1	bit	SET F1 = CASE WHEN R1_WATCH_LIST = 1 OR R0_WATCH_LIST = 1 THEN 1 ELSE 0 END
F2	bit	SET F2 = CASE WHEN R1_IFRS9_STAGE = 3 OR R0_IFRS9_STAGE = 3 THEN 1 ELSE 0 END
F3	bit	SET F3 = CASE WHEN R1_DPD > 0 OR R0_DPD > 0 THEN 1 ELSE 0 END
F4	bit	SET F4 = CASE WHEN R1_LTV > 1 OR R0_LTV > 1 THEN 1 ELSE 0 END
C1	bit	SET C1 = CASE WHEN R1_COL_ALLOC > R0_COL_ALLOC THEN 1 ELSE 0 END
C2	bit	SET C2 = CASE WHEN R1_INT_RATE < R0_INT_RATE THEN 1 ELSE 0 END
C3	bit	SET C3 = CASE WHEN R1_MATURITY > R0_MATURITY THEN 1 ELSE 0 END

Table 6. Underlying validation requirements for the first validation cycle – level 3.

ID	Data type	Logic description
| S1 | bit | ```
SET S1 = CASE
WHEN F1 = 1 OR F2 = 1 OR F3 = 1 OR F4 = 1 THEN 1
ELSE 0
END
``` |
| S2 | bit | ```
SET S2 = CASE
WHEN C1 = 1 OR C2 = 1 OR C3 = 1 THEN 1
ELSE 0
END
``` |

Potential forbearance status (P_FB) is derived from the signs of financial difficulties and granted concessions (Table 7). As a part of the same level, actual forbearance status is returned.

Table 7. Underlying validation requirements for the first validation cycle – level 2.

ID	Data type	Logic description
| P_FB | bit | ```
SET P_FB = CASE
WHEN S1 = 1 AND S2 = 1 THEN 1
ELSE 0
END
``` |
| A_FB | bit | ```
SET A_FB = CASE
WHEN R1_IS_FORBORNE = 1 THEN 1
ELSE 0
END
``` |

Final comparison is made between potential and actual forbearance marks (Table 8). Possible results returned by the first validation level are described below (Table 9).

Table 8. Underlying validation requirements for the first validation cycle – level 1.

ID	Datatype	Logic description
| V1 | int | ```
SET V1 = CASE
WHEN A_FB = 0 AND P_FB = 0 THEN 1
WHEN A_FB = 1 AND P_FB = 1 THEN 2
WHEN A_FB = 1 AND P_FB = 0 THEN 3
WHEN A_FB = 0 AND P_FB = 1 THEN 4
ELSE 0
END
``` |

Table 9. V1 possible validation values description.

V1	A_FB	P_FB	Description
1	0	0	Contract is not forborne according to the methodology and is not marked as forborne in the sampled portfolio.
2	1	1	Existing forbearance status is assigned according to the regulations.
3	1	0	Contract is not forborne according to the methodology but is marked as forborne in the sampled portfolio.
4	0	1	Contract is marked as forborne according to the methodology but without forbearance status in the sampled portfolio.
0			Technical issue.

4.3.3 Execution

Execution results are derived based on returned values according to the first validation level requirements (Table 10). According to the results, AQR validation rules have identified 18,98% (202 contracts) of the actual forborne sampled portfolio. The result of executed rules states that 2 922 (5,57% of the whole not forborne sampled portfolio) contracts miss forbearance status, however according to the credit risk review sampled portfolio is fully compliant with the ECB regulations.

Table 10. Aggregated results of the first validation cycle.

V1	Description	Count	Expected
1	Contract is not forborne according to the methodology and is not marked as forborne in the sampled portfolio.	49 582	52 504
2	Existing forbearance status is assigned according to the regulations.	202	1 064
3	Contract is not forborne according to the methodology but is marked as forborne in the sampled portfolio.	862	0
4	Contract is marked as forborne according to the methodology but without forbearance status in the sampled portfolio.	2 922	0
	Total	**53 568**	**53 568**

Validation result **V1 = 1** has returned not forborne contracts in scope of the actual contract status and potential status returned by the validation rules (Table 11).

Row ID	V1	A_FB	P_FB	S1	S2	Count	%
1	1	0	0	0	0	26 845	54,14
2	1	0	0	0	1	19 756	39,85
3	1	0	0	1	0	2 981	6,01
					Total	49 582	100

Validation result V1 = 2 has returned cases, where actual forbearance status was assigned to the contract according to the requirements described by the validation rules (Table 12). Detailed overview of level 4 requirements presents top 5 the most common combinations for cases, where forbearance status was identified correctly.

Table 12.Detailed results of the first validation cycle – V1=2 (level 4).

Row ID	V1	A_FB	P_FB	S1	S2	F1	F2	F3	F4	C1	C2	C3	Count	%
1	2	1	1	1	1	0	1	1	0	0	0	1	53	26,24
2	2	1	1	1	1	0	0	1	0	0	1	0	40	19,8
3	2	1	1	1	1	1	1	1	0	0	1	0	17	8,42
4	2	1	1	1	1	0	1	1	1	0	1	0	17	8,42
5	2	1	1	1	1	1	0	0	0	0	0	1	13	6,44
6	2	1	1	1	1								62	30,68
												Total	202	100

Detailed overview of **V1 = 2** level 4 requirements results is returning varied combinations of rules where the following patterns can be followed:

- **row 1** - the most popular combination of signs of forbearance status is non-performing contract in stage 3 (F2), days past due (F3) and extension of maturity as a sign of granted concession (C3);
- **row 2** - as well as days past due (F3) as a sign of financial difficulties and interest rate reduction as a sign of granted concession (C3).

However, significant part of actually forborne contracts was not identified as forborne according to the described validation rules (81,02%). According to the level 3

requirements the biggest part of deals has not any sign of forbearance or only sign of financial difficulties was presented (Table 13).

Table 13. Detailed results of the first validation cycle – V1=3 (level 3).

Row ID	V1	A_FB	P_FB	S1	S2	V1	Count	%
1	3	1	0	0	0	4	349	40,49
2	3	1	0	1	0	4	382	44,32
3	3	1	0	0	1	4	131	15,19
						Total	862	100

It could be said that the most important part of the analysis should focusing on cases, where according to the validation rules contract is forborne, but actually it is not. Due to that the full list of identified combinations is returned for the analysis. According to the execution results, there are 2 922 contracts marked as potentially forborne without forbearance status assigned in the sampled portfolio (Table 14).

Table 14. Detailed results of the first validation cycle – V1=4 (level 4).

Row ID	V1	A_FB	P_FB	S1	S2	F1	F2	F3	F4	C1	C2	C3	Count	%
1	4	0	1	1	1	0	0	1	0	0	1	0	1416	48,46
2	4	0	1	1	1	0	1	1	0	0	1	0	611	20,91
3	4	0	1	1	1	0	0	0	1	0	1	0	518	17,73
4	4	0	1	1	1	0	1	0	0	0	1	0	136	4,65
5	4	0	1	1	1	0	1	1	1	0	1	0	107	3,66
6	4	0	1	1	1	0	0	1	1	0	1	0	83	2,84
7	4	0	1	1	1	1	0	0	0	0	1	0	16	0,55
8	4	0	1	1	1	1	1	0	0	0	1	0	8	0,27
9	4	0	1	1	1	0	0	1	0	1	0	0	7	0,24
10	4	0	1	1	1	0	0	0	1	1	0	1	5	0,17
11	4	0	1	1	1	1	1	1	0	0	1	0	3	0,10
12	4	0	1	1	1	0	1	0	1	0	1	0	3	0,10
13	4	0	1	1	1	1	1	1	1	0	1	0	3	0,10
14	4	0	1	1	1	0	1	1	0	0	0	1	2	0,07

Row ID	V1	A_FB	P_FB	S1	S2	F1	F2	F3	F4	C1	C2	C3	Count	%
15	4	0	1	1	1	0	0	0	1	0	1	1	2	0,07
16	4	0	1	1	1	1	0	1	0	0	1	0	2	0,07
												Total	2922	100

- **Row 1** - the most cases identified as forborne, but without actual forbearance status in the sampled portfolio, have meet days past due as a financial difficulties and interest rate reduction as granted concession validation rules combination, in total 48,46%.

- **Row 2** - the same rules were satisfied for additional 20,91% of cases, where in addition IFRS9 rule was meet.

- **Row 3** – the combination of standalone LTV rule as a sign of financial difficulties and interest rate reduction as a standalone sign of granted concession, was satisfied for 17,73% of all cases where according to the applied AQR validation rules, forbearance status was missing.

The most common sign of financial difficulties is a count of days past due – 2 234 deals are past due (76,45% of selected portfolio without forbearance mark), of which 1 506 deals (51,54% of selected portfolio without forbearance mark) do not have other visible signs of financial difficulties. It could be also said that interest rate reduction was the only visible concession in selected potentially forborne portfolio, it was identified for 2 908 contracts (99,52% of selected portfolio without forbearance mark), of which 2 906 deals do not have other visible signs of concession granted.

4.3.4 Review

Results returned by the validation rules are unsatisfactory. As the AQR validation rules were performed on the sampled portfolio, that contains fully compliant financial data of the exposures having forbearance status, it could be stated, that provided validation rules could not be treated as hard rules as they are not necessarily selecting the full potentially forborne portfolio and the results are misleading. The overall percentage of identified forborne exposures, that meet forbearance methodology and are already marked as forborne in the sampled portfolio, is relatively small – 18,2%.

According to the execution phase validation results, the following adjustments could be proposed:

- **F2 IFRS9_STAGE -** AQR validation rule is defining stage 3 as a sign of financial difficulties of the customer. However, forbearance is usually granted to prevent customer of becoming non-performing (classification of customer assets into stage 3). According to the definition, stage 2 refers to the increased risk of becoming default and could be added as a potential sign of financial difficulties [42].

- According to the returned results, days past due was a main evidence of customer in financial difficulties. However, as mentioned in the design phase, **F3 DPD** rule is considering overdue payments without any filter of exact number of days past due. Meaning that if customer is overdue by 1 day, he or she are automatically considered as in financial difficulties. Such a low limit could not be considered as a feasible sign. Filter up to 30 days can be introduced according to the regulation: payments that are 30 days past due should be treated as a backstop for significant increase in credit risk [24].

- Interest rate reduction, validated by the rule **C2 INT_RATE,** was identified as a standalone measure for 92,7% exposures, what provokes an additional clarification regarding the rule definition. Interest rate can be different in two analysed reference dates due to its type – interest rate can be fixed or variable; therefore, rule cannot be treated as a hard rule in such interpretation. In case of variable interest type (e.g. EURIBOR), rate can differ during the period. Rule remains valid if validation would be performed on interest rate margin, as change of margin, both increase and decrease, can refer to the granted concession. Interest rate margin increase can be triggered by postponement of the payment or extension of maturity.

- Both rules **F3 LTV, C1 COL_ALLOC** are related to the value of collateral. According to the AQR defined rules, loan to value ratio validation should be performed for corporate customers with commercial real estate, shipping or aviation sector of activity and mortgage customers. However, according to the practice, financing of large segment low credit risk customers is often based on

their cash flow. As a result, it cannot be treated as a sign of forbearance. Additional note can be added regarding collateral value increase, as financial institutions are evaluating its collateral values, that may trigger a direct change in the LTV and collateral allocated amount values. Additional collateral, as stated in the forbearance measures description, could not be used as a standalone measure due to its purpose to compensate a higher risk exposures, not to support a payments renewal [8]. Due to the reasons described above, sign of change in collateral during the period does not necessarily lead to an evidence of forbearance.

4.4 Second Cycle of Forbearance Rules Validation Process

The second cycle of data validation follows the same structure: design, implement, execute and review. The output of the first validation cycle is used as input for the second one. The business logic of the forbearance status validation rules remains the same:

- customer and contract data should present a sign of financial difficulties;
- visible sign of concessions granted;

Underlying rules logic is adjusted and tested on the same sampled portfolio. According to the adjusted rules, data requirements for the sampled portfolio are also changed, fields not used for validation are eliminated and new added.

4.4.1 Design

The structure of the validation rules and requirements level, where validation results are derived into 4 levels: underlying validation rules are grouped by signs of financial difficulties and concession granted, signs of both groups are unified into on check if contract has an evidence of being forborne and the last check compares actual forbearance status in provided sampled portfolio against returned status by the validation rules – remains the same.

Level 4 requirements: sign of financial difficulties and sign of granted concession are adjusted according to the first cycle review phase output. Cycle two adjustments are presented in a tracked changes view (Table 15).

Table 15. Tracked changes between Cycle 1 and Cycle 2 validation rules.

Reference			Cycle 1		Cycle 2		Change description
Type ID	Type	Rule ID	Rule	Field	Rule	Field	
S1	Sign of financial difficulties	F1	Customer is in a watch-list at R0 or R1 reference date.	WATCH_LIST	Customer is in a watch-list at R0 or R1 reference date.	WATCH_LIST	Rule remains the same.
		F2	Exposure is credit-impaired at R0 or R1 reference data.	IFRS9_STAGE	Exposure is credit-impaired or has a significant increase in credit risk at R0 or R1 reference data.	IFRS9_STAGE	Significant increase in credit risk (stage 2) added.
		F3	Payments of exposure are past due at R0 or R1 reference date.	DPD	Payments of exposure are more than 30 days past due at R0 or R1 reference date.	DPD	Filter for up to 30 days past due added.
		F4	Loan-to-value amount is higher than 100% at R0 or R1 reference date.	LTV	Loan-to-value amount is higher than 100% at R0 or R1 reference date.	LTV	Rule is valid, however is not included into validation as a standalone sign. Rule should be used as a supportive sign of financial difficulties in combination of any other financial difficulties sign.

Reference			Cycle 1		Cycle 2		Change description
Type ID	Type	Rule ID	Rule	Field	Rule	Field	
S2	Sign of concession	C1	Allocated collateral amount increase at R1 reference date.	COL_ALLOC	Allocated collateral amount increase at R1 reference date. Rule should be used as a supportive sign of concession in combination of any other concession sign.	COL_ALLOC	Rule is valid, however is not included into validation as a standalone sign.
		C2	Interest rate decrease at R1 reference date.	INT_RATE	Interest rate margin change at R1 reference date.	INT_RATE _MARGIN	Interest rate replaced with interest rate margin.
		C3	Maturity date extension at R1 reference date.	MATURITY	Maturity date extension at R1 reference date.	MATURITY	Rule remains the same.
		C4			Outstanding principal amount of the exposure has increased at R1 or has not changed comparing at R1 and R0 reference dates.	CURRENT _PRINCIPAL _AMOUNT	Newly added.
		C5			Remaining payoff balance on the payment schedule has changed at R1 reference date comparing the same contract payment schedule at R0 reference date starting from R1 reference date period.	PAYOFF _BALANCE	Newly added.

F1 validation rule of the listed signs of financial difficulties remains the same as described by ECB AQR cross-time validation rules. **F4 LTV** validation rule context is not changed, however according to the adjusted requirements rule could not be treated as a standalone sign of financial difficulties but can be used as a supportive sign of financial difficulties identified by any other described sign.

- **F2 IFRS9_STAGE** stage rule, previously defined only for credit-impaired customers, was extended to identify exposures in stage 2. Significant increase in credit risk (stage 2) could be used as an indicator of early warning signal of becoming non-performing [42], [43]. According to the forbearance guideline, forbearance measure is aimed to prevent customers to becoming non-performing, meaning that looking into stage 3 only cannot give a full scope of actually forborne contracts.

- **F3 DPD** validation rules was adjusted to take into account only exposures with more than 30 days overdue. Applied border of days past due could potentially filter out cases, when payment is missing due to other factors not related to financial difficulties.

C3 validation rule of described signs of concession was not changed. **C1 COL_ALLOC** validation rule, similarly to **F4 LTV** validation rule, was adjusted to be taken into account only as a supportive sign of granted concession due to collateral value sensitivity of performed evaluations. Rules described below were adjusted or newly added.

- **C2 INT_RATE_MARGIN** validation rule is changed to compare interest rate margin instead of interest rate. Variable interest type may trigger change in interest rate comparing two different points in time. Despite the fact, original sign of concession was derived from the EBA proposed forbearance measure interest rate reduction (Annex 1), not only reduction can refer to granted concession. Interest rate margin increase can be triggered by postponement of the payment or extension of maturity, what are potential forbearance measures to be applied for exposure of the customer being in financial difficulties.

- **C4 CURRENT_PRINCIPAL_AMOUNT** is a newly added validation rule what can be used as a sign of the payment reduction related measures. Principal

amount is the amount borrowed by the customer without interest being count. Such forbearance measures as interest only, reduced payments and grace period are related to reduction or postponement of the payment and may be visible from not changed outstanding principal amount.

- **C5 PAYOFF_BALANCE** validation rule could be also treated as a sign of forbearance measures related to the payment reduction**.** Payoff balance is the amount to be paid off by the customer, including principal and interest payments. In scope of this thesis, payoff balance is derived based on the payment schedule at R1 and R0 reference dates, where R0 reference date payment schedule is taken into account only from R1 reference date or, in other words, the total payoff balance as of 30.06.2020 is compared against the payoff balance as of 30.06.2019, where the sum of payments from 30.06.2020 is considered. R1 and R0 payoff balances starting from R1 reference date are compared, changes in the total payoff balance more than 2% are considered as the potential sign of granted concession. Payment reduction measures are usually granted together with the change in interest rate, therefore the total payoff balance for the same date analysed from the different reference dates could differ.

4.4.2 Implementation

Validation rules requirements, described in the design phase, and additional reference data are used to derive data requirements. Two reference dates, where R1 is the most recent and R0 initial reference date, are merged into one final sampled portfolio (Table 16). Data requirements are logically derived into two parts: reference data and data required by the validation rules. Validation rules defined in design phase and data requirements are described for MS SQL Server.

Table 16. Data requirements for the second validation cycle.

Reference	Cycle 1	Cycle 2				Change description
Type	Attribute	Attribute	Datatype	Description	Possible values	
Reference data	CONTRACT_ID	CONTRACT_ID	nvarchar (50)	Contract identification number		Requirement remains the same.
	CUSTOMER_ID	CUSTOMER_ID	nvarchar (50)	Customer identification number		Requirement remains the same.
	R1_IS_FORBORNE	R1_IS_FORBORNE	bit	Identifies if exposure is forborne or not	1 – yes 0 – no	Requirement remains the same.
		R1_LATEST_FB_START_DATE	datetime	Latest forbearance measure start date		Newly added.
Data requirements defined by validation rules	R1_WATCH_LIST	R1_WATCH_LIST	bit	Identifies if customer is in a watch list	1 – yes 0 – no	Requirement remains the same.
	R0_WATCH_LIST	R0_WATCH_LIST				
	R1_IFRS9_STAGE	R1_IFRS9_STAGE	int	Stage identificatory according to IFRS9	1 – stage 1 2 – stage 2 3 – stage 3	Requirement remains the same.
	R0_IFRS9_STAGE	R0_IFRS9_STAGE				
	R1_DPD	R1_DPD	int	Count of days past due		Requirement remains the same.
	R0_DPD	R0_DPD				
	R1_LTV					Delisted in the second cycle.
	R0_LTV					

Reference	Cycle 1	Cycle 2				Change description
Type	**Attribute**	**Attribute**	**Datatype**	**Description**	**Possible values**	
Data requirements defined by validation rules	R1_COL_ALLOC					Delisted in the second cycle.
	R0_COL_ALLOC					
	R1_INT_RATE					Delisted in the second cycle.
	R0_INT_RATE					
		R1_INT_RATE_MARGIN	numeric (12,4)	Interest rate		Newly added.
		R1_INT_RATE_MARGIN				
	R1_MATURITY	R1_MATURITY	int	Maturity date		Requirement remains the same.
	R0_MATURITY	R0_MATURITY				
		R1_CURRENT_PRINCIPAL _AMOUNT	numeric (12,4)	Outstanding principal amount		Newly added.
		R0_CURRENT_PRINCIPAL _AMOUNT				
		R1_PAYOFF_BALANCE	numeric (12,4)	Remaining payoff balance from R1 reference date		Newly added.
		R0_PAYOFF_BALANCE				

The overall structure of the validation logic is not changed, the only adjusted part is level 4 requirements (Table 17).

Table 17. Underlying validation requirements for the second validation cycle – level 4.

ID	Data type	Logic description

F1	bit	`SET F1 = CASE`
		`WHEN R1_WATCH_LIST = 1 OR R0_WATCH_LIST = 1 THEN 1`
		`ELSE 0`
		`END`

F2	bit	`SET F2 = CASE`
		`WHEN R1_IFRS9_STAGE IN (2, 3) OR R0_IFRS9_STAGE IN (2, 3)`
		`THEN 1 ELSE 0`
		`END`

F3	bit	`SET F3 = CASE`
		`WHEN R1_DPD > 30 OR R0_DPD > 30 THEN 1`
		`ELSE 0`
		`END`

C2	bit	`SET C2 = CASE`
		`WHEN R1_INT_RATE_MARGIN < > R0_ INT_RATE_MARGIN THEN 1`
		`ELSE 0`
		`END`

C3	bit	`SET C3 = CASE`
		`WHEN R1_MATURITY > R0_MATURITY THEN 1`
		`ELSE 0`
		`END`

C4	bit	`SET C4 = CASE`
		`WHEN R1_CURRENT_PRINCPIAL_AMOUNT =`
		`R0_ CURRENT_PRINCPIAL_AMOUNT THEN 1`
		`ELSE 0`
		`END`

C5	bit	`SET C5 = CASE`
		`WHEN ABS(R1_PAYOFF_BALANCE – R0_PAYOFF_BALANCE) /`
		`R0_PAYOFF_BALANCE * 100 > 2 THEN 1`
		`ELSE 0`
		`END`

4.4.3 Execution

As for the first validation cycle, execution results are derived based on returned values according to the first validation level requirements (Table 18). Identified not forborne portfolio, described by the V1=1 validation result, was totally matching with the expected outcome of the validation. According to the execution results, adjusted validation rules have identified 46,33% (493 contracts) of the actual forborne sampled portfolio, overall accuracy has increased for 23,35% comparing the results of the first validation cycle. However, not full actual forborne portfolio was identified by the

validation rules, there are 571 contracts for which forbearance status exists in the sampled portfolio, but not identified by the described validation rules of the second phase.

Table 18. Aggregated results of the second validation cycle.

V1	Description	Count	Expected
1	Contract is not forborne according to the methodology and is not marked as forborne in the sampled portfolio.	52 504	52 504
2	Existing forbearance status is assigned according to the regulations.	493	1 064
3	Contract is not forborne according to the methodology but is marked as forborne in the sampled portfolio.	571	0
4	Contract is marked as forborne according to the methodology but without forbearance status in the sampled portfolio.	0	0
	Total	**53 568**	**53 568**

As previously mentioned, result returned by the **V1 = 1** validation was fully matching with the expected result. Looking into more details it can be noticed that there were cases for which signs of financial difficulties or granted concession were still found (Table 19).

Table 19. Detailed results of the second validation cycle – V1=1 (level 3).

Row ID	V1	A_FB	P_FB	S1	S2	Count	%
1	1	0	0	0	0	39 548	75,32
2	1	0	0	0	1	10 890	20,74
3	1	0	0	1	0	2 066	3,94
					Total	**52 504**	**100**

Validation result **V1 = 2** has returned cases, where actual forbearance status was assigned to the contract according to the requirements described by the validation rules (Table 20). Detailed overview of level 4 requirements presents top 5 the most common combinations for cases, where forbearance status was identified correctly.

Table 20. Detailed results of the second validation cycle – V1=2 (level 4).

Row ID	V1	A_FB	P_FB	S1	S2	F1	F2	F3	C2	C3	C4	C5	Count	%
1	2	1	1	1	1	0	1	0	0	0	0	1	162	32,86
2	2	1	1	1	1	0	1	0	1	0	0	0	46	9,33
3	2	1	1	1	1	0	1	1	0	0	1	0	45	9,13
4	2	1	1	1	1	1	1	0	0	0	0	1	39	7,91
5	2	1	1	1	1	0	1	1	0	0	0	1	31	6,29
6	2	1	1	1	1		1						170	34,48
												Total	493	100

Detailed overview of **V1 = 2** level 4 requirements results is returning varied combinations of rules where the following patterns can be followed:

- **rows 1 to 6** – adjusted IFRS9 rule (F2) is a sign of financial difficulties presented for each identified forbearance case;
- **row 3, 5** – in case days past due (F3) signs of financial difficulties is satisfied, IFRS9 (F2) rule is always meet as well;
- **row 1, 4, 5** – the most common sign of granted concession is a newly introduced rule regarding customer's remaining balance.

Table 21. Detailed results of the second validation cycle – V1=3 (level 3).

Row ID	V1	A_FB	P_FB	S1	S2	Count	%
1	3	1	0	0	0	89	15,59
2	3	1	0	1	0	482	84,41
					Total	571	100

Despite the improved accuracy of the validation rules, there are still more than a half forbearance cases, what are not covered by the validation rules described in the second validation cycle – 571 contracts out of 1 064 actually forborne ones (53,67%) (Table 21).

To enable a more detailed analysis, V1 = 3 validation results were extended by R1_LATEST_FB_START_DATE field. Returned results have showed that validation

rules described in the second phase have uncovered cases, where forbearance status was assigned outside of the analysed period, before 30.06.2019 (Table 22).

Table 22. Detailed results of the second validation cycle – V1=3 (level 3) and R1_LATEST_FB_START_DATE.

Row ID	R1_LATEST_FB_START_DATE	V1	A_FB	P_FB	S1	S2	Count
1	< 30.06.2019	3	1	0	0	0	89
2	>= 30.06.2019	3	1	0	0	0	0
3	< 30.06.2019	3	1	0	1	0	482
4	>= 30.06.2019	3	1	0	1	0	0
						Total	571

4.4.4 Review

According to the execution results, defined validation rules have identified a full not forborne portfolio. Detailed results have shown that there were cases, where one of the signs of two groups (financial difficulties or granted concession) were still satisfied. Such situation is logical, as concessions are not automatically granted for all customers in financial difficulties, as well as concession can be granted as a part of contract renegotiation without granting a forbearance status (meaning that customer is not in financial difficulties).

Despite the positive results of the identification of not forborne portfolio, accuracy of actually forborne portfolio was below 50%. Afterwards, actually forborne portfolio validation results should be split into two parts:

- cases, when forbearance measure was granted during the analysed period between R1 and R0;
- cases, when forbearance measure was granted already before R0.

Extended controls based on R1_LATEST_FB_START_DATE field have returned that all forborne contracts with the latest forbearance measure granted during the analysed period between 30.06.2019 and 30.06.2020 were identified by the validation rules, while all contracts with granted forbearance measure before 30.06.2019 had only sings of customer being in financial difficulties or no any sign of forbearance at all (Table

23). Such situation is possible as validation rules performed for the specific period of time are comparing contract conditions between two reference dates.

Table 23. Review of the actual forborne portfolio against the validation results of the second validation cycle.

Row ID	R1_LATEST_FB_START_DATE	V1	A_FB	P_FB	S1	S2	Count
1	>= 30.06.2019 (R0)	2	1	1	1	1	493
2	< 30.06.2019 (R0)	3	1	0			571
						Total	1 064

If, for example, forbearance measure was granted before the analysed period, then changes in contract terms and conditions would not be visible – forbearance granted in 30.06.2015 analysed in period of 30.06.2019 - 30.06.2020 will have the same contract terms and conditions at 30.06.2019 and 30.06.2020 reference dates. To catch forbearance status granted in 30.06.2015 it would be needed to review at least one day before the measure was granted as a R0 reference date and R1 any date after measure was granted.

It can be concluded that rules defined in the second validation cycle were validated and could be considered as an adequate validation rules for the forborne portfolio, where the latest forbearance measure is granted after R0 reference date.

4.5 Conclusion

The first validation cycle has proved that the hypothesis of this Master's thesis that - existing forbearance business validation rules provided by ECB are not sufficient for the identification of the potentially forborne portfolio - is true. Validation process performed on the sampled dataset, where forborne status of the contract was considered as a fully compliant with the EBA/GL/2018/06 guideline according to the credit review, has shown that the AQR validation rules have identified only 18,98% of the actual forborne portfolio. The result of the validation rules stated that 2 922 contracts (5,57% of the whole not forborne sampled portfolio) missed forbearance status.

In scope of the second validation cycle, AQR validation rules were reviewed and adjusted according to the official regulations and standards published under the SSM. Derived set of rules was validated against the same sampled portfolio what was used in the first validation cycle. According to the validation results, adjusted list of rules has identified 46,33% of the whole forborne portfolio. Returned results were split by date when latest forbearance measure was applied. Additional split has proved that derived rules have identified a full forborne portfolio for cases, when forbearance measure was granted between analysed R1 and R0 reference dates.

The final list of forbearance cross-time validation rules developed in scope of this Master's thesis could be used for the two purposes:

- to validate if forbearance status is assigned according to the SSM methodology for the contracts where the latest forbearance measure is applied between the analysed R1 and R0 reference dates;
- or to identify potentially forborne contract, for which potential forbearance status is missing between the analysed R1 and R0 reference dates.

The final list of forbearance cross-time validation rules contains a comparison of two datasets representing a basic financial information at two different points in time, where R1 is the most recent reference date and R0 is a reference date in the past (Table 24).

Minimum data requirements for the comparison are:

- watch list - early warning or watch list status is a precaution for closer monitoring in case of uncertainty of the customers' future development [42];
- ifrs9 stage - classification of financial instruments according to International Financial Reporting Standard 9 [43];
- days past due - count of days from the date when payments should have been made;
- interest rate margin;
- contract maturity date;
- current principal amount - outstanding principal amount of the exposure;
- payoff balance – outstanding principal and interest amount of the exposure.

Table 24. The final list of forbearance cross-time validation rules.

Type	Rule	Field
Sign of financial difficulties	Customer is in a watch-list at R0 or R1 reference date.	WATCH_LIST
	Exposure is credit-impaired or has a significant increase in credit risk at R0 or R1 reference data.	IFRS9_STAGE
	Payments of exposure are more than 30 days past due at R0 or R1 reference date.	DPD
Sign of concession	Interest rate margin change at R1 reference date.	INT_RATE _MARGIN
	Maturity date extension at R1 reference date.	MATURITY
	Outstanding principal amount of the exposure has increased at R1 or has not changed comparing at R1 and R0 reference dates.	CURRENT _PRINCIPAL _AMOUNT
	Remaining payoff balance on the payment schedule has changed at R1 reference date comparing the same contract payment schedule at R0 reference date.	PAYOFF _BALANCE

4.5.1 Future Development

The final set of forbearance cross-time validaiton rules defined in scope of this Master's thesis could be used by significant financial institutions under the ECB direct supervision to improve their NPL and forbearance data validaiton process or by the regulators to validate if data submitted by institutions is compliant with the official regulations.

The final set of forbearance cross-time validaiton rules defined in this Master's thesis was used by the regulatory departments of the considered financial institution to validate forbearance status in the final dataset used for regulatory reporting.

As a future development additional cycles of the validaiton can be performed to adjust proposed set of forbearance cross-time validaiton rules according to the future updates in the official regulations and methodologies. This Master's thesis could be used as an input for the development of the cross-time data validation framework in the future.

5 Summary

The purpose of the thesis was to define harmonised validation rules for the forbearance status assignment that would be applicable for all banks under the ECB direct supervision due to the common set of regulations used to derive the final set of validation rules. Forbearance validation rules were derived through the validation cycle process based on the existing forbearance validation rules defined by the ECB in scope of the Asset Quality Review (AQR) exercise. The hypothesis stated that existing forbearance validation rules provided by the ECB are not sufficient for the identification of the potentially forborne portfolio.

The first validation cycle has proved that the hypothesis of this Master's thesis is true. The second validation cycle was performed to define and validate the final list of forbearance cross-time validation rules. During the second validation cycle it was discovered that forbearance status assignment validaiton rules are applicable only for cases, when forbearance measure was granted between analysed R1 and R0 reference dates.

The final list of forbearance cross-time validation rules developed in scope of this Master's thesis could be used for the two purposes:

- to validate if forbearance status is assigned according to the SSM methodology for the contracts where the latest forbearance measure is applied between the analysed R1 and R0 reference dates;
- or to identify potentially forborne contract, for which potential forbearance status is missing between the analysed R1 and R0 reference dates.

The final set of forbearance cross-time validaiton rules defined in scope of this Master's thesis could be used by significant financial institutions under the ECB direct supervision to improve their NPL and forbearance data validaiton process or by the regulators to validate if data submitted by institutions is compliant with the official regulations.

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