MODELING CASH FLOWS UNDER IFRS17: TÜRK CASE

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ABSTRACT

MODELING CASH FLOWS UNDER IFRS17: TÜRK CASE

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By the introduction of IFRS17, vital changes in measurements of insurance contracts are expected. This requires to assess the liabilities of insurance companies by two kinds. These are (i) fulfilment cash flows and (ii) contractual service margin, in which policyholder cash flows are the nucleus of both. Hence, this thesis consists of two main parts. Firstly, we use panel data analysis to analyze policyholder cash flows in respect to Türk returns, insurer's cash outflows and changes in cash. Secondly, we consider a top-down modeling technique for the Türk insurance sector. The latter uses machine learning to model, simulate, and forecast future policyholder cash flows and compares the usage of IFRS17 with previous standards. We conclude that under IFRS17 insurers should expect their liabilities to be higher, which would change their capital structure; influencing their performance and position. This change in the liabilities of insurance companies will enhance the transparency, quality and trustfulness of the financial statements. Correspondingly, it will decrease the future variability and create homogeneity within insurance financial statements, which is the core aim of IASB in establishing IFRS17.

Keywords: IFRS17, Fulfilment Cash Flows, Contractual Service Margin, Policyholder Cash Flows, XGBoost, Prophet.

ÖZ

UFRS 17 KAPSAMINDA NAKİT AKIŞLARININ MODELLENMESİ: TÜRKİYE ÖRNEĞİ

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UFRS17'nin kullanıma sunulmasıyla birlikte, sigorta sözleşmelerinin ölçümlerinde önemli değişiklikler beklenmektedir. Bu, sigorta şirketlerinin yükümlülüklerini iki türe göre değerlendirmeyi gerektirir. Bunlar (i) poliçe sahibi nakit akışlarının her ikisinin de çekirdeğini oluşturduğu sözleşmenin ifasına ilişkin nakit akışları ve (ii) sözleşmeye dayalı hizmet marjı. Dolayısıyla bu tez iki ana bölümden oluşmaktadır. İlk olarak, Türkiye'deki getiriler, sigortacının nakit çıkışları ve nakit değişimleri açısından poliçe sahibi nakit akışlarını analiz etmek amacıyla panel veri analiz uygulanması yapılmaktadır. İkinci olarak, Türk sigorta sektörü için yukarıdan aşağıya bir modelleme tekniği ele alınmaktadır. Burada gelecekteki poliçe sahibi nakit akışlarını modellemek, simüle etmek ve tahmin etmek için makine öğrenimini kullanılmaktadır, ve UFRS17'nin etkisi önceki standartlarla karşılaştırılmaktadır. UFRS17 kapsamında sigortacıların performanslarını ve konumlarını etkileyen sermaye yapılarını değiştirecek olan yükümlülüklerinin daha yüksek olmasını beklemeleri gerektiği sonucuna varılarak, yeni yapılanmanın şirketlerin performans ve konumlarını etkileyeceği belirlenmiştir. Sigorta şirketlerinin yükümlülüklerindeki bu değişiklik mali tabloların şeffaflığını, kalitesini ve güvenilirliğini artıracaktır. Buna bağlı olarak, IASB'nin UFRS17'yi oluşturmadaki temel amacı olan sigorta finansal tablolarında gelecekteki değişkenliği azaltacak ve homojenlik yaratacaktır.

Anahtar Kelimeler: UFRS17, Yerine Getirme Nakit Akışları, Sözleşmeye Dayalı Hizmet Marjı, Poliçe Sahibi Nakit Akışları, XGBoost, Prophet.

To Future Me

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LIST OF ABBREVIATIONS

Adjusted R2	Multiple Coefficient of Determination
AR	Auto Regressive Model
BPV	Best Estimate of Present Value
CC	Cash Change
CF	Cash Flow
CSM	Contractual Service Margin
DA	De-recognition of Assets at Initial Date
DP	De-recognition of Previous Assets
FCF	Fulfilment Cash Flow
GAAP	General Accepted Accounting Principal
GMM	General Measurement Model
GMOM	Generalized Method of Moments
IASB	International Accounting Standards Board
ICF	Insurer's Cash Flows
IFRS	International Financial Reporting Standards
LC	Loss Components
LM	Lagrange Multiplier
MA	Moving Average Model
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
OLS	Ordinary Least square
PCF	Policyholder's Cash Flow
R2	Coefficient of Determination
RA	Risk Adjustment of Non-Financial Risk
RE	Return
RMSE	Root Mean Square Error
SD	Standard deviation
VFA	Variable Fee Approach
WP	With-Profits

CHAPTER 1

INTRODUCTION

Financial reporting is the documentation of the financial position, performance and changes in a company's financial activities throughout the fiscal reporting period to external and internal stakeholders (e.g., investors, management, regulators, and analysts). This process is of huge importance, as it provides useful data for a company's related decision-making activities such as investing, lending, merging, terminating, consulting and tax-paying [4]. However, until the end of 1990 there were no specific standard for measuring and dealing with insurance contracts. This created a huge gap in the reporting procedure for the insurance companies which induced the International Accounting Standards Board (IASB) to launch a specific program for insurance contracts, which combines accounting standards with actuarial estimations to represent each insurance contract at its fair value; increasing the transparency and consistency of the financial reporting procedure.

IFRS17, established by IASB, is the most recent insurance-related standard, which will be in practice in 2023. Thus, it is the result of a twenty years project along with a previously released standard called "IFRS4". Thus, the aim of IFRS as a principle-based, is to establish a solid international framework for firms to conduct and disclose financial-statements. The goal of IFRS17 comes from the main goal of the IFRS, which is to make the global accounting for insurance-contracts standardized, in order to enhance the comparison, transparency and understanding of insurance companies' financial practices, performances and any relevant uncertainties. So, this standard sets up many new conceptions and approaches, generating modified statements that depends on revised assumptions, calculations and aggregations [1]. Therefore, IFRS17

eliminates any current inconsistencies and allow investors, regulators and auditors to compare insurers, sectors and even countries. This standard creates a huge challenge for any insurance company, generating one of the biggest universal insurance market matters, hence it puts heavy weights on actuarial information in the accounting procedures.

IFRS became mandatory for the Türk insurance sector in 2005, which created many challenges in the application part but contributed positively in reflecting the uncertainty and transparency of the financial accounts. The Türk insurance market is vert competitive as there are sixty-seven insurance companies, in which forty-two of them are non-life insurance, twenty of them are life insurance and five of them are reinsurance companies. The increasing strength and security of the insurance market relies on the continuous development and security of the whole Türk economy and the general financial market. As of 2020, the total premiums reached 82,000 million TL with a grow of 19% compared to 2019, and total assets of the insurance sector grew by 30% in 2020. The insurance market ranked to be the second in the Türk financial sector in terms of market share in 2020 [53]. Given the raising uncertainties and risks in the Türk insurance sector, the application of IFRS17 will contribute in firstly understanding, measuring, reporting financial statements and secondly in comparing and competing with global markets.

IFRS17 introduces two main new building blocks for the valuation of insurance contract liabilities: the fulfillment cash flows (FCF) and the contractual service margin (CSM), their summation represents the liability of incurred claims and liability of the remaining coverage [30]. Thus, the introduction of those two blocks is to capture the effect of future changes, uncertainties and risks related to the expected cash flows. In order to create high quality and transparent financial statements due to the inherent risks in the insurance process; these two accounts are computed by "an explicit, unbiased and probability-weighted estimate of the present value of the future policyholder's cash outflows minus the present value of the future inflows that will arise as the entity fulfills insurance contracts" [49]. So, the achievement of any insurance company depends on its capability in estimating the expected policyholder cash flows with the highest accuracy. The main purpose of this estimation is for the insurer to collect the adequate quantity of cash inflows which would finance the policyholder's

expected future costs and also to compensate the insurer for its services in covering the risks associated with the insurance contracts.

Thus, IFRS17's main purpose is to capture and minimize the uncertainty which is created by the insurance company's policyholders. Since policyholders have the option to exercise their available choices such as renewal, surrender, conversion or even the choice of not paying premiums any longer (Lapse) [55]. So, anticipating how policyholders will exercise their available choices increases the transparency in measuring insurance contracts.

1.1 Research Objective

Since this standard is for a global use with huge relevance on subjectivity, its application creates huge challenges to insurance companies. Researchers, accountants and actuaries raced on understanding and studying its requirements. Yet, there are few studies with different results and standpoints regarding the application of IFRS17 on real data, see Section 1.2. So, studying and applying new methods for key components of measurements of insurance contracts and merging those methods with new technologies would create new aspects, introducing a solid bath for homogeneity within insurance campanies' financial statements.

Accordingly, this thesis aims to create a real data framework to capture the effect of IFRS17 on the insurance company's liabilities. The new contribution of this standard is to merge the future with the past; through cash flows. The analysis of past financial history can be a rich source of inspiration and guidance for the future. Correspondingly, understanding the basis of the variations in policyholders cash flows, a panel data analysis of the effect of balance sheet, income statement and cash flow statement through returns, insurer's cash flows, and changes in cash on the policyholder cash flows is conducted. The analysis is applied on an emerging market, the Türk insurance industry, for the years 2011 to 2021. Thus, the analysis depends on financial statements, so these years are chosen to include the biggest dataset for the largest number of insurance companies. So, due to the availability of financial statements, 22 out of 42 non-life insurance companies are selected. Studying and understanding this

panel data analysis will have a significant impact on the measurement of contractual service margin (CSM), fulfilment cash flows (FCF), total liabilities and consequently influencing the insurer's financial position.

Due to the nature of the insurance sector, the main requirements of IFRS17 assumes that it is impossible to build a solid future expectation of policyholder cash flows without fully understanding the historical data. Therefore, after analyzing and grasping the impact of different variables on the historical policyholders cash flows, exploring the uncertainty in the future will take place. Hence, the application of the fulfilment cash flows and contractual service margin goes into action by simulating, forecasting, calculating the present value of policyholder cash flows and finally comparing the effects of IFRS17 to previously used standards. A substantial framework is driven that will contribute to the literature and users of IFRS17 in how to understand, apply and be prepared to the new era of modeling cash flows. Thus, this thesis considers a top-down modeling technique; which considers the aggregate cash flows calculated at time "t=0" and then adjust them to capture diverse scenarios. Thus, this thesis will fill the gap of knowledge concerning modeling cash flows under IFRS17.

Based on the pre-mentioned motivation and aim in this section, the research questions raised in this thesis are:

(i) How does modeling cash flows under IFRS17 affect the liabilities of insurance companies?

(ii) How can balance sheet, income and cash flow statements affect policyholder cash flows?

(iii) What is the main purpose of the two new techniques introduced by IFRS17: fulfilment cash flows and contractual service margin?

(iv) Does the application of IFRS17 on cash flows produces insured liabilities different than previously used standards?

1.2 Literature Review

Since IFRS17 is an important topic, many researchers, accountants and actuaries put a lot of efforts to understand, model and measure the effects of the standard on the financial statements. For example, many researchers try to understand the text-regulations by defining mathematical-actuarial/accounting point of views. Thus, Bjorn and Jansson [54] establish a mathematical valuation-model that investigates the implication of the standard on reporting statements; which concludes that a good investment scheme that values insurance contracts might clash with asset/liability management. Also, they show a negative relationship between risk adjustment and contractual service margin (CSM); that will smooth gains. They also recommend that the policies that relate to contractual service margin ought to use real and risk neutral estimations. Furthermore, Palmborg et.al. [34] study the financial positions and performances using IFRS17, by bringing the accounting and actuarial sciences together by a mathematical explanation of the regulations, also through making an algorithm for gain/loss in a broad scale of numerical methods. They suggest a computational efficiency risk model for insurance-contracts' portfolios and show how to allocate this model for sub-portfolios. They explain the contribution service margin, loss components, gains and losses by algorithms and mathematical equations.

In line with this, some researchers analyze the efficiency of the new standards, such as Anyango [41] analyzes the effect of IFRS17 on the transparency of financial reporting, by gathering the statements of eighteen Kenyan's insurers from 2010 to 2019. This study uses regression analysis (OLS) and takes dependent variable as insurer's earning, independent variables as the contractual service margin (CSM), profit before taxes and the disclosure intensity measure. The results show that the implementation of IFRS17 improves the transparency of financial reporting if CSM is unlocked by using varying interest rates. Furthermore, Dahiyata and Owaisa [43] has the same research question; but the paper relies on questionaries distributed on insurer's financial employees in Jordan, concluding that the quality, comparability and faithfulness of financial information will increase with the introduction of IFRS17.

Longoni [35] examines the effect of IFRS17 on the firm value of insurance company's reporting. The study uses more than 400 insurance companies' stock returns

given sixteen different events that might affect IFRS17 using regression analysis. The results show that the application of IFRS17 on average has negative abnormal returns. It indicates that the abnormal event returns negatively associate with size; showing that IFRS17 is costly for large insurers. Moreover, book-to-market values have an opposite relationship with the abnormal event returns, indicating that a lack of growth opportunities exacerbates the negative returns associated with the introduction of IFRS17.

Since IFRS17 is a principle-based approach, many measurements and estimates rely on different assumptions. So many papers aim to define ways and processes to understand the regulations and make it easier for insurers to apply. For example, Wairimu [40] studies the risk adjustment measure, by determining the most suitable risk-adjustment measures for insurers; through the use of discounted cash flows and cost of capital methods. Four approaches are made to obtain the risk adjustment using data from 2015 till 2019 for the Kenyan insurance sector for claims, premiums and net profits; Discounting, Value at Risk, Tail Value at Risk/Conditional Tail Expectation and Proportional Hazard Transform. This paper shows that proportional hazard transform is the appropriate measure for Kenya; as it has the power to show the risk-appetite in a superior way. Also, Chevallier et. al. [11] study the risk adjustment measure for life insurance contracts using coefficient of variation and relative skewness without using heavy models, relaying on interest rates and biometric risk; which provides a simple general framework for estimating the probability of sufficiency of the technical provisions under IFRS17. Thus, Marques [36] introduces a risk-adjustment model for non-life insurance companies using NP-approximation; that relies on estimating the 2nd and 3rd order moments of the present value of the expected cash flows, also the paper develops multinomial and Dirichlet assumptions for real data of compensation claims gathered from 2007 till 2017 in Australia's insurance sector.

Furthermore, England.et.al [16] bring analytics with simulations to estimate the insurance reserve's risk; enforced by the traditional actuarial aspects of liabilities' risks. Their application of simulation methods on data using ResQ and Igloo (Willis Towers Watson) create a complete predictive-distribution; that estimates IFRS17's risk adjustment by using cost of capital and simulates uncertainty measures. Also, Hallema [23] specifies the use of metrics by stochastic scenarios for the contract service mar-

gin's main methods; variable fee approach (VFA), in order to analyze insurance companies' policyholder shares and variabilities to determine "VFA eligibility assessment methodology" In so, he quantified matrices through three different chosen scenarios of the returns on underlying-assets including different discount factors, reflecting IFRS17 through a probability weighted present-value average of scenarios over the duration of the group of insurance contracts.

Additionally, Morrison [39] uses stochastic scenarios to assess VFA. This paper contributes to the literature by analyzing the eligibility of direct participation contracts using a huge number of stochastic scenarios by discussing the main decision criteria and how contracts can be analyzed. It defines the insurer's cash flows, the policyholder's participation share and the variability in those cash flows by using metrics for variety of features; those metrics are calculated by dealing with one thousand stochastic-scenarios for the returns on underlying-assets created by a real-world calibration of the "Moody's Analytics Economic Scenario Generator". Those researches show the importance of the application of stochastic scenarios for the application of IFRS17.

Based on the existing literature, this thesis's outputs are expected to enhance the significancy of actuaries to dominate some of the competences in measurements proposed by IFRS17 on policyholders cash flows and insurance liabilities. Since, IFRS17 does not specify concrete methods to obtain expected cash flows, the understanding of the effects on financial statements would require a qualitative knowledge of the policyholders cash flows, time value of money, market considerations, and firm specific considerations. The significance of this study captures the effect of both historical and future expected data. As this thesis determines the effect of different financial statements' accounts on the Türk policyholders cash flows, giving guidance in how to increase net cash flows. Moreover, it shows a new perspective in simulating the future cash flows by using machine learning methods. Thus, these aspects will be revealed by analyzing the effect of IFRS17 on the insured liabilities, so that insurers will be more cautioned in understanding and applying the new regulations. Besides, modeling cash flows for Türkiye as an emerging market economy will show the effects of interest rates, inflation and market driven risks in simulations, which will widen the knowledge on IFRS17 to explain the differences in findings from other developed and

emerging economies' results in the future. Also, it will benefit future researchers in studying the use of stochastic scenarios with machine learning for forecasting insurers' cash flows using IFRS17. From these aspects this thesis contributes the literature to demonstrate how cash flow modeling using panel data analysis and machine learning improve the predictions.

Since one of the most important questions that has grabbed a lot of attention for actuaries, accountants and management is that of the role of IFRS17 on insurance cash flows; this thesis will include six chapters. Chapter 1 is about the general framework of IFRS17. Chapter 2 addresses the IFRS17's building blocks; the fulfillment cash flows (FCF) and contractual service margin (CSM). Chapter 3 summarizes the proposed approaches of IFRS17 being used in this thesis. Chapter 4 focuses on the Türk insurance market regarding its insurance related regulations and standards. The data analysis takes place in Chapter 5 with actuarial modeling of IFRS17. Firstly, we analyze policyholders cash flows through panel data models. Secondly, we forecast the policyholders cash flows through machine learning methods. Thirdly, we calculate the present value of the forecasted policyholders cash flows. Lastly, we compare the result of IFRS17 to previously used standards. Chapter 6 finalizes the thesis where we present our conclusions and provide recommendations and suggestions regarding this topic.

CHAPTER 2

IFRS17 FRAMEWORK

Until the end of 1990 there were no standards that were made for actuarial reserves in insurance contracts; General Accepted Accounting Principles and IAS-1 were used instead. In the last years of 1990, the IASB made a program called *Insurance Contracts* to cover this problem. Their main goal was to create practical standards to deal with exact insurance matters, and to make insurance companies consistent in their accounting procedures [38]. This program emphasizes the importance of remeasuring the balance sheet accounts at the fair value method; as there is no active market prices for some of the actuarial balance sheet accounts. However, a huge doubt was seen from the insurance sector.

The introduction of IFRS creates many challenges for the insurance sector. The comparison between sector-oriented specifications(IFRS) with rules-oriented "General accepted accounting principal(GAAP)" shows different reporting of revenues, income and equity. The first official IFRS's regulations related to insurance companies were in 2004 *IFRS4* [19]. As it has been observed, the new IFRS standards were an essential point in estimating assets and liabilities in a market-based view. Hence, the recognition of the insurers' revenues became earlier and the volatility of the measurement of their equity-capital increased [13]. However, IFRS4 was just a temporary solution.

The purpose of IFRS4 is to identify the financial reporting for insurance-contracts. Insurance contracts are interrupted as any contract with a high transferred insurance-risk [46]. Thus, IFRS4 reinforces the comparison and transparency of the insurance sector's financials by putting more obligations on the disclosure process. As it re-

quires insurers to use well modified capital-markets in order to make consolidated financial statements using IFRS [38]. However, at the same time it enables the domestic interpretations to intervene in the insurance contract's measurements which creates an accounting mis-match in the balance sheet where a decrease in the interest rate leads to an increase in the market value of bonds that is accounted for in fair value. But the actuarial reserves depend on the country specific standards which the amounts are not discounted, this produces a mismatch between the accounts [1].

Since IFRS4 was the first standard for the insurance contracts, it was renovated and modified many times. Its final version was published in 2014. Some of its changes were expected to disturb the insurance-contracts' sales; since those contracts have to be accounted for at the present-value of fulfilment cash flows; depending on a discount rate and risk adjustment factor. Also the positive profits at the inception of an insurance contract will not be reported, rather, a residual margin appears. But from the other side, an immediate reporting of the negative profits as an expense must be made. Any related modifications of the estimates have to be reported as gains or losses and they should be remeasured each period [13]. Moreover, those changes considered the claims as repayments to the insureds and the premiums as deposits. Therefore, rather than reporting those in income statement; "the underwriting margin, the differences between the expected and actual cash flows, the interest on insurance liabilities and any changes in estimates" they are all reported in the comprehensive income statement. Lastly, it was required that contracts have to be estimated by the present value of fulfilment cash flows and the related adjustments to be recorded in the retained earnings. Those changes are expected to make the income more volatile [14] [46].

In 2014, the final-draft was issued by IASB in order to create a real global standard for insurers; which had three main components. (i) the expected present value of the future liabilities consisting of the effect of time value of money, (ii) a risk-margin that reflects the uncertainties in the future cash flows, and (iii) a contractual service margin [13]. This draft did not specify any approach that will be used to calculate the undiscounted probability weighted future cash flows, it left the decision for each individual company with no fixed requirements. As, it excluded previously used risk adjustments methods "confidence interval, conditional tail expectation and cost of

capital". Rather, the final draft only spotlights the broad aspects that the risk adjustment needs to have [29]. This flexibility made each insurance company use a risk evaluation process that revealed the true risk associated to it.

At the end of 2015, a renewed insurance contract standard amending IFRS4 and financial instrument contract IFRS9 were released. Both IFRS4 and IFRS9 construct the financial statements of any insurance company. The settings of those contracts were one of the most challenging things for the IASB and they created a huge volatility in the financial reporting aspect [25]. For this cause, the renewed insurance contract proposed two strategies [28]:

(i) Overlay strategy offers all insurers the option to report the volatility which might emerge from applying IFRS9 before the issuance of the new standards in other comprehensive income statement, instead of income statement.

(ii) Deferral strategy offers insurers a temporary exception from using IFRS9 till 2021.The companies that uses thus method will persist employ the current standards IAS39.

IASB didn't settle for those standards, therefore in the first half of 2017; a new standard IFRS17 was issued to replace IFRS4. Since IFRS4 approved the usage of diverse accounting principles to account for the same insurance contracts. As stated by IFRS foundation: "In many cases, features of the accounting models used by the insurance industry are inconsistent with the IFRS Standards applied by other industries in the same country-limiting comparisons with other industry sectors" [29]. Moreover, the measurement of insurance contracts by IFRS4 reflects the insurer's expectation without modifying this expectation in the future; which would create a mis-match in the sides of the balance sheet. So, IFRS17 aims to provide a persistent standard for every prospect in accounting of insurance contracts. Hence, it eliminates all of the current reporting deviations and empower external and internal accounting users to truly examine the differences between firms, insurance contracts and even sectors. As IFRS17 is going to increase the transparency and consistency [19].

IFRS17 will be mandatory as of 2023 and any company can start using it before this date as long as they also use IFRS9 and IFRS15. IFRS17 captures the complica-

tions related to insurance contracts and require constant procedures, capturing all the economic factors effecting the companies. Therefore, it calls for using adjusted estimations and assumptions which take into account time value of cash flows and any risk associated with them [34]. Thus, this will create an increase in transparency of the financial statements and a decrease in the uncertainties. Besides, it requires the firms to report revenues when they deliver insurance services instead of when premiums are received and also to specify the expected revenues in the following years. This will create a metric which will help in evaluating the efficiency and effectiveness of the insurance companies and give a clear view of the future and create solid budgets and plans [57].

For insurers to measure their profits; they have to assure that they have an adequate loss reserve in order to face any expected future claims and expenses. IFRS17 requires that those reserves should result from three accounts [34]:

(i) 'Contractual service margin' illustrates the unreleased gains from the insurance contracts, which would be released in the future during the policy duration.

(ii) 'Discounted expected cash flows' illustrate the expected future "probability-weighted" cash flows; in-flows (premiums) and out-flows (claims) with taking the effect of discounting factors through time.

(iii) 'Risk adjustment' illustrates the uncertainty in the change in the expected claims; which is used as a protection reserve against any increase in claims.

Thus, the main principles of IFRS17 that a company has to measure its insurance contracts are:

(i) 'Fulfilment cash flows' represent a risk adjusted present values of expected cash flows. It takes into account all of the available data about the future cash flows in a rational perspective with the given market observations.

(ii) 'The contractual service margin' represent unearned profits of the insurance contracts.

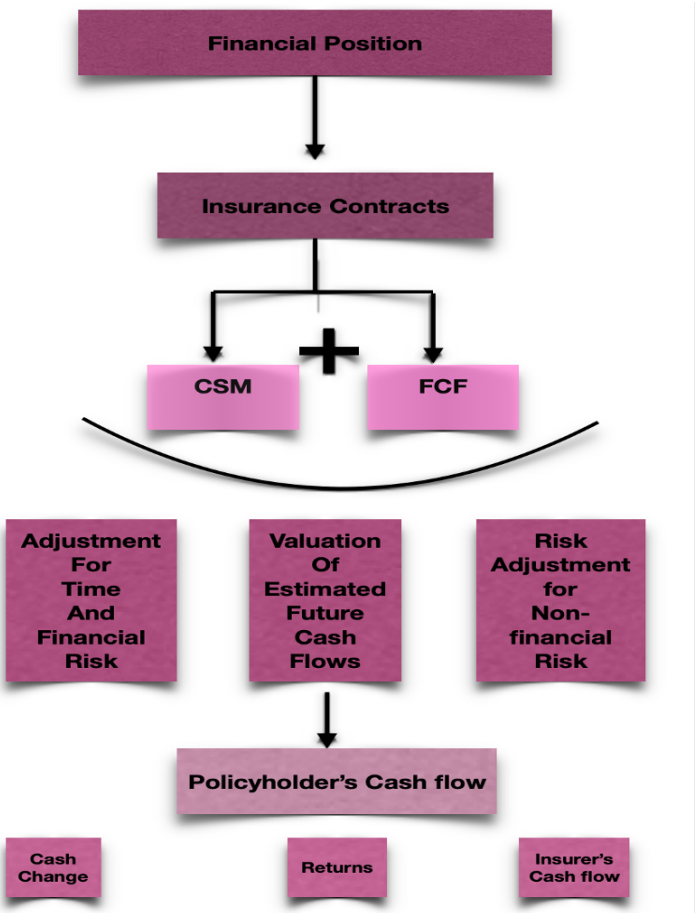

Figure 2.1: The Structure of IFRS17

The structure of IFRS17 explained above shortly is summarized in Figure 2.1 whose details are given in the following sections.

2.1 Fulfilment Cash Flows

It is required by IFRS17 to recognize insurance contracts by modified estimations and assumptions which indicate the time value of money and all the associated risks. This would contribute in a sincere view on the insurer's performance and position. Moreover, an insurer has to report revenues when it delivers services instead of receiving premiums and to also report the expected future revenues. This puts heavy weights on assessing current cash flows and expected future cash flows, taking into consideration firm specific risks, time, economic factors and market changes [35]. On account of the huge responsibility that insurers undertake concerning situations that did not happen yet, diverse requirements on calculating those cashflows create influences on

Neutral	Entity Prespective	Current	Explicit
Probability weighted mean of all possible outcomes	Yet, Consisitent with observable market prices	Estimated at the measurement date	Cash flows estimated separately from discount rates

Figure 2.2: Characteristics of Future Cash flows

the insurance companies' financial reports.

Accordingly, IFRS17 obligates insurance companies to measure their insurance liability by *Three Building Blocks* method. This method assesses the present value of expected cash flows by revealing the uncertainties related to these cash flows. Tann [44] argues that the variables that should be used for the measurement ought to be constant with the current market-prices, which assures that the measurement process generates updated outcomes. The first building block consists of the entire expected policyholders cash flows (inflows and outflows), which those flows have to be within the contracts' boundary. Meaning that the amounts that have to be involved are the ones that any party has a contractual-agreement to pay [2]. If a contract is renewable; at the exact time when there is a possibility for the contract to end it will be its boundary, so any cash flow after that won't be accounted for even if the insurance company anticipates the renewal of that contract.

IASB specifies that the estimates of expected cash flows have to consider the probability weighted average of every probable result (Figure 2.2 , Neutral), have to be explicitly calculated and have to express the initial measured assumptions [29]. Nichol [42] discusses that this implies that those cash flows have to be calculated with the best estimation assumption for the insurers' expected experience. By this way, the estimated cash flows are updated and reflect the correct and fair value of the reporting procedure, thus increase transparency. The features of the future cash flows are summarized in Figure 2.2 , since they should be neutral, reflect insurer's perspectives, current and explicit [28]. The calculations have to display market and non-market changes: An insurer can adopt historical information to evaluate claims or apply expected inflation rates to evaluate benefits and costs [33]. The main goal for estimating future cash flows is to wisely decide on the variables that would demonstrate the fair view of the company, by this way a company can report its position with the highest transparency.

The insurance company has to determine all the probable scenarios that might happen to each portfolio of insurance contracts. The complexity related to any technique used for the estimation of the scenarios depends on the complications that are related to the specific portfolio of insurance contracts and the factors that drive its policyholder's cash flows [55] (Figure 2.2 , Entity Perspective). Sometimes simple approaches might be used to demonstrate a fairly precise result, other times detailed simulations with advanced stochastic-models have to be applied to capture the complexity inherited in those cash flows. Thus, the anticipated cash flows can be calculated by the best estimate-assumptions, but this only works if they have a symmetric distribution. Yet, for different distributions of real data, stochastic simulations are the suitable methods to conclude the anticipated future cash flows [55]. However, IFRS17 does not specify the application of a unique approach, insurance companies should use their judgements to decide the best approach that maximizes the adoption of the related market-inputs.

Yet, identifying a metric that quantifies the relationship between the historical financial statements and the policyholder's cash flows, creates a basis for expecting the changes and scenarios that might affect the cash flows in the future [54]. Hence, Morrison [39] argues that the evolution of the policyholders cash flows is attributed to the company's returns, its cash expenses and the yearly change in the company's cash; stating that at the end of the contract's duration those three accounts will be the reason for the variation in the policyholders cash flows. Thus, to adapt for any future changes a qualitative knowledge of the policyholders cashflows, time value of money, market considerations, and firm specific considerations are required (Figure 2.2 , Current) . So, IFRS17 requires to define the impact of different financial accounts on policyholders cash flows to create a hedging technique towards the company's future insurance liabilities.

After that, those expected cash flows will express the time value of money by calculating their present values through discounting (Figure 2.2 , Explicit) [34]. Hence, the second building block comes to action here. Discount rates are estimated in a way that exhibits both time and financial-risks. It is argued that the selected rate has to be persistent with the expected insurance liabilities' features. Accordingly, this rate has to reflect the fair market prices and ignore any element that will not disturb the future

cashflows [12]. Those provisions ensures that discounting depends on relevant and updated data. The discounting factor should

(i) demonstrate the features and liquidity of insurance cash flows,

(ii) have consistency with coherent financial instruments' current market-prices, and

(iii) not include the impact of the factors that affect coherent instruments' current market prices.

Since the estimated cash flows should not be biased, they should not include any further estimations higher than the probability-weighted mean for uncertainties, cautions and management loading [11]. This third block "risk adjustment for non-financial risk" has to express and indicate this coverage of holding the uncertainty in amounts, timings, and magnitudes of cashflows. Regular risks that could be faced are mortalities and withdrawals, those risks have to be displayed in the discounted cash flows. Thus, risk adjustment is like the cost defined by the insurance companies for tolerating the non-financial risks in the insurance contracts [27]. Therefore, the risk adjustment provides insurance companies' point of views on the impact of the uncertainties related to time and amounts of cash flows. This would strength the financial statements' users in their decision-making process since users would have more information on the company's performance in regard to non-financial risks. The three building blocks altogether make up the fulfilment cash flow.

2.2 Contractual Service Margin

IFRS17 is a new standard that is made to organize all the aspects related to insurance contracts; beginning with recognition, measurement, and presentation and ending with disclosure. Through the financial reporting process; the standard is intended to raise the usefulness, comparability, transparency and quality [43]. In the concern of the main goal of insurers, profit is calculated as the excess of premiums over claims and other expenses. But, due to the huge responsibility of insurers to their policyholders depending on unknown future circumstances, diverse requirements and

procedures are made on the calculations and estimations of the cash flows related to this process. This creates huge efforts to deal with the sensitiveness of reporting the profit and risk in order to reflect the cash flows with the highest transparency. In so, one of the main principles that IFRS17 obligates insurers to recognize contracts by either a risk adjusted present value of cash flows the fulfilment cash flows, which takes into consideration all of the feasible market data that affects cash flows, or an account that shows the unearned revenues, contractual service margin [57].

Thus, contractual service margin (CSM) solves a lot of problems. This margin is either an asset or a liability for the portfolio of insurance contracts, and it considers the unearned gains as same as services provided [29]. Yet, IFRS17 is a principle-based standard in which it relies heavily on the company's judgments to calculate the assumptions, risk, time, inputs and approaches. Firstly, IFRS17 makes two main principles for the recognition of profit and loss for insurance companies. These are as follows:

i In dealing with profitable contracts;

The profits are distributed for the contract's period, since companies are prevented to recognize any initial profits. In so, CSM will be established; as it will show the assumed unearned profits of the contract for each period. This account ensures a null-effect on the revenues among the cash inflows (reported in the assets side), contrast to the cash outflows and risk adjustment (reported in the liabilities side). Thus, IFRS17 made the process of revenue-recognition more complex as it asks for reporting this margin upon the delivery of the insurance service by introducing coverage-units' approach [57] .

ii In dealing with unprofitable contracts;

Unprofitable contracts are recognized when the net fulfilment cash flow becomes negative, recognizing an instant loss of their net value.The losses are taken into consideration instantly with highly dynamic mechanisms, implying that net-outflows are predicted in a future-oriented analysis. IFRS17 obligates to define each unprofitable contract individually and directly report its expected loss in the income statement,

taking into account that the CSM cannot take minus amounts distributed on the future periods. The application of IFRS17 will result with more precise reported accounts since the effect of the unprofitable contracts will not affect the insurance companies' outcomes for the year [54].

Thus, the insurance industry faces various unexpected events and risks. The CSM should always reflect the updated situations. Those events are classified as future-services' modifications, such as preferable mortality changes increase this margin but unpreferable lapse experiences decrease this amount. Furthermore, if an insurance company faces an unexpected loss for a previously stated profitable contract, firstly it has to eliminate the contractual service margin that has been spread for the period and after that creates a loss account for the remaining balance instantly [11].

IFRS17 also states how to calculate the profit that must be reported for each period, the company must classify the number of coverage-units [19]. Thus, this number is used to assess the services contributed by the insurance company. It is calculated by analyzing the quantity of benefits and for how long *on average* the contracts are expected to stay, taking into account the predicted lapse and mortality percentages. This number of proposed units for each year is defined as coverage-units, and so, an *amortization ratio* is calculated by dividing coverage-units for this year on the total predicted coverage-units. This ratio is then multiplied by the service margin; this number is identified as profit. For each period those coverage-units must be reevaluated for any changes in any event [57]. Hence, companies should allocate the CSM in an equal basis to every converge-unit in the present period and also anticipate the change to the upcoming periods; showing the adjustments for profit or loss. For the last year; this amortization rate will be 100 percent, which closes the service margin and the unearned profits with no further services to be implemented.

Contractual service margin at the initial recognition is calculated by;

$$CSM_{Initial} = +BPV - RA - DA \pm DP \tag{2.1}$$

Here, BPV stands for the best estimate of the present value of cash flows: inflows minus outflows in the future and at inception, RA defines for risk adjustment of non-financial risk, DA refers to the de-recognition at the date of inception of any asset for insurance acquisition cashflows, and DP defines for the de-recognition at the date of

inception of any asset or liability previously recognized for cash flows related to the group of contracts, other than insurance acquisition cash flows.

The BPV is calculated by a company based discount rate that expresses the nature, essence and liquidity of the cash flows. The RA is also a company-based measure which should express the uncertainties related to the amount and timing of the cash-flows that is due to the non-financial risks. Moreover, the DA looks for the acquisition expenses that are set for future purposes. Lastly, the DP is for any previously recorded cashflows. The contractual service margin at day one is only a number to balance the initial profit to zero [28].

Very importantly, the CSM has to be computed for different groups of contracts. Initially, insurers should group together the contracts with the same risks then divide those contracts based on their performances, three groups at least; a group of unprofitable contracts, a group of contracts with no possibility to become unprofitable, and a group of all of the rest contracts. After this, sub-groups should be made in which each sub-group should contain contracts with close time intervals (no more than 12 months) [43]. Additional sub-sections are allowed, so a group can contain one contract if this process is applied. The chosen group for any contract is decided at the inception and can't be modified afterwards.

However, the measurement of the contractual service margin in future reporting periods is much different. The measurement varies depending on the type of the contract. This demonstrates a crucial IFRS17 discrimination between insurance contracts without direct participation characteristics and insurance contracts with direct participation characteristics. This discrimination creates many diverse procedures that IFRS17 calls for. Such as for the non-direct contracts; it is not allowed to adjust the contractual service margin for the variations in discount rates and other financial risks. The two discriminated approaches are the general measurement model (GMM) and the variable fee approach (VFA) [57]. The creation of those two approaches signifies that the measurement of the CSM at subsequent periods can extremely vary. Those two approaches could have a significant effect on the amounts and timing of the realization of profits. In which the calculation of CSM under both methods is presented in Figure 2.3 and Figure 2.4 (Yousuf. et.al, 2021):

Contractual service margin at subsequent periods (GMM)	Contractual service margin at start of the reporting period.	
	Add	Contractual service margin at respect of new business.
	Add	Interest accretion based on locked-in discount rates.
	Add or Subtract	Changes relating to future services arising from e.g: • non economic assumption updates , • impact of experience variances n fulfilment cash flows , • modelling changes , • premium variances include preiumum relate cash flows such as premium based taxes , • acquision expense variances , • non distinct investment component variances.
	Add or Subtract	Effect of currency exchange differences.
	Subtract	Release of Contractual service margin in profit or loss (amortization).
	Contractual service margin at the end of the reporting period.	

Figure 2.3: Measurement of CSM under General Measurement Model (GMM)

Contractual service margin at subsequent periods (VFA)	Contractual service margin at start of the reporting period.	
	Add	Contractual service margin in respect of new business.
	Add or Subtract	Changes in the entity's share of the fair value of the underlying items as well as changes relating to future services arising from e.g: • economic and non economic assumption updates, • impact of experience variances n fulfilment cash flows , • modelling changes , • premium variances include preiumum relate cash flows such as premium based taxes , • acquision expense variances , • non distinct investment component variances.
	Add or Subtract	Effect of currency exchange differences.
	Subtract	Release of Contractual service margin in profit or loss (amortization).
	Contractual service margin at the end of the reporting period.	

Figure 2.4: Measurement of CSM under Variable Fee Approach (VFA)

In observing the differences between the adjustments in CSM (Figure 2.3 and Figure 2.4): firstly, GMM uses the interest accretion at locked-in discount rates; in which this rate is predetermined at the initial measurement date, and can be calculated by weighting the average rates of an insurance contracts' portfolio historically, but VFA uses current rates. Secondly, VFA takes economic and market assumptions in the modifications of further services. Yet, GMM reports the changes in CSM directly in income or other comprehensive income statements [35].

Yousuf. et.al [57] summarizes that for both methods, CSM should be adjusted for any further services such as

(i) Modifications of a premium received in a time earlier than its future services.

(ii) Modifications in the present value of cash flows for liabilities of outstanding coverage, despite the modifications that are related for income and other comprehensive income statements.

(iii) Modifications that are related to the variation in the anticipated investment from the actual amount for the period.

(iv) Modifications to the risk adjustment for non-financial risk related to any further services.

However, CSM should not be adjusted

(i) If the raise in the fulfilment cash flows outcomes the value of CSM; this creates a loss.

(ii) Nor if the decline in the fulfilment cash flows is due to the loss in the liabilities of the outstanding coverage.

Based on the main frame of IFRS17, Chapter 3 proposes an approach to model cash flows and illustrates the impact of modeling using performance indicators.

CHAPTER 3

PROPOSED CASH FLOW MODELING

Driven by IFRS17, policyholders cash flows are the solid ground for insurance companies. That is, inflows consisting of premiums minus outflows consisting of claims. The measurement of the financial statement depends not only on the premiums and claims but also on the timing of those payments, the associated risks, their future estimated amounts and also any related economic and statistical consideration [34]. Consequently, the merge of actuaries with accountants happens in this specific point, where actuaries estimate, simulate and calculate risk, time and uncertainties related to cash flows and accountants use that information in order to fairly report the financial statements under accrual basis. Accordingly, the algorithm followed in proposed approach is given in Figure 3.1. In the first step historical cash flows are modeled by using panel data for each company which also takes into account the time influence. Based on the proposed model, simulation and forecasting of cash flows are performed in step 2 by using machine learning methods, whose results are discounted and yield weighted average present value in step 3. Then, we compare the results with earlier standards.

3.1 The Historical PCF

Initially, in order to fully understand IFRS17; the first step takes place in preparing this solid ground of the policyholder cash flow (PCF). Thus, modeling historical policyholder cash flows has a vital impact on the future cash flows, IFRS17 suggests analyzing the effect of different financial statements' variables on PCF to thoroughly

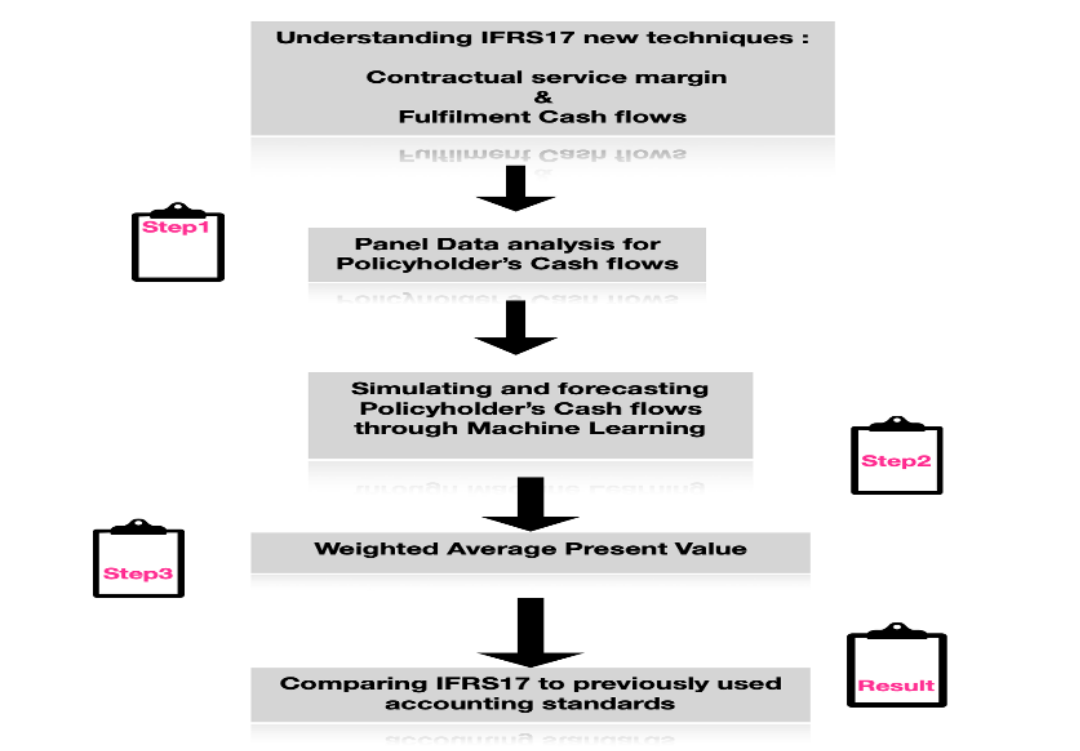

Figure 3.1: The Flowchart of the Proposed Approach

prepare the insurance companies to any change that would cause huge variability in cash flows. This variability will disturb the balance sheet statement for this period and the income statement for the future periods.

Thus, the successfulness of insurance companies depends on the power of estimating the PCF, the key goal of these estimations is that the insurance company can expect the amount of inflows that would be both used to pay for the expected cash outflows and compensate the company for its services in insuring the policyholders. Accordingly, to create a hedging scheme for the variation in the future cash flows the relationship between three variables insurer's cash flows (ICF), returns (RE), cash changes (CC) on PCF will be analyzed. This step reveals what to expect when those financial accounts changes, related to policyholder cash flows.

In so, driven by IFRS17 this thesis applies the proposed approach on the cash flows for the Türk insurance sector of eleven years from 2011 till 2021, subject to the availability of financial statements. These years are chosen to include the biggest dataset for the largest number of insurance companies. Thus, we have 22 (out of 42) non-life insurance firms which were operating and had their financial statements reported

since 2011 in our dataset. Note that the earliest year that financial statements were publicly reported in the Türk insurance market is 2007, however only five companies had their statements available at that year. On the other hand, after 2011 the highest number of dataset has been observed.

Firstly, this paper examines the relationship between PCF, ICF consisting of cash outflows the insurer pays for its operating expenses except the ones paid for policyholders, RE, and CC (yearly). Using the data extracted from secondary resources; the annual financial reports of each company: balance sheets, income statements and cash flow statements. This thesis uses panel data analysis that has both time series and cross-sectional dimension. Since the collected data has the same years for all cross-sectional companies; balanced panel data is used. The analysis are done using R-software.

In order to estimate the unobserved effects in this model; the time-invariant individual components removed by first-differencing the data "to get rid of the individual effects": lagging the model and subtracting, the time-invariant components (the individual error component) is eliminated [26]. The panel

$$\Delta Y_{it} = \alpha_{it} + \beta_{it}^{T} \Delta X_{it} ... + \Delta \epsilon_{it}, i = 1, .., N : t = 1, ..T \tag{3.1}$$

where i denotes the individual insurance company index, t is the time index, $\Delta Y_{it} = Y_{it} - Y_{i,t-1}$, and $\Delta \epsilon_{it}$ is a random-disturbance term of mean, will tend to be serially uncorrelated.

PCF denotes the dependent variable which is the *policyholder cash flow*. It is calculated as cash inflows from insurance operations minus cash outflows due to insurance operations, those values are taken from the *'Cash Flow Statement'*. RE (returns), ICF (insurer's cash flows) and CC (the change in cash) denote the independent variables. RE is calculated as the insurance company's net income taken from the *'Income Statement'*, ICF consists of (a) interest payments (-) (b) income tax payments (-) (c) other cash outflows generated from the operating activities (-) all values are taken from the *'Cash Flow Statement'*, and CC is calculated yearly taken from the *'Balance Sheet Statement'* [39].

$$\Delta PCF_{it} = \beta_{0it} + \beta_{1it}\Delta RE_{it} + \beta_{2it}\Delta ICF_{it} + \beta_{3it}\Delta CC_{it} + \Delta\epsilon_{it} \tag{3.2}$$

Since we have balanced panel data, this model can be regressed using various ways depending on the nature and assumptions of the intercept, coefficients and error term. In panel data analysis, pooled, fixed and random effect models are the basic models. The pooled model uses the ordinary least squares (OLS) approach. This approach deals with the data as there is no diversity among the companies. But this situation is very restrictive in determining different special effects from time and company, since it neglects the panel structure and deals with each data point as serially uncorrelated with its company, along with homoscedastic errors through companies and years [6].

The fixed effect model is used when the main focus is to determine the effect of the variables that change over the years. "In a fixed effects model, the unobserved variables are allowed to have any associations whatsoever with the observed variables" [3]. In so, fixed effect model controls for the impact of the time-invariant nature and controls for omitted variable bias which change among companies yet are fixed throughout the years. It assumes that each company is diverse from other companies, the company's error term and the constant will be uncorrelated with other companies' errors and constant terms. Besides, "In a random effects model, the unobserved variables are assumed to be uncorrelated with (or, more strongly, statistically independent of) all the observed variables" [3]. In so, company's error term will be uncorrelated with the predictors, this enables the time-invariant variable to have a part as an explanatory variable. Moreover, random approach permits the generalization of inferences outside the sample used [8].

3.2 Simulation of PCF

The consequences of PCF expand to their future values, as the estimated values form the fulfilment cash flows and the contractual service margin which both together form the insured liabilities. This step calls for simulating and forecasting future values, and increases the need for actuaries to assess, evaluate and govern the skills of simulation, measuring probabilities and risks of future cash flows. Since cash flows are

the main building block of the balance sheet under IFRS17, having a solid forecasting technique is of a huge importance impacting the insurance liabilities. Hence, for forecasting and simulating cash flows many new approaches are used to get a high level of accuracy, which would reflect the historical path and trends that a cash flow has through time. After simulating cash flows, adjustments for any economic, market and company specific risk could be applied. Here, the forecasts will separate the PCF into inflows and outflows driven by the requirements of IFRS17 in order to get the highest accuracy and transparency for the financial reporting.

We use nested forecasting method to simulate the proposed panel data. The main aim of using is that we have panel dataset for 22 companies in 11 years' time frame which do not offer a large sample size. Thus, this method converts the panel data into a nested data, then fits many models to each created dataset. These results of an iterative forecasting process, that generates nested model time tables with all of the forecast attributes, needed to make decisions. This method uses logged attributes, which is vital for complicated workflows when loops are performed, making a lot of operations into the fitting-refitting stages, logging significant aspects such as test accuracy, test forecast, error reports, best models, and future forecasts [37]. A machine learning feature selection method XGboost, and a linear model, Prophet, will be used to simulate the policyholders cash inflows and outflows in which both methods can determine relationships for all time series panels with a single model having the highest accuracy.

XGBoost, is a scalable, distributed gradient-boosted decision tree (GBDT) machine learning library. This model supplies parallel-tree boosting and is the leading machine learning library for regression, classification, and ranking problems [20]. Using XGBoost for time-series analysis can be considered as an advanced approach of time series analysis. This approach also helps to improve the results and speed of modeling. Hence, Prophet is a special case of the generalized additive model, it detects the changes in trends "change points"; it works as a curve-fitting. This model forecasts time series data based on an additive model where non-linear trends are fit with yearly, weekly, and daily seasonality, plus holiday effects. Thus, it fits various linear and non-linear functions of time as components for forecasting [51]. Prophet is designed for increasing efficiency, geometric flexibility, equation extensibility, and

prediction accuracy.

Choosing XGBoost was due to the fact that XGBoost is achieving the best performance on a range of difficult machine learning tasks, since it dominates structured or tabular datasets on classification and regression predictive modeling problems [20]. The XGBoost library implements the gradient boosting decision tree algorithm. This algorithm is an ensemble technique where new models are added to correct the errors made by existing models. Thus, the new created models predict the residuals or errors of prior models, and then they are added together to make the final prediction [10]. Moreover, Prophet was used for the reason that Prophet is robust to missing data, shifts in the trend, and handles outliers very well. It is a very powerful model that has as an algorithm for the in-house prediction of time series values for different business applications. Therefore, it is specifically designed for the prediction of business time series. As it captures the general trend of the series [32]. Prophet's advantage is that it requires less hyper parameter tuning as it is specifically designed to detect patterns in business time series [51].

3.3 Determining the impacts of modeling PCF under IFRS17

Step one and two explained in detail in Section 3.1 and Section 3.2 are done in order to get to the computation of the IFRS17 insured liabilities. Next the weighted average present value of the policyholders cash flows is computed using all of the expected scenarios and their assigned weights driven by IFRS17 simulation examples. Accordingly, our main result will be disclosed by determining the effect of the implementation of IFRS17 on the insured liabilities (fulfilment cash flows and contractual service margin). This step will answer this question: How will this new standard affect the insurance liabilities compared to IFRS4 and other previously used standards? This will be done by calculating the present values for the different methods with the assumption of holding the discount rate fixed and constant throughout the period. We will focus on the cash flows without taking into consideration the effects of adjustment to financial or non-financial risks. Therefore, a top-down modeling method, which considers the aggregate cash flows calculated at time t=0 is proposed.

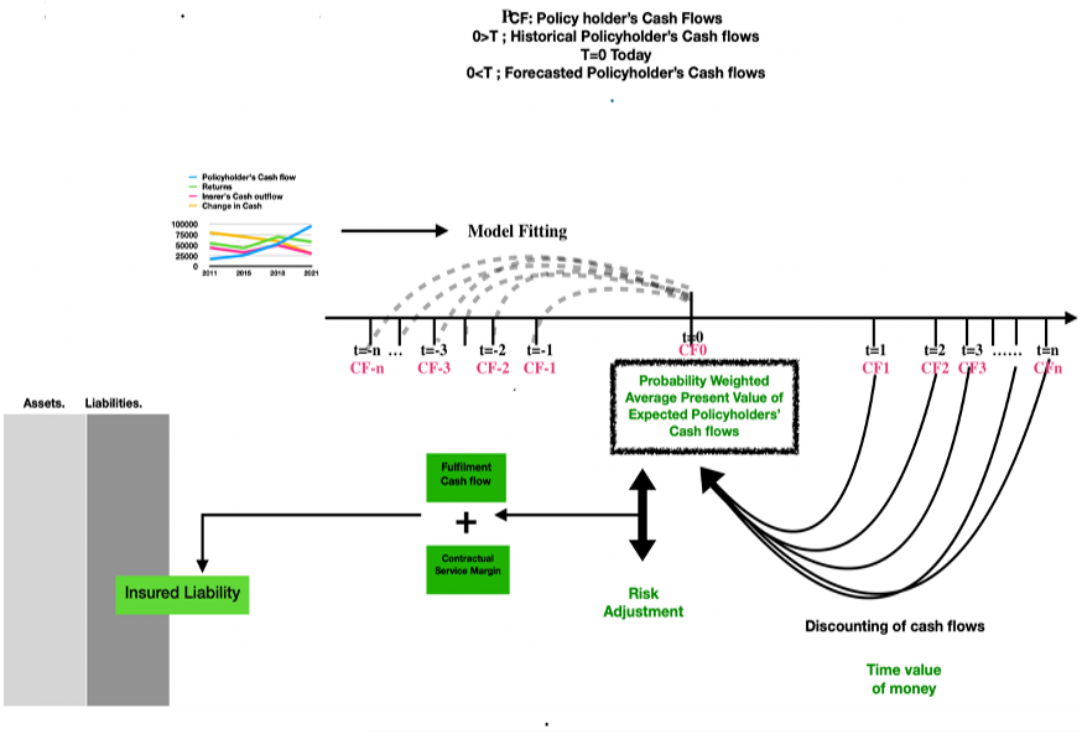

Figure 3.2: Modeling Cash Flows Under IFRS17

Figure 3.2 visualizes the modeling of cash flows through IFRS17, as it connects the past and future with today. To capture the whole picture, the historical PCF through model fitting needs to be analyzed to mitigate future risks (Section 5.3) . Future cash flows have to be simulated and forecasted to accurately compute the present value of expected cashflows (Section 5.5). Then this estimate has to be adjusted for risk and time in order to calculate the FCF and CSM (Section 5.6).

CHAPTER 4

TÜRK INSURANCE MARKET

The insurance sector in Türkiye is highly competitive as there are sixty-seven Insurance companies; forty-two of them are non-life insurance, twenty of them are life insurance and five of them are reinsurance companies as stated by insurance Association of Türkiye. The concept of insurance came into the Türk market in the nineteenth century, when a huge damaging fire happened, the first company was developed in 1892. This sector has a small penetration quota which gave it a huge power to grow and this increased the attention of foreign investors [47].

Nowadays, the insurance market was ranked as the 2nd in the Türk financial sector in terms of market share with a percentage of 4.5. The increasing strength and security of the Insurance market depends on the continuous development and security of the whole Türk economy and the general financial market. As of 2020, the total premiums reached 82 billion TL with a grow of 19% compared to the 2019. As we can see in Figure 4.1, gross premiums are increasing throughout the years 2014-2018 by approximately 20% for the three types (life , health and property & casualty)[52]. Moreover, in 2020 net assets of investments totaled 170 billion TL with a grow of 3.4%, and total assets of the insurance sector were realized as 307 billion TL with a 30% grow than the previous year [53] Figure 4.2 illustrates the market indicators as stated by the Insurance Association of Türkiye [52].

In the last decade, the Türk insurance market got into a lot of ups and downs, even though it got huge attention throughout the years. It faces many difficulties and financial crises due to; increasing inflation, elusive economic-growth with the changes in the gross domestic product (GDP), deficiencies in the financial and monetary struc-

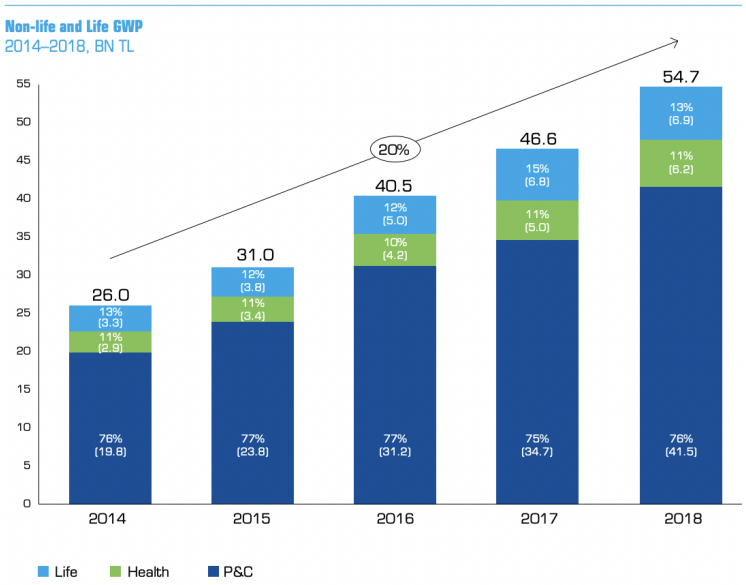

Figure 4.1: Gross Written Premiums in Türkiye (2014-2018)

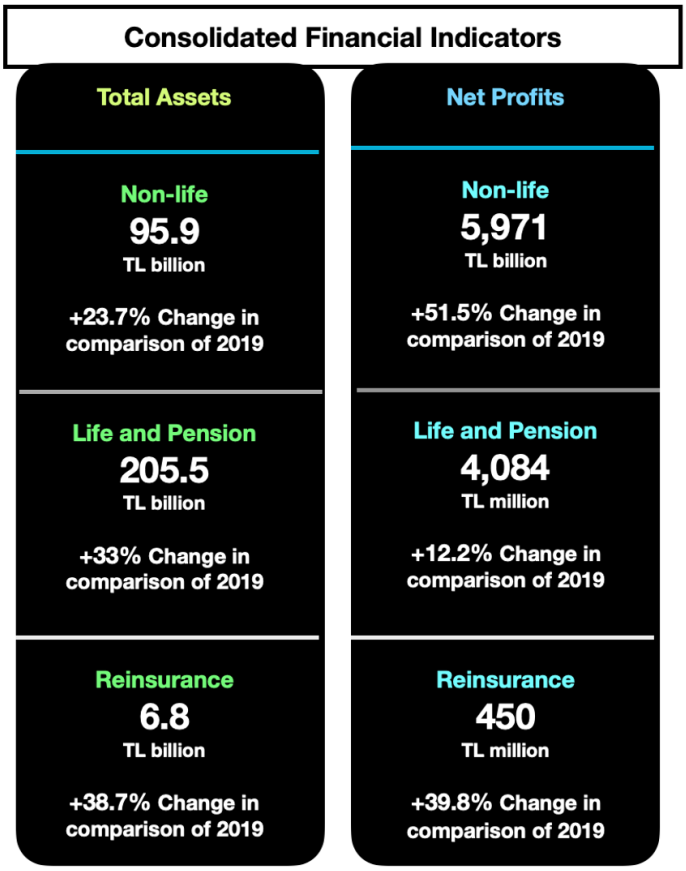

Figure 4.2: Türk Market Indicators for 2020

ture, the instability in the debt systems, the increase in the unemployment rates and the problems related to the distributions of income [18].

Despite all the difficulties, in the beginning of 2005 many alliances, mergers and combinations happened that developed and huge investments were made [18]. Moreover in 2007, the main legislation Law No. 5684 ruling the insurance market came into action along with its secondary-legislation that made huge adjustments; those laws control "the establishment, management, operations, supervision, and audit of insurance/reinsurance companies, agencies, and brokers operating in Türkiye" [47]. Through the application of those laws, many in depth revisions are made specifically in the years 2008 and in 2011; such as the Türk commercial code in 2011, the Catastrophe Insurance Law in 2012, and the private pension savings and investment Law in 2014. These laws give a sold framework for the insurance sector [47].

Hence, in the beginning of 2013 a new act in regard to twenty-five percent government contribution as an encouragement to save in the private-pensions were made. This contribution increased the investments in the pensions sector which create a big opportunity for the insurance companies. In the same year the number of candidates in these pensions raised up by thirty-three percent and became about 4 million candidates [52]. Moreover, an updated insurance agencies-regulations renew the previously existing laws. The main goal of this law is to make the work of the insurance companies clearer and to make conservative covenants for whoever deals with the insurance companies; by "institutionalizing agency systems based on essential principles" [47]. Also, laws were made to administer the implementation of regulations; which consist of minimizing the paid in capital amount to 50,000 TL, making at least half of it of cash and cash equivalence investments. The companies who operate in the leasing, factoring and financial companies are not allowed to register as insurance companies anymore, so they should be treated as a separate company [7].

After that, many different laws were launched and some of the previous laws were updated. So, as a consequence of those advancements, the sector had real growth each year besides the years with the economic crisis have happened. Such as; the recession that happens in 2013-2014; it has bad consequences on the international insurance market. As a result, the total global premium volume increased at a rate of

only 1.4 percent to 4,641 billion dollars in 2013 [53].

In 2020 due to the covid-19 pandemic, the Türk insurance sector faced an average growth of 21% mainly driven by life and health insurance. In addition, the market also had continued growth in liability risks along with increases in Property, Credit, and Surety Bond insurances. Thus, it is observed that covid-19 pandemic accelerated to decrease the demand for insurance services. However, the entire premiums increased by 19.3% between 2019-2020; life insurance premiums increased by 27% and non-life premiums by 18%. However, in analyzing the premiums by the dollar exchange rates; the premiums declined by approximately 3.5 percent; life insurance grew by 3 percent and non-life declined by 5 percent [53]. Accordingly, covid-19 affected the policyholders cash flows and the financial statements. The Insurance and Private Pension Regulatory and Supervisory Authority “IRSA” is the main regulatory body legacy for the insurance and reinsurance market along with Union of Chambers and Commodity Exchanges of Türkiye, Financial Crimes Investigation Board, Ministry of Treasury and Finance, and Ministry of Trade. Thus, the main regulations summarized [15] are:

(i) “Commercial code No. 6102 (for insurance contracts)".

(ii) "Insurance Law No. 5684 (for corporate, regulatory and operational matters)".

(iii) "Obligations code No. 6098 (for general contract law provisions)".

(iv) "Private pension activities are regulated by the Private Pension Savings and Investment System Law No. 4632 and its secondary legislation”.

The insurance contracts are also regulated by IRSA besides many provisions. But there are no particular provisions for the reinsurance contracts.

CHAPTER 5

ACTUARIAL MODELING OF IFRS17

5.1 Data and Descriptive Statistics

Descriptive statistics are used to define the basic features of the data in a study. Policyholders cash flow is the dependent variable, returns, insurer's cash flows and cash changes are the independent variables (Equation (5.1)). Data was extracted from the annual financial statements of non-life Türk insurance companies. The descriptive features of the dependent and independent variables after adjusting for Türk market inflation rates, through dividing the data by the Türk inflation rates and multiplying the result by 100 [53]. Descriptive statistics for the model are demonstrated in Table 5.1.

$$\Delta PCF_{it} = \beta_{0it} + \beta_{1it}\Delta RE_{it} + \beta_{2it}\Delta ICF_{it} + \beta_{3it}\Delta CC_{it} + \Delta\epsilon_{it} \tag{5.1}$$

Each variable used is calculated as:

(i) Policyholders cash flows: cash inflows from insurance operations minus cash outflows due to insurance operations (Cash Flow Statement).

(ii) Insurer's cash flows consist of the payments of (a) interest (b) income tax (c) other cash outflows generated from the operating activities (Cash Flow Statement).

(iii) Change in cash (yearly) (Balance Sheet Statement).

(iv) Returns: net income (Income Statement).

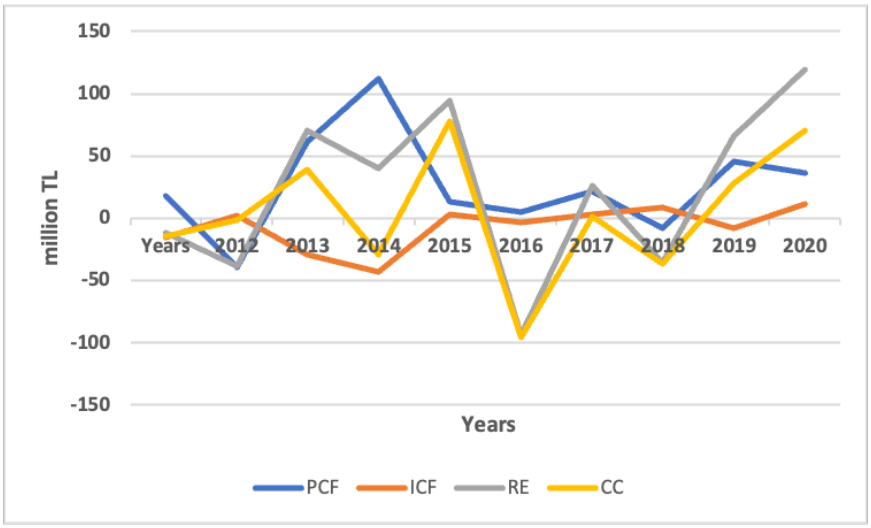

Figure 5.1: PCF, ICF, RE and CC for a Türk non-Life Insurance Company.

The visualization of the change in these variables on one of the non-life Türk insurance companies is shown in Figure 5.1.

In the table, it is seen that the standard deviation for all of the variables is very high due to the different sizes and strengths of the observed companies. 22 non-life insurance companies out of 42 are studied for the years 2011-2021, these 22 companies are selected subject to the availability of financial statements and years are chosen to include the biggest dataset for the largest number of insurance companies. Thus, in observing the policyholder changes in cash flow, it ranges from (-4.1E+09 to 2.9E+9) for the different insurers. The mean value is positive which means that the net cash flows for policyholder are mostly increasing in the companies. The yearly change in cash through the companies have an average of 10 million TL, with a range of 27 million TL; showing the difference in size of the insurance transactions of the different Türk insurance companies. Also the mean value of entity cash outflow and returns is positive as seen in Table 5.1.

Before starting any analysis; each variable is tested for stationarity using unit root tests, since for time series data, the mean and variance shouldn't change over time. Therefore, after using Levin-Lin-Chu Unit-Root Test for each one of the panel variables; that has the null hypothesis of that all the panels contain a unit root; it reveals that all are stationary. They have a significant p-value rejecting the null hypothesis [9].

Table 5.1: Descriptive statistics of the Variables

	Min.	Max.	Mean	SD.	Kurt.	Skew.	Stationarity
PCF	-4.1E+09	2.9E+09	1E+07	5E+08	35.08	-2.833	< 2.2e-16
ICF	-2.3E+09	1.582E+09	2.5E+07	2.4E+08	51.68	-2.547	< 2.2e-16
RE	-4.9E+08	4.83E+09	2.22E+08	7.87E+08	16.65	0.687	< 2.2e-16
CC	-1.5E+09	1.1E+09	1E+07	2.6E+08	9.95	-0.600	< 2.2e-16

5.2 Dependence Analysis

After adjusting the data for inflation, the correlation matrix between the variables is analyzed (Table 5.2). A positive correlation between the dependent variable PCF and all the independent variables is observed. There is a high correlation between PCF and the RE with 80% linear relationship, also there is a moderately-low correlation between PCF and ICF and the CC of 28% and 21% respectively. There is a positively moderate correlation among ICF and RE. There is a very low correlation between ICF and other variables. A positive correlation of 23% is observed between RE and CC. Furthermore, the relationship between years and all the variables is positive and ranged from 3 to 9 %. The dependent variables have low correlation coefficients among them. This low correlation coefficients are one of the basic advantages of using panel data [48].

Table 5.2: Correlation Coefficients

	PCF	ICF	RE	CC
PCF	1			
ICF	0.28	1		
RE	0.79	0.52	1	
CC	0.21	0.07	0.23	1

Moreover, the VIF scores for the predictor variables are calculated; as they are used to detect multicollinearity models. Thus, the values for insurer's cash flows, returns and yearly cash changes are 1.371976, 1.439231, and 1.057668, respectively. These variables do not show multicollinearity.

Furthermore, scatter diagrams (Figure 5.2) show a clear view of the relationship between each independent variable with the dependent variable. Three scatter plots are used to represent the relationship between each independent variable and the dependent variable taking into consideration the 22 companies used. As seen the re-

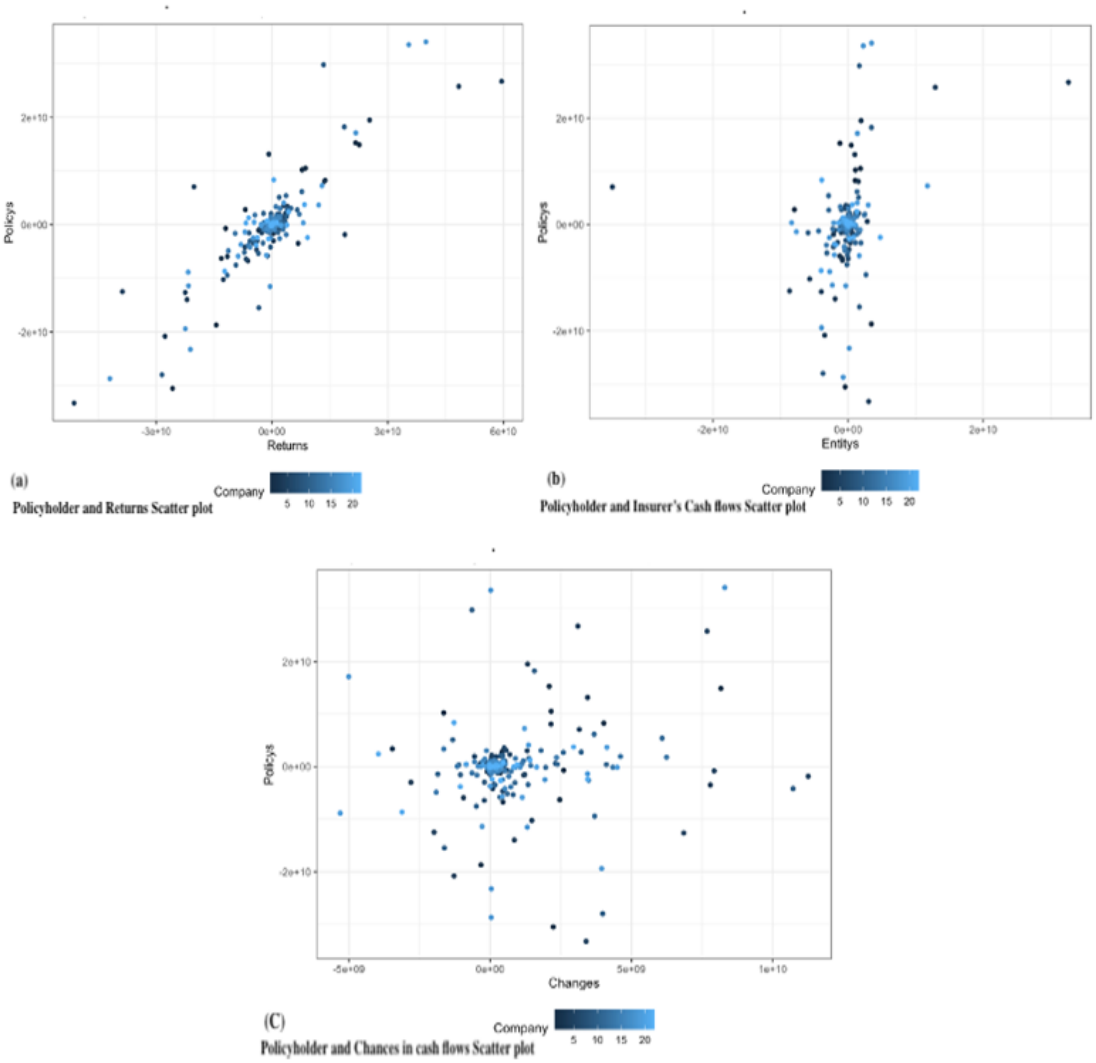

Figure 5.2: Scatter Diagrams of the Variables. (a) PCF and RE, (b) PCF and FCF and (c) PCF and ICF

lationship between RE and PCF shows a significant positive relation. However, the relationship between PCF, ICF and PCF, CC are not clearly defined.

5.3 Empirical Analysis

To comprehend which among the independent variables are associated with the dependent variable, as well as to explore the forms of these relationships we employ panel data analysis on the equation (5.1) which determines the economic relationship between the variables by using both cross-sectional data and time dimension [50].

Pooled OLS, fixed model and random model were all preformed for the data (Equation (5.1)) using R-Software. In order to choose the best model, F-test, Breusch-Pagan lagrange multiplier (LM), and Hausman tests are made. The pooled OLS is rejected against the random model using the LM test with a significant chi-square value at the 5% level (P-value of .0032). Since pooled OLS does not consider the diversity between the companies throughout the years. After the conclusion of the presence of individual effects; it ought to find if those effects are random or fixed. In so, Hausman test is made where it tests if the unique errors ϵ_i are correlated with the independent variables, the null hypothesis is that they are uncorrelated *Random model* [24]. For this data set the null hypothesis is not rejected at the 5% level and random model is chosen(p-value of 0.7056). The outcomes of pooled and fixed models are in the appendix, Section A.

The analysis does not stop on the static panel data. Moreover, dynamic panel data is demonstrated using generalized method of moments (GMM). GMM estimator is suitable for data with low time points and high cross-section data, we have 10 years after taking the difference and 22 companies. GMM is used in order to examine if a lagged value of the dependent variable should be included as independent variable. Thus, the method of Arellano–Bover/Blundell-Bond, "one of the system's GMM methods, two-step system GMM estimator" is implemented for the data. However, the lagged dependent variable has an insignificant value, and adding this lagged variable lowered the adjusted R square. In so, Arellano and Bond [5] serial correlation test of degree 2 is made. The test does not reject the null hypothesis at any plausible significance level and does not provide any indication that the model specification might be inadequate(p-value of 0.939). Moreover, the Hansen J-test [31] of the over-identifying restrictions is also made, the test does not reject the over-identifying restrictions and does not provide any indications that the validity of the instruments employed in estimation may be in doubt (p-value of 0.9997). Hence, the coefficients do not change their signs or significances after adding the lagged dependent variable as seen in Table 5.3.

Thus, for the random model, the tests for serial correlation are made. Firstly, L-M test for serial correlation in the idiosyncratic component of the errors under (normal, heteroskedastic) random effects is made. This test is identical for both the alterna-

Table 5.3: Outcomes of Generalized Method of Moments (GMM)
Dynamic linear panel estimation (twostep)

Coefficients:	**Estimate**	**P-value**
L1.PCF	-6.10E-02	0.2317
L0.ICF	-4.58E-01	< 2e-16 ***
L0.RE	7.38E-01	< 2e-16 ***
L0.CC	-7.92E-01	0.00022 ***
2013	3.83E-11	0.21498
2014	-5.97E-11	0.01813 *
2015	3.80E-11	0.00295 **
2016	-5.61E-12	0.53197
2017	-9.95E-12	0.57684
2018	-5.00E-11	0.00080 ***
2019	1.08E-12	0.83523
2020	1.59E-10	< 2e-16 ***
J-Test (overid restrictions):	19.99 with 35 DF	p-value: 0.9803
F-Statistic (slope coeff):	241.88 with 4 DF,	p-value: <0.001
F-Statistic (time dummies):	241.88 with 8 DF,	p-value: <0.001

tive of AR(1) and MA(1) processes [8]. This L-M test depends on maximum likelihood residuals of the restricted model. The null could not be rejected at 5% level of confidence (p-value of 0.982). The null hypothesis suggests random effects is with uncorrelated errors. Furthermore, for random model [56] assesses "if under the null of homoskedasticity and no serial correlation in the idiosyncratic errors, the residuals from the quasi-demeaned regression must be spherical as well". The null also could not be rejected (p-value of 0.6178) , there is no serial correlation in idiosyncratic errors, and the residuals are homoscedastic (p-value > .05), seen in Figure 5.3.

Moreover, robust standard errors are tested using weighted least squares to assess for any unobserved effects, with weights based on a random effects model; in so variance estimator to calculate the robust Wald statistic is used [21]; concluding that all of the independent variables are significant, assuring that there are no unobserved effects in the random model. Results of robust standard error test are summarized in Table 5.4

Consequently, static model with random effects is chosen to represent the data in equation (5.1) whose results are shown in Table 5.5. Each coefficient in the random effect model has both within-company and between-company effects, it represents the average effect on the policyholders cash flows across years and between companies.

Table 5.4: Robust Standard Error test

Variance Estimator for Robust Wald Statistic Test

Coefficients:	Estimate	P-value (naive-t) Sig.
(Intercept)	3.21E+08	0.0203 *
ICF	-5.06E-01	<0.001 ***
RE	7.43E-01	<0.001 ***
CC	-3.75E-01	0.0028 **

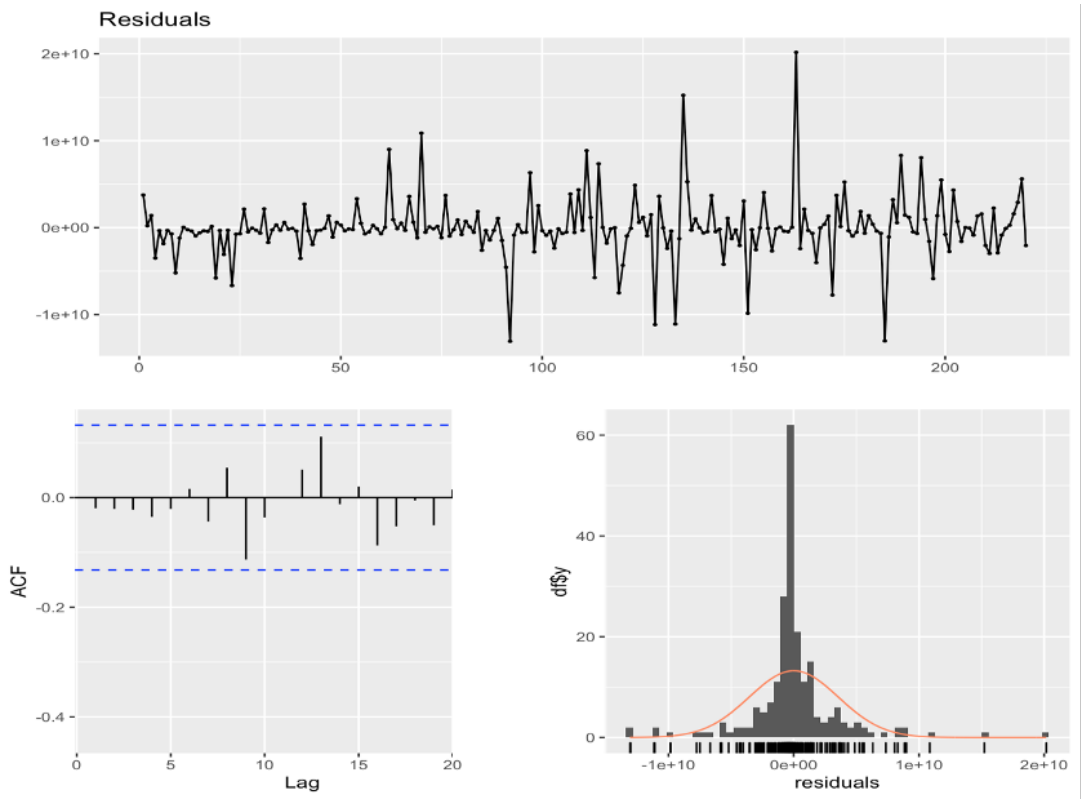

Figure 5.3: Residual Checks

In accordance with the results, a negative relationship between policyholders cash flow and both insurer's cash flow and yearly cash changes is observed at a statistical 5% significant level. Thus, a positive significant relationship between returns and policyholders cash flow is determined. In interpreting the coefficients, for one percent increase in insurers cash flows, policyholders cash flows is expected to decrease by 5.6% across years and between companies, holding all other variables constant. Also, on average when cash changes by 1% , policyholders cash flows decreases by 3.7%, holding all other variables constant. Moreover, the average effect of returns over policyholders cash flow is positive 7.5% when returns changes across time and between companies by 1%, ceteris paribus.

The model's coefficient of determination R^2 is 80%; which is a very good indicator. Thus, 80% of the changes of the policyholders cash flows are due to the changes in company's returns, insurer's cash flow and yearly change in cash. Moreover, looking at the high chi-square test value (905) shows that the whole model is highly significant (Table 5.5).

Table 5.5: Outcome of the Random Panel Data Analysis

One-way (individual) effect Random Effect Model
(Swamy-Arora's transformation)
Dependent Variable: Policy Holder's Cash Flow

Independent variables	**Estimate**	**P-value**
(Intercept)	3.21E+08	0.2174112
t-stat	(2.60E+08)	
Insurer's Cash Flow	-.506	3.562e-12 ***
t-stat	(7.28E-02)	
Returns	.743	< 2.2e-16 ***
t-stat	(2.61E-02)	
Yearly Cash Changes	-.375	0.0009971 ***
t-stat	(.114)	
Adj. R-Squared:	0.80468	
Chisq:	905.263 on 3 DF,	p-value: < 2.22e-16***
Balanced Panel:	n = 22, T = 10,	N = 220

5.4 Model Estimates

Fitting a model means that we are defining the relationship between the independent variables and the dependent variable. Figure 5.4 shows the plots of fitting different models for 22 non-life insurance companies; pooling, within and between against the historical values of policyholder cash flows. The dotted lines show the result of the regression analysis of each model on the policyholder cash flows.

Accordingly, each company should put huge attention on the variables that would change their policyholders cash flows; by which would affect their insurance liability that changes their overall financial position and performance. Insurance companies should be careful on their spending on their insurer's expenses and on their yearly cash changes, which will create lower policyholder's cash flows. However, increasing their returns would create more policyholders cash flow. Therefore, as suggested by

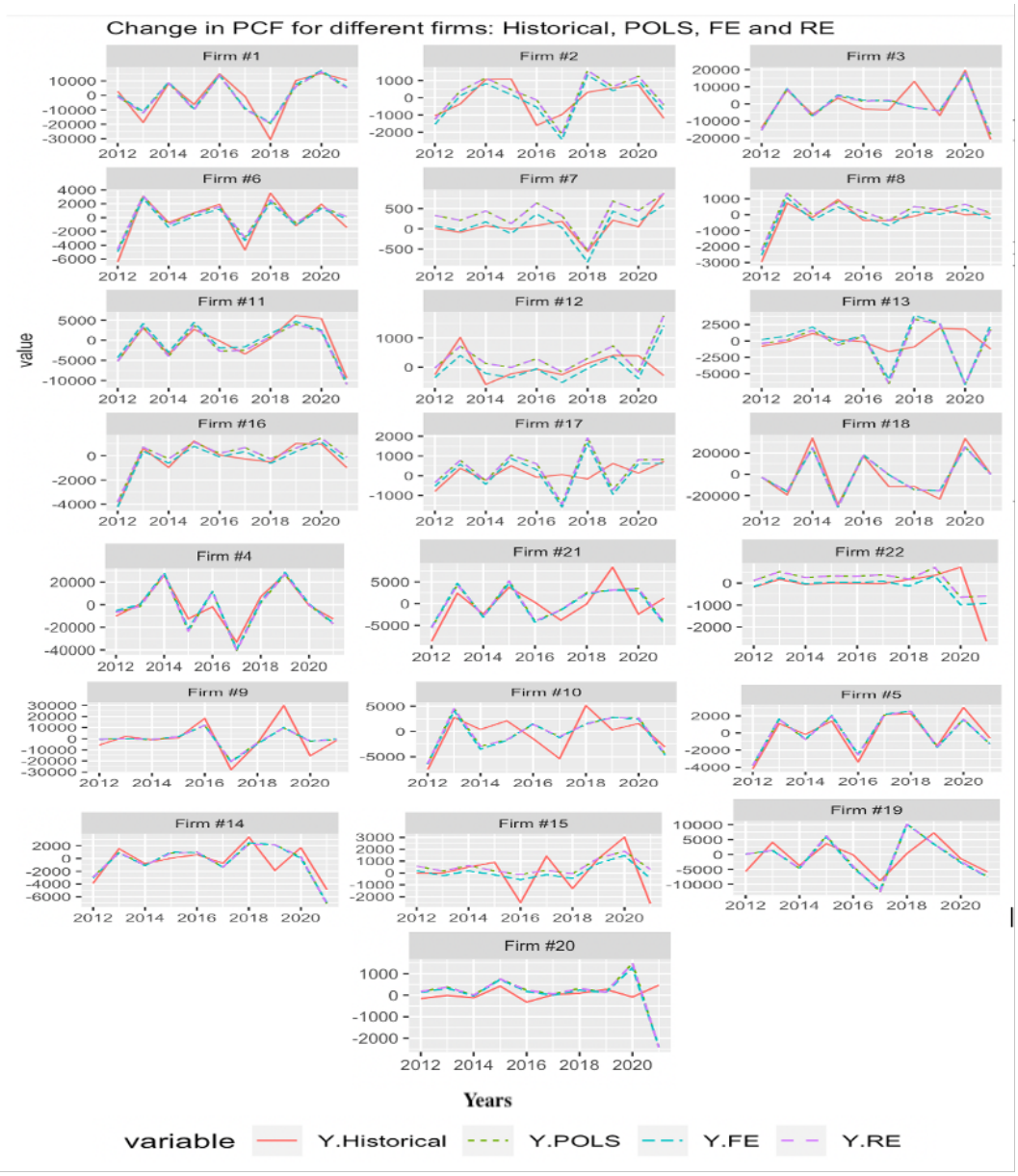

Figure 5.4: Random, Fixed, Pooled estimates on Policyholder Cash flows. Green, blue and purple dotted lines represent pooled, fixed and random models respectively.

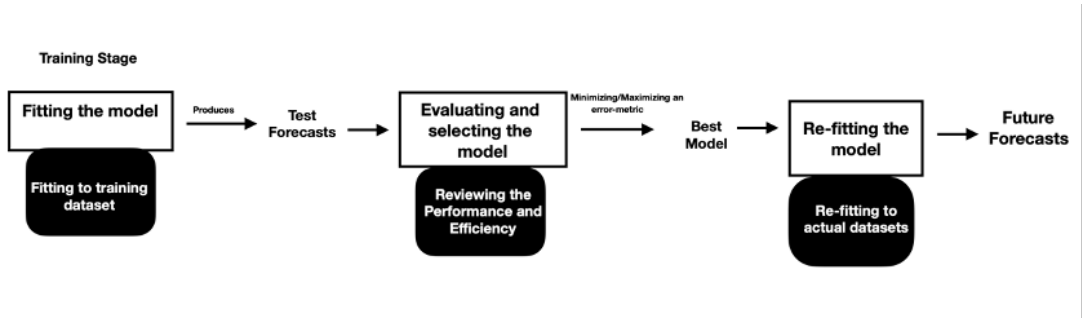

Figure 5.5: Flow Chart of the Model using Nested Forecasting.

IFRS17 studying the association of different financial statements on cashflows is of high importance to mitigate the future risks.

5.5 Forecasting Policyholders Cash Flows

Having a solid forecasting technique is very important to mitigate and manage future risks. Forecasting and simulating cash flows has many new approaches that achieve a high level of accuracy, reflecting the historical path and trends that a cash flow has. Our forecasts will separate the policyholders cash flows into inflows (consisting of premiums) and outflows (consisting of claims) in order to get the highest accuracy and transparency for the financial reporting.

Iterative forecasting is used for panel data. Thus, it is one of the best methods that has very high accuracy results using a nested data structure, since it uses many resources by cause of "for-loop" iteration. The key point of nested-forecasting is converting data sets that contain a lot of time series groups to embedded data, and then, fitting different approaches for each of the embedded data sets. The outcome would be an iterative process which creates nested-model time tables capturing all of the forecasting nature. After creating the nested data, the flow chart of the next steps are illustrated in Figure 5.5.

The forecasting starts by understanding the characteristic of each data set. The visualizing of fitted policyholders cash outflows for 22 insurance companies for the years 2011 to 2021 show different cash flows patterns. As seen in Figure 5.6, all of the cash outflows for all the companies are increasing except company #18.

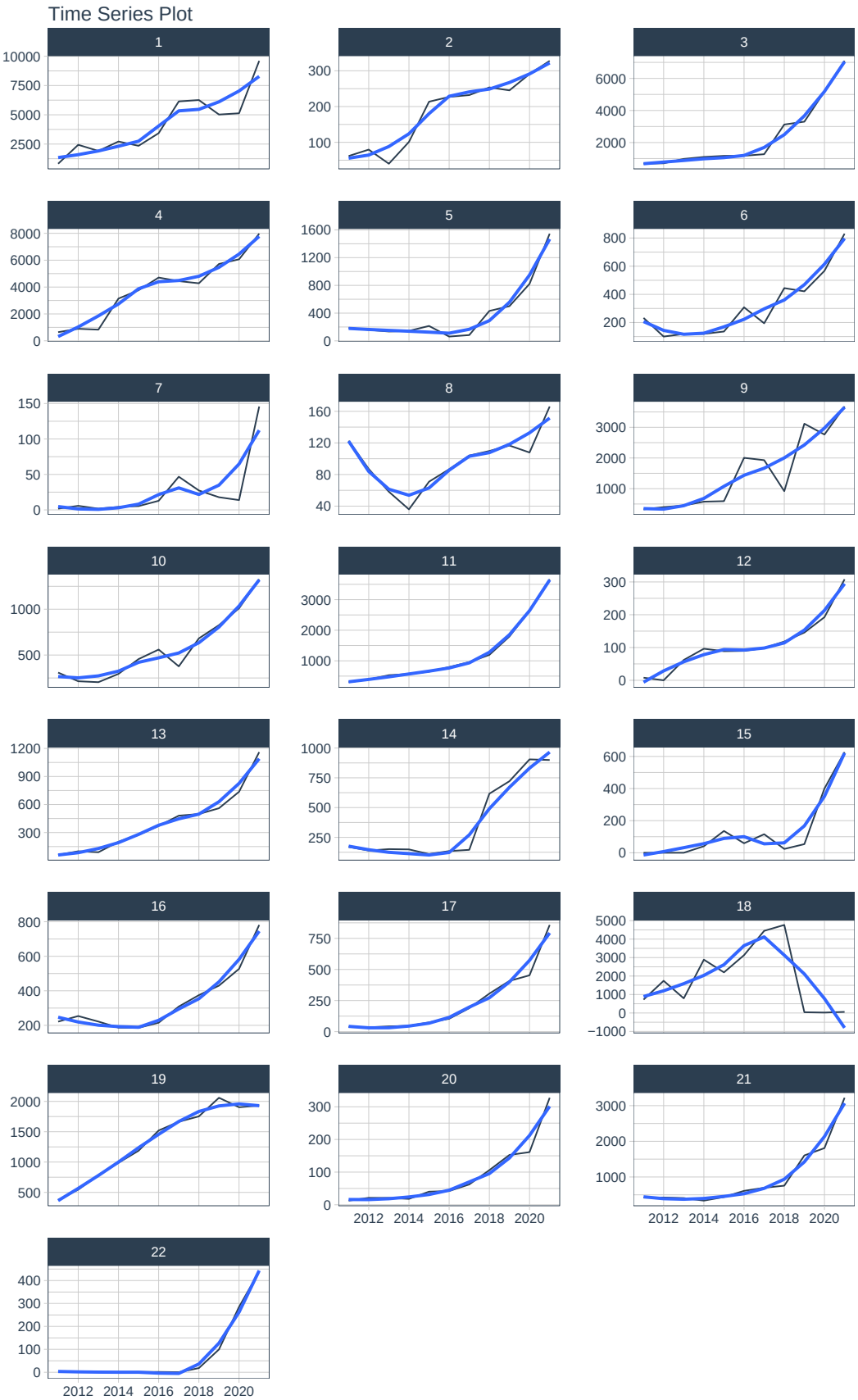

Figure 5.6: Policyholder Cash outflows (2010-2021) Million TL. The black lines show the actual cash flows and the blue lines follow the trend of the time series.

The policyholders cash inflows for 22 insurance companies between 2011 to 2021 (Figure 5.7) depicts that most of the companies has increasing trend in their cash inflows despite company #18 's decreasing trend in its cash outflows.

As next, two main parts have to be prepared; nested data structure and nested model's flow chart. The crucial step is preparing the dataset, through (i) defining the identity that sets apart each time series group *Company*, (ii) outlining the needed time length we want to predict *5 years*, and (iii) converting data sets into train and test splits. Test sets will be taken to assure the accuracy and confidence-interval estimations, it is chosen as 18.18% of the data. The ratio of approximately 80:20 (Train: Test), referred to as the Pareto principle, is the most commonly used partition for data predictions. This principle implies that for several results, approximately 80% of effects derived by 20% of causes [45].

Two methods are selected to be applied on the cash flows: (i) *Prophet* which is very famous forecasting-method and (ii) machine learning method *XGBoost*. Both methods are selected due to their high accuracy in forecasting panel datasets with small period of time. Therefore, testing both of the methods on each time series through fitting each model to each nested time series train/ test splits is done. This creates many logged-attributes which shows the accuracy measures by each time-series and model, allowing us to determine which of "Prophet or XGBoost" achieves the best performances on each data set. The algorithm given in Figure 5.5 takes place.

Figure 5.8 and Figure 5.9 show the datasets for each company with test forecasts and prediction limits; Prophet with red line and XGBoost with green one. The red and green lines represent the test forecasts for the training set, since each method has its own test forecasts the red and green lines differ for each company.

Thus, if any of the models have errors, then we can investigate the error logs with extract nested-error report. Fortunately, by extracting the log errors we did not encounter any errors, but if we did we could have investigated further. Choosing the best model will be the next step. Through the accuracy information criteria, we select a metric then choose the best-model depending on this metric. There are several measures to compute forecast accuracy: such as mean absolute error (MAE), root mean square error (RMSE), mean absolute percentage error (MAPE), mean square error

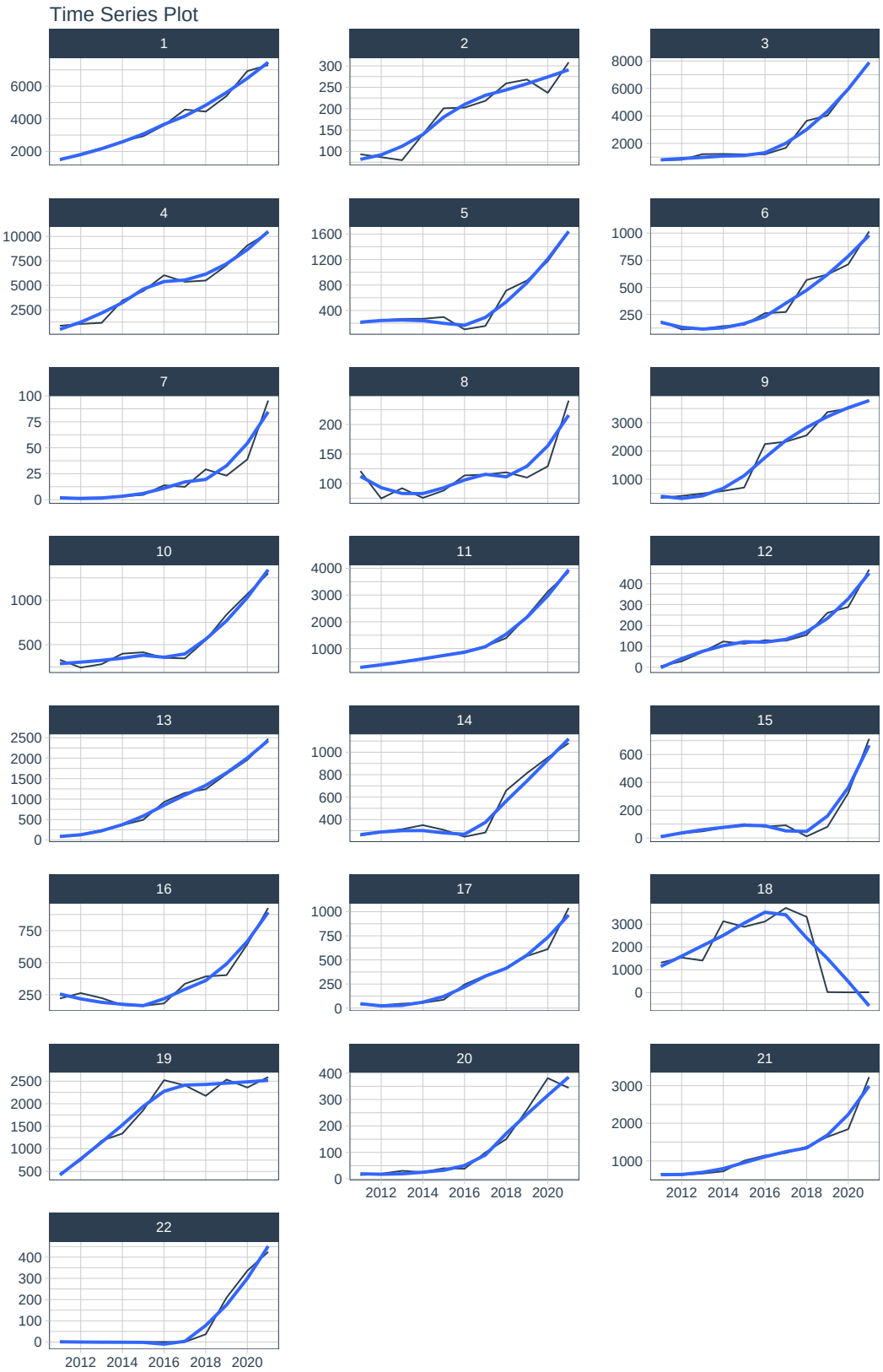

Figure 5.7: Policyholder Cash Inflows (2010-2021) Million TL. The black lines show the actual cash flows and the blue lines follow the trend of the time series.

Figure 5.8: Test forecasts with Prophet and XGboost on Policyholders Cash outflows Million TL. Black lines are actual cash flows, the light grey shade is 95% confidence interval around the test forecast and the uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

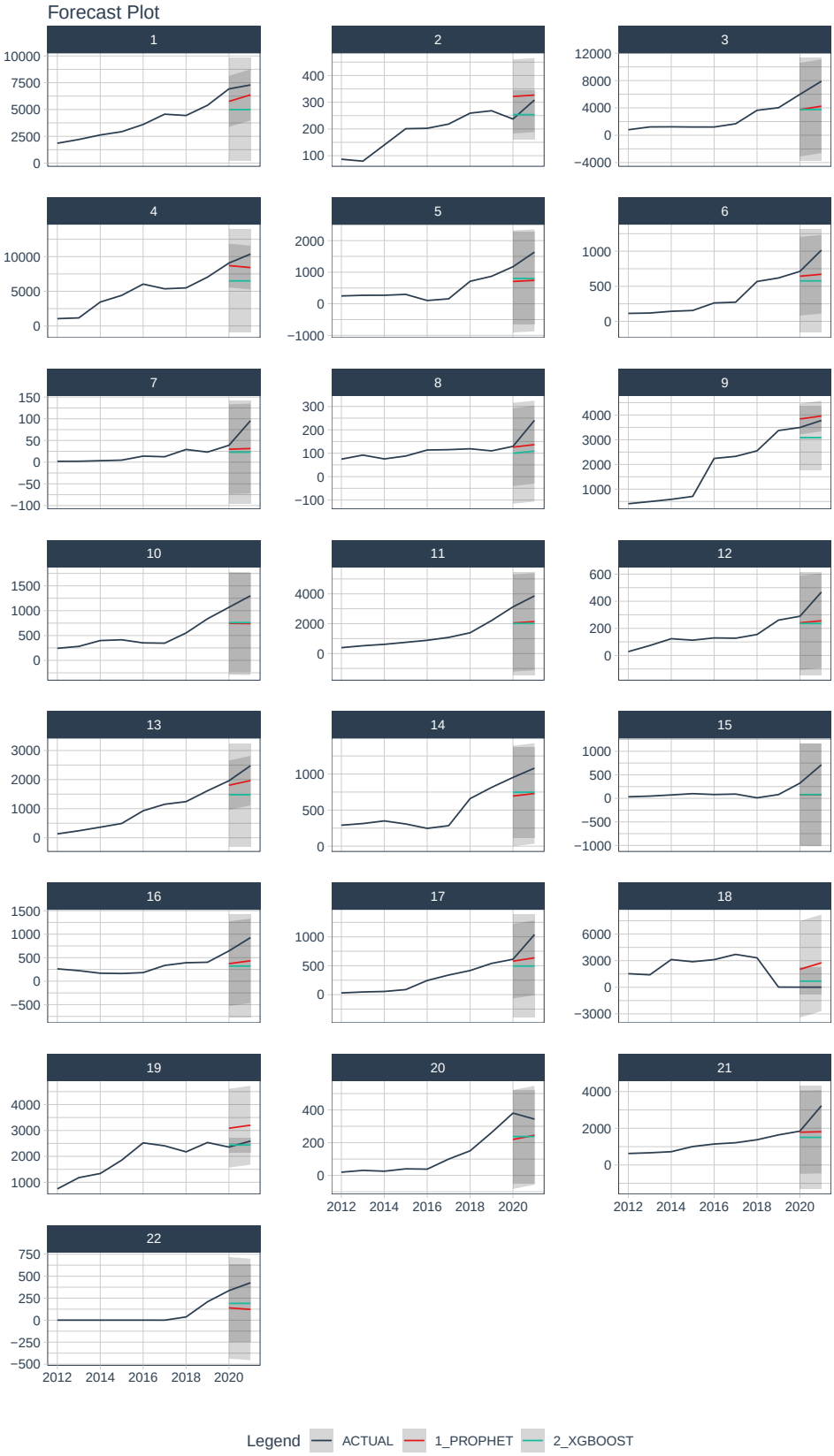

Figure 5.9: Test forecasts with Prophet and XGboost on Policyholders Cash Inflows Million TL. Black lines are actual cash flows, the light grey shade is 95% confidence interval around the test forecast and the uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

(MSE) or R-Squared (RSQ) . These measures of forecast accuracy represent how well the forecasting method can predict the historical values of the time series. The lower the values of these measures, the more accurate the prediction of the model. Each company has both Prophet forecasting and XGBoost with their accuracy values.

While approximately all the measures summarize the variability of the observations around the mean, they are not in the same scale. A good way to choose the best forecasting model is to find the model with the smallest RMSE, since RMSE is the most commonly used criterion if the main purpose of the model is prediction [17]. Hence, RMSE corresponds to the square root of the average of the squared difference between the target value and the value predicted by the regression model, it normalizes the scales factors, so it's less prone to struggle in the case of outliers [22]. Thus, the best forecast with the lowest RMSE is chosen for each company. A slice of the selected are visualized in Table 5.6. For example, the model for company id 1 is preferably chosen using Prophet yielding the smallest performance measure.

Table 5.6: Accuracy Table.

id	**.model,id**	**.model,desc**	**MAE**	**MAPE**	**MASE**	**RMSE**	**RSQ**
1	1	PROPHET	625.89	26.74	1.44	913.33	0.23
1	2	XGBOOST	1101.10	47.79	1.96	1288.73	0.45
9	1	PROPHET	340.33	17.62	1.48	527.08	0.72
9	2	XGBOOST	216.81	27.23	1.72	369.49	0.81

Thus, in Figure 5.10 and Figure 5.11, the time series of each company with the more accurate prediction model is presented, each data set now has either Prophet or XGBoost forecasts and prediction limits. In so, either red or green line is visualized for each company.

As the final step, future values are forecasted by re-fitting each model into the whole data set. Thus, the forecasting for five years with their prediction limits are visualized in Figure 5.12 and Figure 5.13, for cash outflows and inflows, respectively. It should be noted that some companies have Prophet forecasts with red lines and others XGBoost with green lines. For each company, the next five years for policyholders cash flows are forecasted either with XGBoost or prophet method along with the highest prediction limit and the lowest prediction limit.

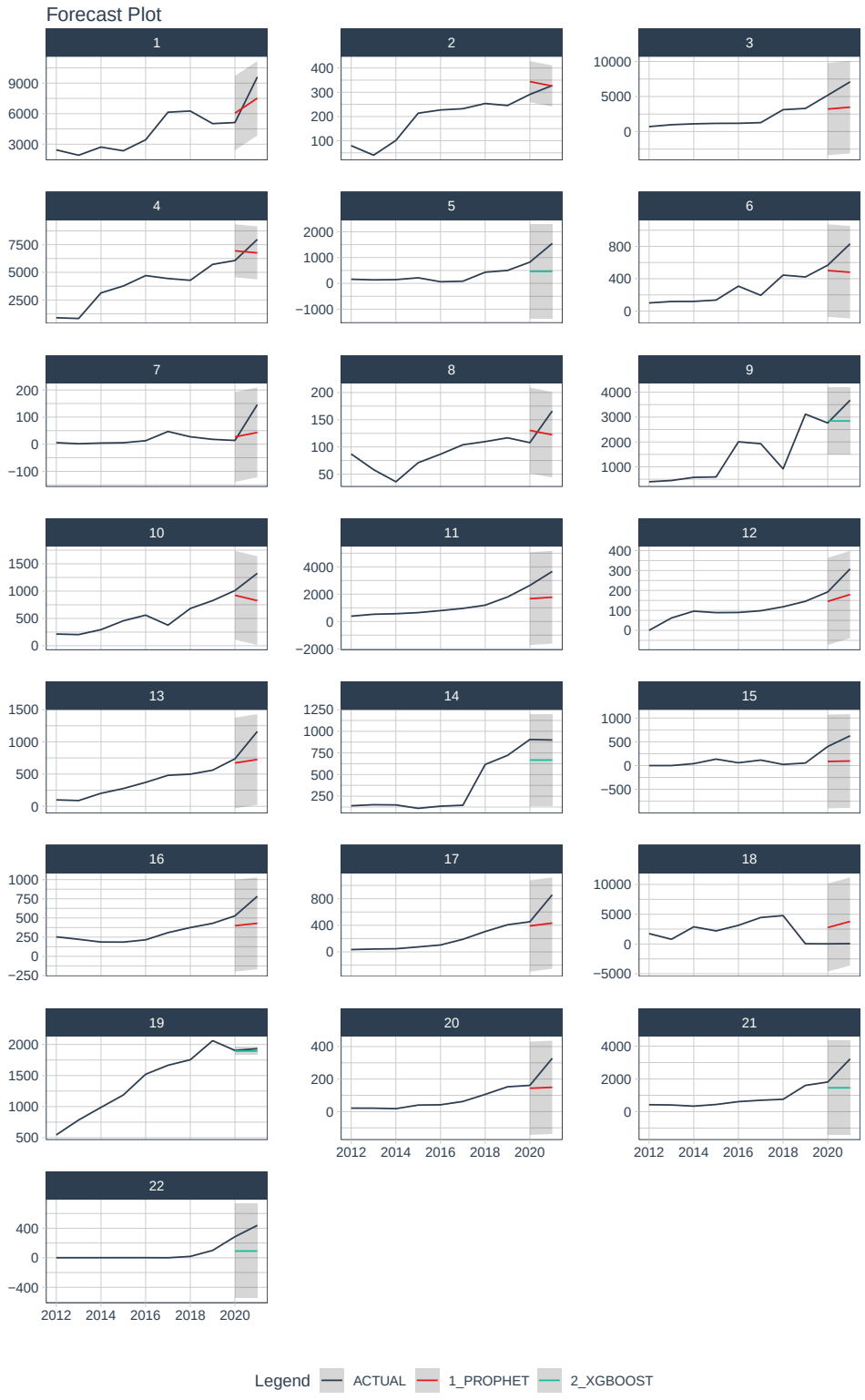

Figure 5.10: Best Nested Model on Policyholders Cash outflows in Million TL. The red or green lines represent the test forecasts for the training set, black lines are actual cash flows. The light grey shade is 95% confidence interval around the test forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

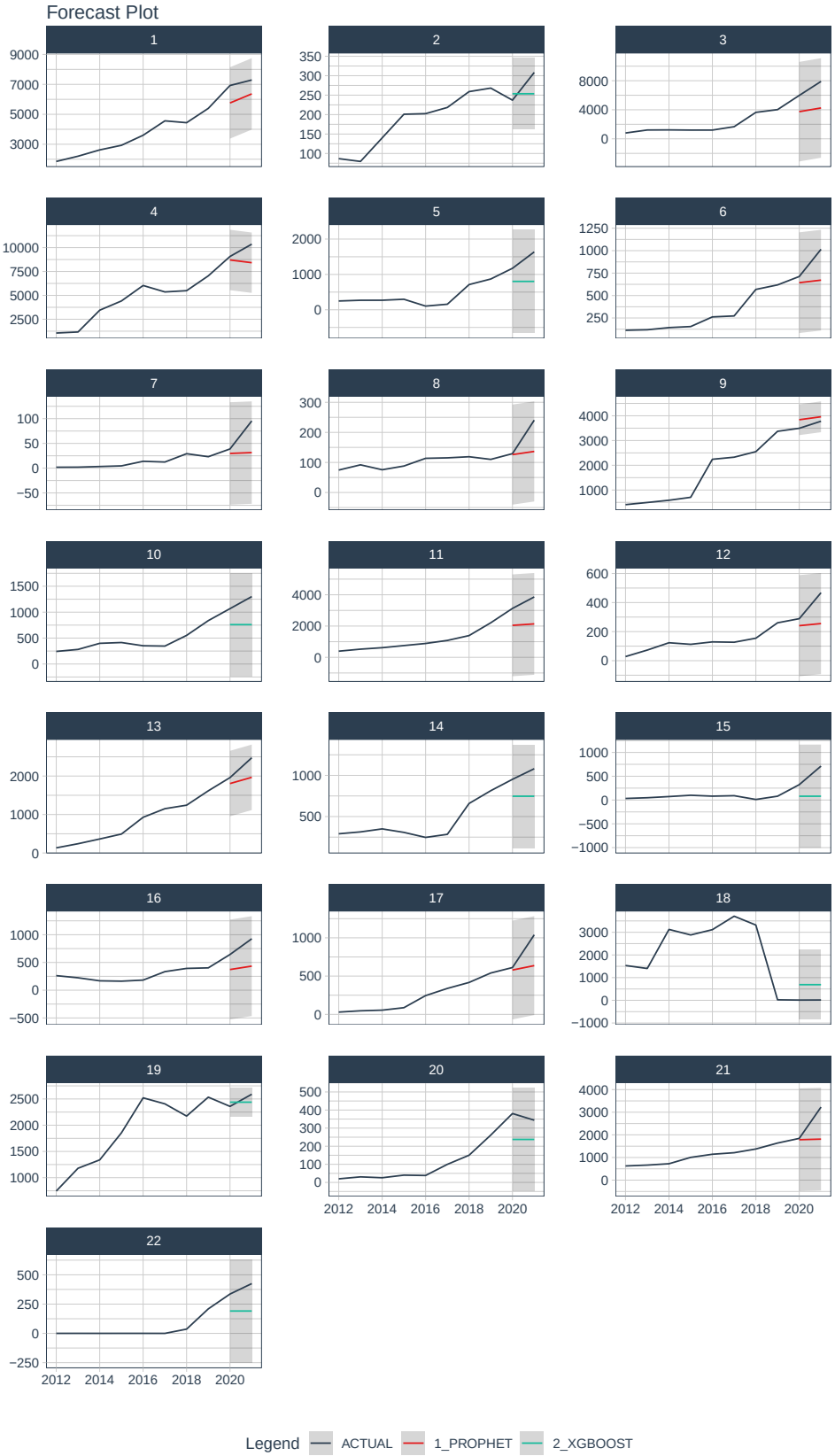

Figure 5.11: Best Nested Model on Policyholders Cash Inflows Million TL. The red or green lines represent the test forecasts for the training set, black lines are actual cash flows. The light grey shade is 95% confidence interval around the test forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

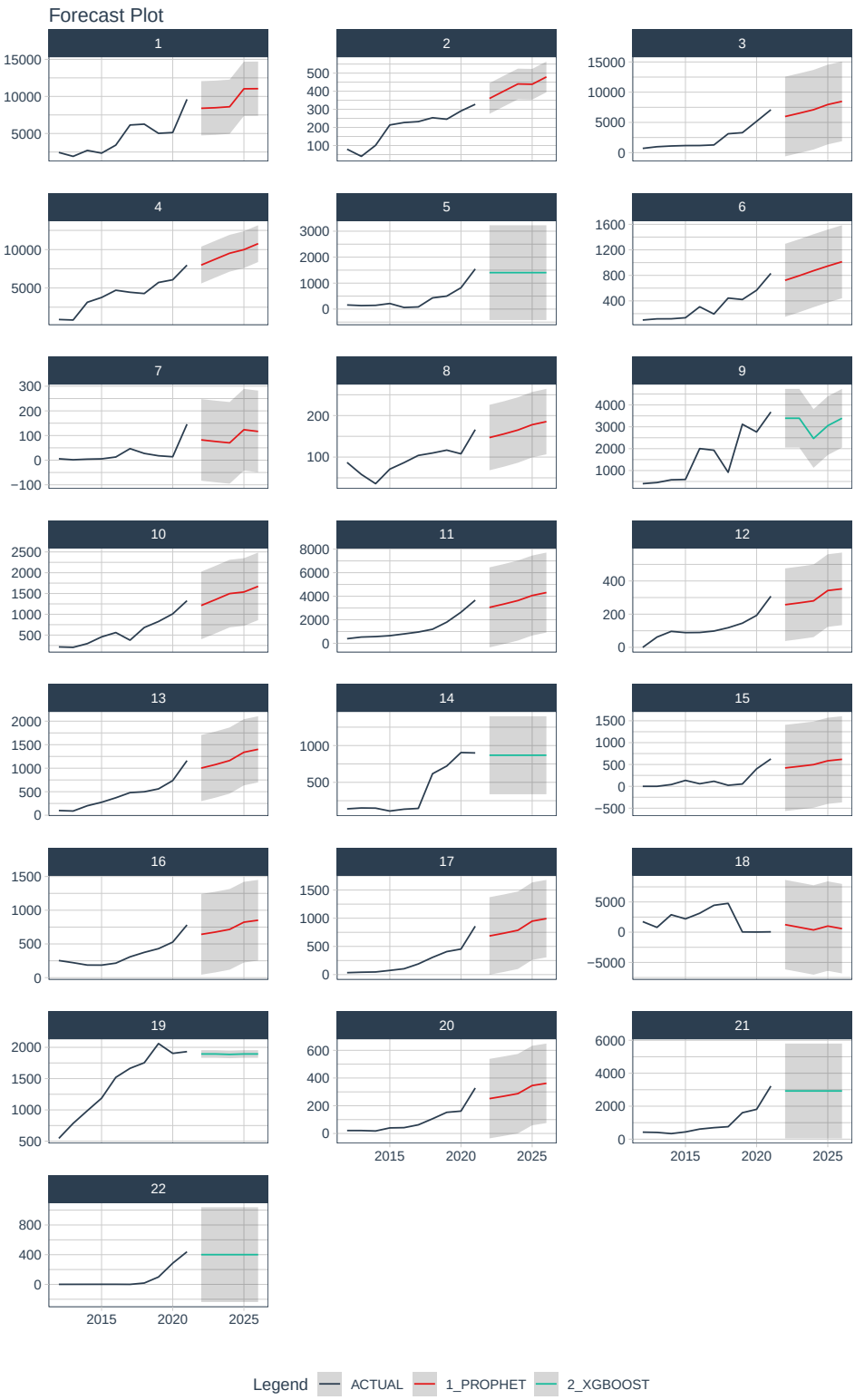

Figure 5.12: Five years Future Forecasts for Policyholders Cash outflow Million TL. The red and green lines represent the future forecasts, black lines are actual cash flows. The light grey shade is 95% confidence interval around the forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

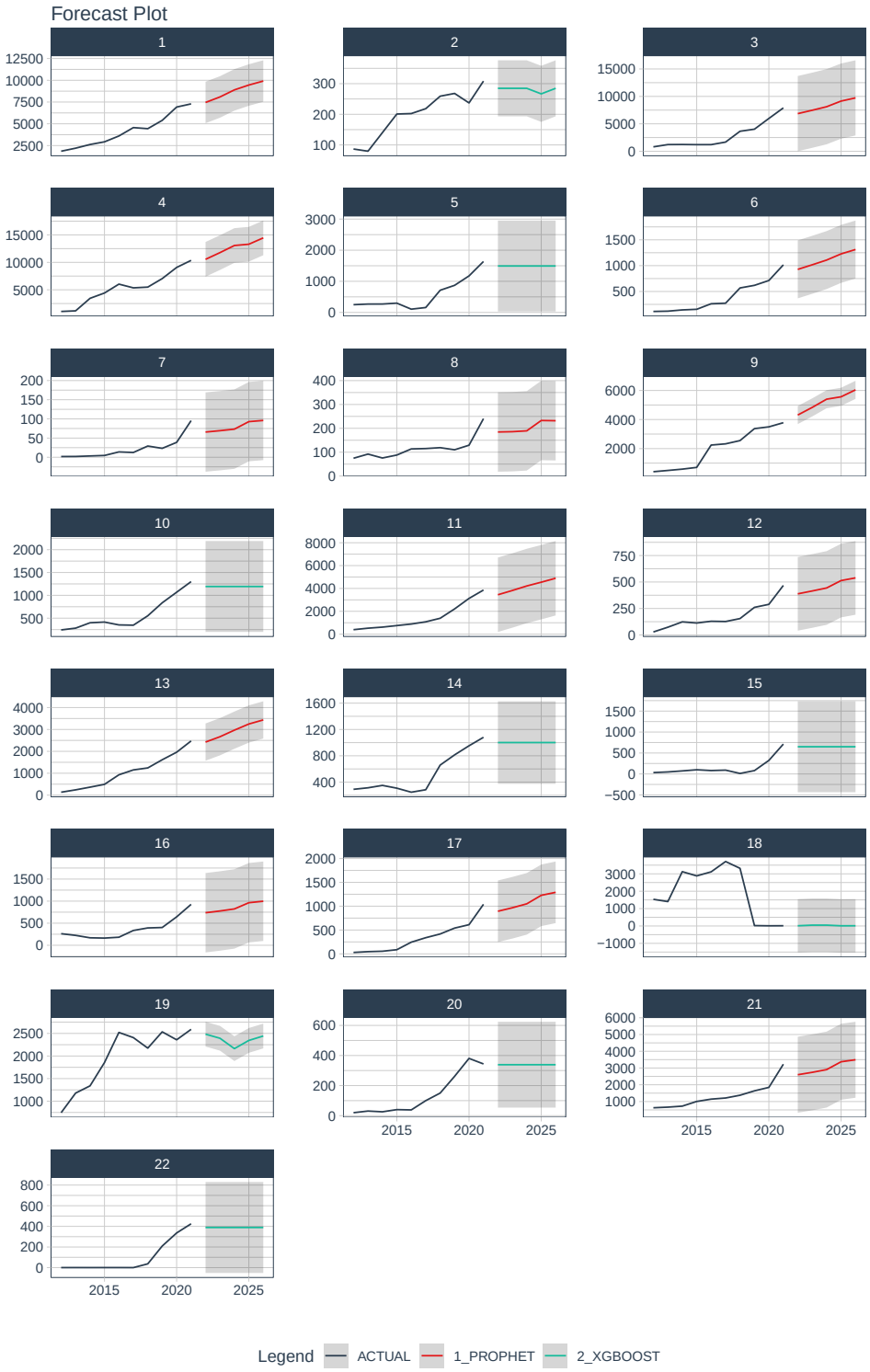

Figure 5.13: Five years Future Forecasts for Policyholders Cash Inflow Million TL. The red and green lines represent the future forecasts, black lines are actual cash flows. The light grey shade is 95% confidence interval around the forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

5.6 The Effect of IFRS17 on Insured Liabilities

This section presents a non-life insurer example that exhibits how computation of the estimated present value under IFRS17 affect the insurance liabilities of the company. The main principle for the measurement of the liabilities according to IFRS17 is that insurance contracts have to be valued as the summation of the fulfilment cash flows and the contractual service margin; representing the liability of incurred claims and liability of the remaining coverage, both depends on the expected policyholders cash flows [57] .

The main point about IFRS17 is that it is not only a reporting standard, it is a standard for measuring, managing and capturing all the related aspects for the insurance process. What makes it different is that it puts huge efforts for each detail in order to get the maximum welfare for policyholders, investors, insurers and regulators. For the estimation of the present value by simulation and stochastic process, the standard requires to define the prediction limits and also to assign extra limits as a risk margin for any future deficiencies. Furthermore, IFRS17 gives main bullet points as a guidance for the measurement process, with many illustrative examples without requiring exact formulas to be used [29]. This makes the understanding of the smallest detail of a significant importance. Therefore, this section shows how IFRS17 requires companies to compute their weighted mean present values, compares how previously used methods compute their present values, and lastly concludes the general impact of using this method on the liabilities of Turkish insurance sector. Yet, this example neglects the effect of the change in interest rates, time of payments, market, economic situations and firm specific conditions.

Table 5.7 shows the forecasted cash flows for the subsequent five years of one of the Türk insurance companies; taking into account the value, Conf_lo and Conf_hi that were simulated using the previous step explained in Section 5.5. Hence, the net cash flows using IFRS17 should be calculated by simulating inflows and outflows separately and then calculating their present value. Table 5.7 summarizes the data on the cash flow and the probability assigned for each scenario using IFRS17 estimations.

It should be noted that:

Table 5.7: Forecasted Cash flows

	Scenario	**Exp. PCF(Out)**	**Exp. PCF(In)**	**Exp. PCF(Net)**	**Prob.**	**Prob. weighted**
Year 1	Conf_lo	-345,947,767	193,438,095	539,385,862	5%	26,969,293
	Value	3,052,622,882	3,449,143,557	396,520,675	73%	289,460,092
	Conf_hi	6,451,193,531	6,704,849,019	253,655,488	9%	22,828,993
	Inflow=outflow	-	-	0	13%	0
Total					**100%**	**339,258,379**
Year 2	Conf_lo	-68,975,139	565,032,150	634,007,289	5%	31,700,364
	Value	3,329,595,510	3,820,737,612	491,142,102	73%	358,533,734
	Conf_hi	6,728,166,159	7,076,443,074	348,276,915	9%	31,344,922
	Inflow=outflow	-	-	0	13%	0
Total					**100%**	**421,579,021**
Year 3	Conf_lo	232,548,924	961,674,192	729,125,267	5%	36,456,263
	Value	3631,119,574	4,217,379,654	586,260,080	73%	427,969,858
	Conf_hi	7,029,690,223	7,473,085,117	443,394,894	9%	39,905,540
	Inflow=outflow	-	-	0	13%	0
Total					**100%**	**504,331,662**
Year 4	Conf_lo	660,139,348	1,290,934,178	630,794,829	5%	31,539,741
	Value	4,058,709,998	4,546,639,640	487,929,642	73%	356,188,638
	Conf_hi	7,457,280,647	7,802,345,102	345,064,455	9%	31,055,800
	Inflow=outflow	-	-	0	13%	0
Total					**100%**	**418,784,181**
Year 5	Conf_lo	912,605,837	1,637,466,553	724,860,715	5%	36,243,035
	Value	4,311,176,487	4,893,172,015	581,995,528	73%	424,856,735
	Conf_hi	7,709,747,136	8,148,877,477	439,130,341	9%	39,521,730
	Inflow=outflow	-	-	0	13%	0
Total					**100%**	**500,621,501**

(i) All amounts are in Türk Liras.

(ii) The probability of each scenario is assigned as (5%,73%,9%, and 13%) according to the illustrative examples of IFRS17; which by using simulating methods 5% is assigned to the lowest prediction limit, 9% is assigned to the highest prediction limit, 13% will be put as a risk margin for zero net flows (outflows equaled inflows), and the rest is for the forecasted value.

(iii) Some computing details are left-out in this example concerning risk adjustments and discount rates, in order to determine the effect of modeling cash flows solely on the financial position.

(iv) It is assumed that cash inflows and outflows happen at the same time at the end of each period.

Before IFRS17, insurance companies had the ability to use different approaches for measuring their insurance liability, stochastic, deterministic or even management-

predictions. These modeling approaches often rely on determining different scenarios and then choosing the most likely-outcome or "more-likely-than-not" outcome and do not take into consideration the range of all of the probable scenarios. And some forecast their "Net Cash flows" without taking the changes in inflows and in outflows separately. Thus, for our forecasted data; the measured amount of the insurance liabilities calculated under deterministic-modeling of IFRS4 would be the value with the highest probability (the most likely outcome). Under IFRS4 the insured liability of the five years will be the present value of CF1= 3.97E+08, CF2= 4.91E+8, CF3= 5.86E+8, CF4= 4.88E+08, CF5= 5.82E+08. For the present-value calculations, it is assumed that there are no changes in the discount rate through the studied period. For the calculations, 5% discount rate is assumed, it is chosen without a significant purpose. Consequently, the present value will be 2.1E+09 TL.

However, under IFRS17; the best estimate of liabilities represents "an explicit, unbiased and probability-weighted estimate of the present value of the future cash outflows minus the present value of the future cash inflows that will arise as the entity fulfills insurance contracts" [49]. Thus, contrary of ongoing accounting approaches that measure their balance sheet's account by *best estimate*, IFRS17 takes into account all of the scenarios and their related probabilities "including remote ones". Each scenario should specify the amount, timing and probability of cash flows, the aim is to encounter every related/relevant data and not to neglect any observation even the probability of having zero net cash flows. In which the best estimate of liabilities would be the weighted average of the present value of CF1= 3.39E+08, CF2= 4.22E+08, CF3=5.04E+08, CF4= 4.19E+08, CF5= 5.01E+08. The weighted average present value is found to be 1.88E+09TL. As visualized in the Figure 5.14 the use of IFRS17 would create higher insurance liabilities by approximately 0.371%.

Replicating the proposed approach for the 22 companies; the difference between the insured liability before and after the application of IFRS17 is observed to be between (0.1033% to 29.61%). Concluding that, modeling cash flows under IFRS17 will increase the insurance liabilities. However, this result does not mean that the companies will face this percentage of increase in their liabilities, since this example does not take into account the effect of time, discount rates, risk adjustments, or management perception. But this example illustrates the impact of modeling cash flows on the

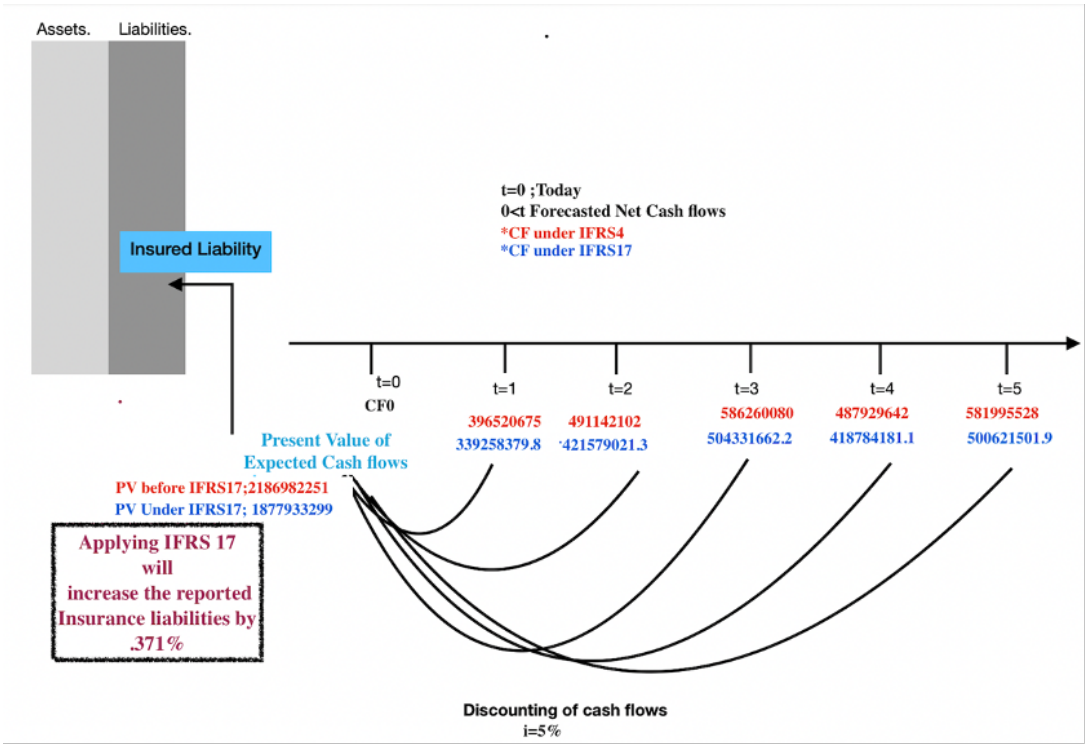

Figure 5.14: The Implication of IFRS17 Compared to IFRS4.

reporting process for insurance companies. Thus, IFRS17 argues that this approach reduces volatility. The aim of the "probability weighted average present value" is to exhibit all of the related information and not neglect anything that is hard to get, encountering more transparency and less variability in the future.

Furthermore, it is allowed to estimate the future cash flows before IFRS17 by the simulation of the net cashflows, not separating the forecasts for inflows and outflows. This technique does not capture the real changes and anticipations that might happen to the inflows and outflows separately and does not take into consideration the trends, management considerations and even related events that might affect only one of the cash flows. Therefore, to study the variation between the use of IFRS17 and the use of previous methods, forecasting for the net cash flows using nested method is also performed in the Appendix (Section B). The differences can be observed in the Figure 5.15. In calculating the present value and comparing it to IFRS17's, Insured liabilities came out to be also higher between 0.0444% to 57.12%.

The main result is that IFRS17 will definitely change the insurance liabilities, which will change the financial position of the company. This change absorbs the risks

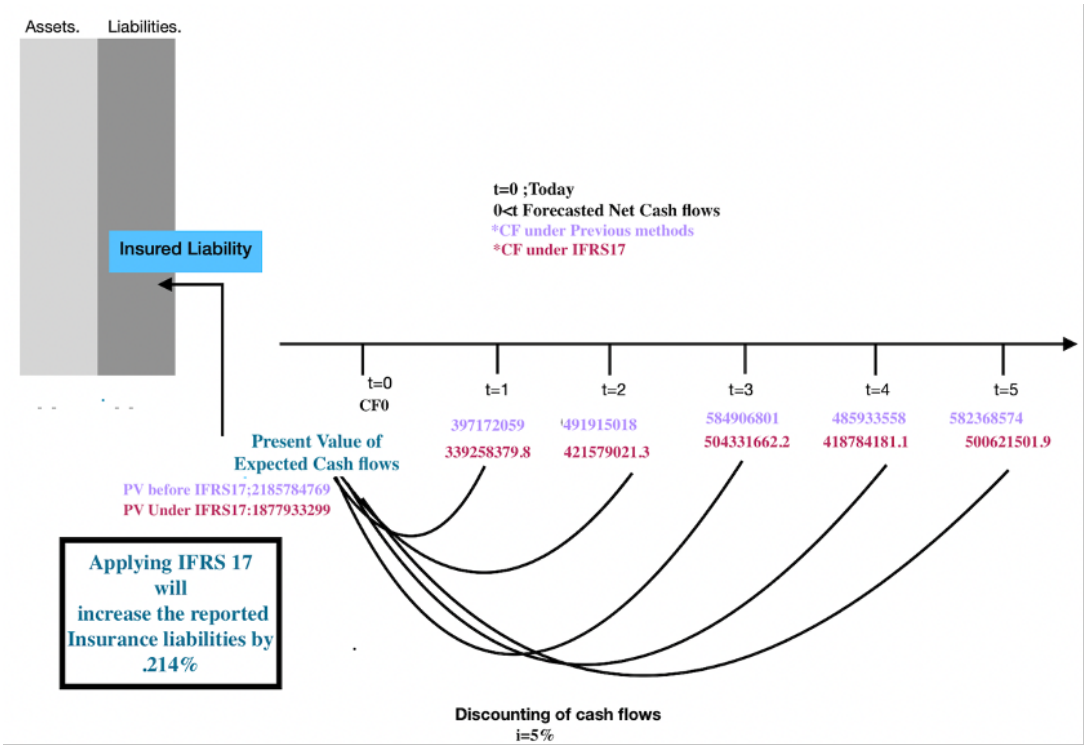

Figure 5.15: The Implication of IFRS17 Compared to Previous Standards.

and uncertainties inherited in the future. This makes sure that by applying IFRS17, insurers have an adequate risk reserve for any anticipated future claims and losses if they apply fulfilment cash flows and contractual service margin approaches.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

This thesis creates a real data framework that captures the effect of IFRS17 on the insurance company's liabilities in which the main contribution is the merge of the future with the past; through policyholders cash flows. Thus, the principles of IFRS17 introduce many questions concerning how to compute the insurance liabilities' value; which is determined through two main building blocks the fulfilment cash flows and the contractual service margin; understanding them creates a huge challenge for insurance companies. Thus, the outcomes of the study reveals that:

(i) By shifting to IFRS17, the financial position of insurance companies will change by the increase of the insurance liabilities (Section 5.6), which has an impact on the performance and capital structure of the companies. This change in the liabilities is expected to enhance the transparency, quality and trustfulness of the reported amounts. Correspondingly, it will decrease the future variability, since the estimations consider every possible outcome; and this is the core aim of IASB in establishing IFRS17.

(ii) The nucleus of IFRS17 is policyholders cash flows. So, the application of IFRS17 requires a deep understanding on modeling policyholders cash flows; from inside to outside (Figure 3.2) . Consequently, to be able to anticipate the variations of the insurance sector's cashflows an analysis of balance sheet, income and cash flow statements through returns, insurer's cash flows, and changes in cash should be made (Equation (5.1)).

(iii) By the introduction of fulfilment cash flows and contractual service margin, insurance companies will have an adequate risk reserve that faces any anticipated

future claims, losses and uncertainties. Thus, compared to previously used standards, IFRS17 will decrease the future variability and create homogeneity within insurance financial statements (Section 2.1 and Section 2.2).

(iv) The Türk insurance companies should mitigate their exposure to cash flow risks by increasing their returns in order to increase their policyholders cash flows. Since the higher the returns, the higher the security, earnings, reserves, and even reputation; which increases the policyholders trust in the company, creating more contracts and attracting new policyholders. Also, Türk insurers have to try to decrease their yearly cash changes; implying that the increase in the variability in cash between the years decreases the policyholders cash flows; due to higher uncertainties in the insurance sector, creating higher outflows and lowering the associated inflows. Thus, there is a contradict between policyholders cash flows and the Türk insurer's cash flows, in so, the main focus of the insurance company should be on its policyholders (Section 5.3).

(v) IFRS17 creates a metric which will help in evaluating the efficiency and effectiveness of insurance companies, giving a clear view of the future creating solid budgets, plans and hedging strategies through merging historical data with future expectations.

(vi) The use of modern technologies in forecasting cash flows could be a hard task for some companies, but it captures historical patterns and trends and makes it easier to simulate cash flows with higher accuracy establishing wider possibilities and views. So, using stochastic modeling is of a huge importance to investigate the inherited risk in the insurer's future cash flows. Accordingly, the benefits of those methods will outweigh their costs (Section 5.5).

(vii) Eventually, IFRS17 calls for having the ability to do more than calculating and reporting of the new financial statements. Insurance companies, policyholders and investors need to find out how those statements change in the future through diverse scenarios. New concepts introduced by IFRS17 make up the basis of insurance contracts. Thus, fulfilment cash flows essentially changes the reported insurance liabilities, and contractual service margin changes the timing of reporting revenues and expenses.

As future study, the extension of this model goes to two directions: (i) Analyze the value of T, when the probability of ruin in cash flows occurs, (insufficient policyholders cash flows). This will contribute for insurance companies to anticipate the time that their future policyholders cash flows hit its minimum. (ii) Compare and study the changes in insurance companies' liabilities that are reported with IFRS17 after 2023. This shows how the introduction of IFRS17 changes the capital structure of insurance companies and their financial positions , and how using machine learning in modeling cash flows can affect asset/liability management.

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APPENDIX A

FIXED AND POOLED MODELS' RESULTS

Table A.1: Fixed and Panel Models Summarized Results
Dependent Variable: Policy Holder's Cash Flow (PCF)

Model	Fixed	Pooled
Independent variables	Estimate	Estimate
(Intercept)		3.21E+08
P-value		0.21875
Insurer's Cash Flow	-.5079	-5.05E-01
P-value	2.30E-08***	4.16e-11***
Returns	7.42E-01	7.43E-01
P-value	<2.20E-16***	< 2.2e-16 ***
Yearly Cash Changes	-.4904	-3.74E-01
P-value	.00041***	.001165**
Adj. R-Squared	.78667	.80338
F-statistic	277.197 ***	301.754***

Balanced Panel: n = 22, T = 10, N = 220

APPENDIX B

THE FORECASTING PROCESS OF NET CASH FLOWS

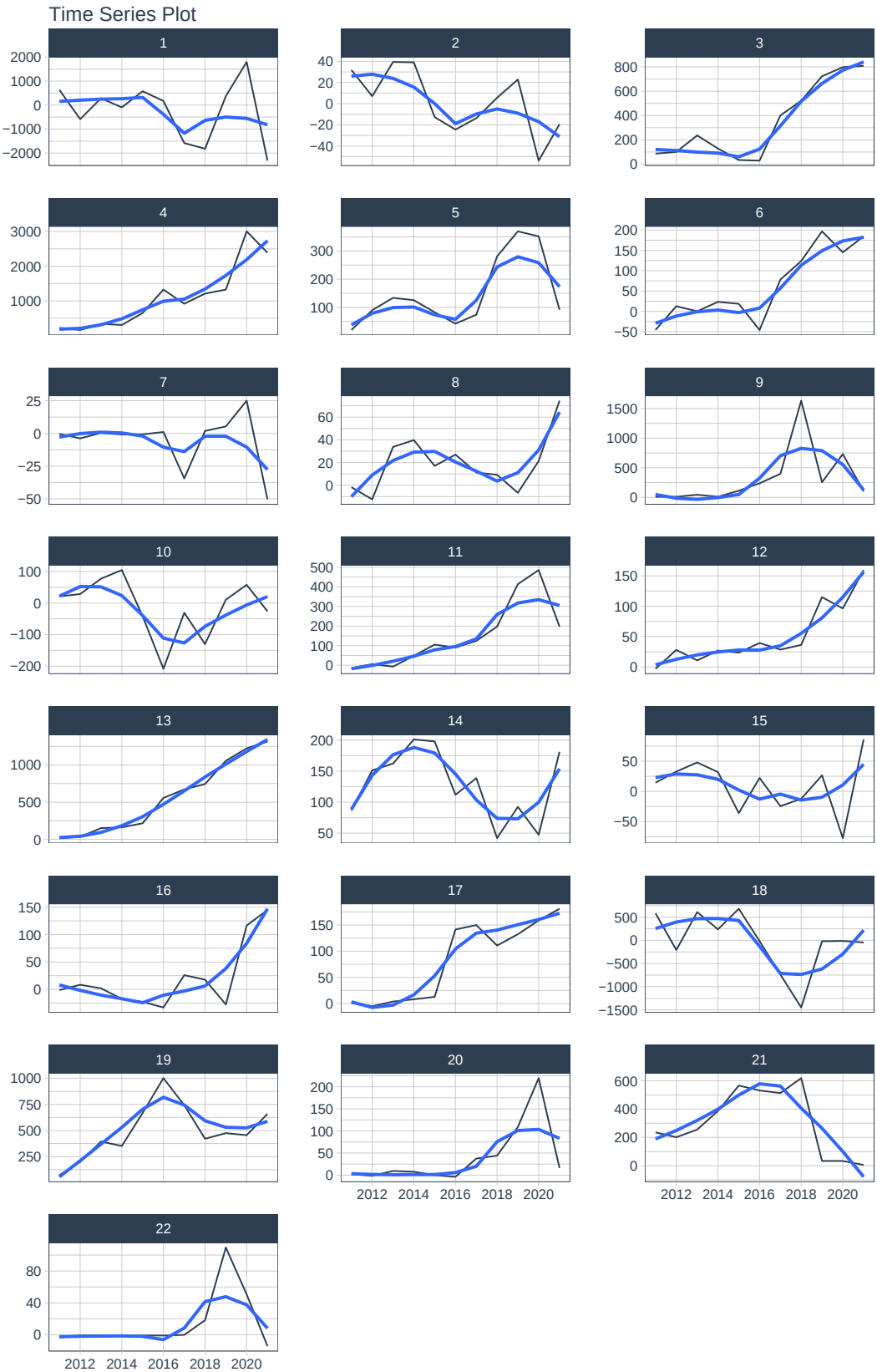

Figure B.1: Policyholder Net Cashflows (2010-2021) Million TL. The black lines show the actual cash flows and the blue lines follow the trend of the time series.

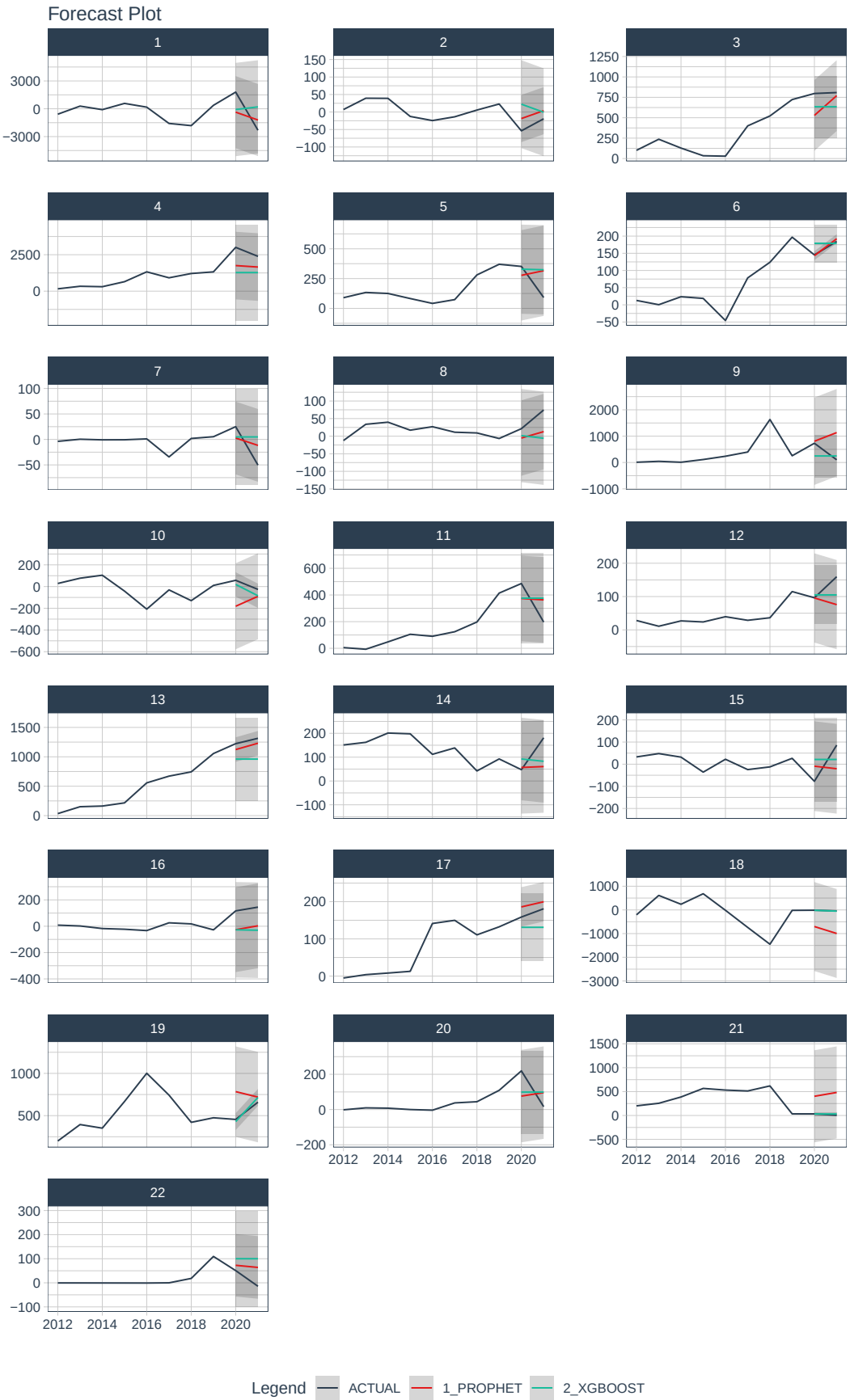

Figure B.2: Test forecasts with prophet and XGboost on Policyholders Net Cashflows Million TL. Black lines are actual cash flows, the light grey shade is 95% confidence interval around the test forecast and the uncertainty interval in this region is bounded by forecast[‘lower’] and forecast[‘upper’] values.

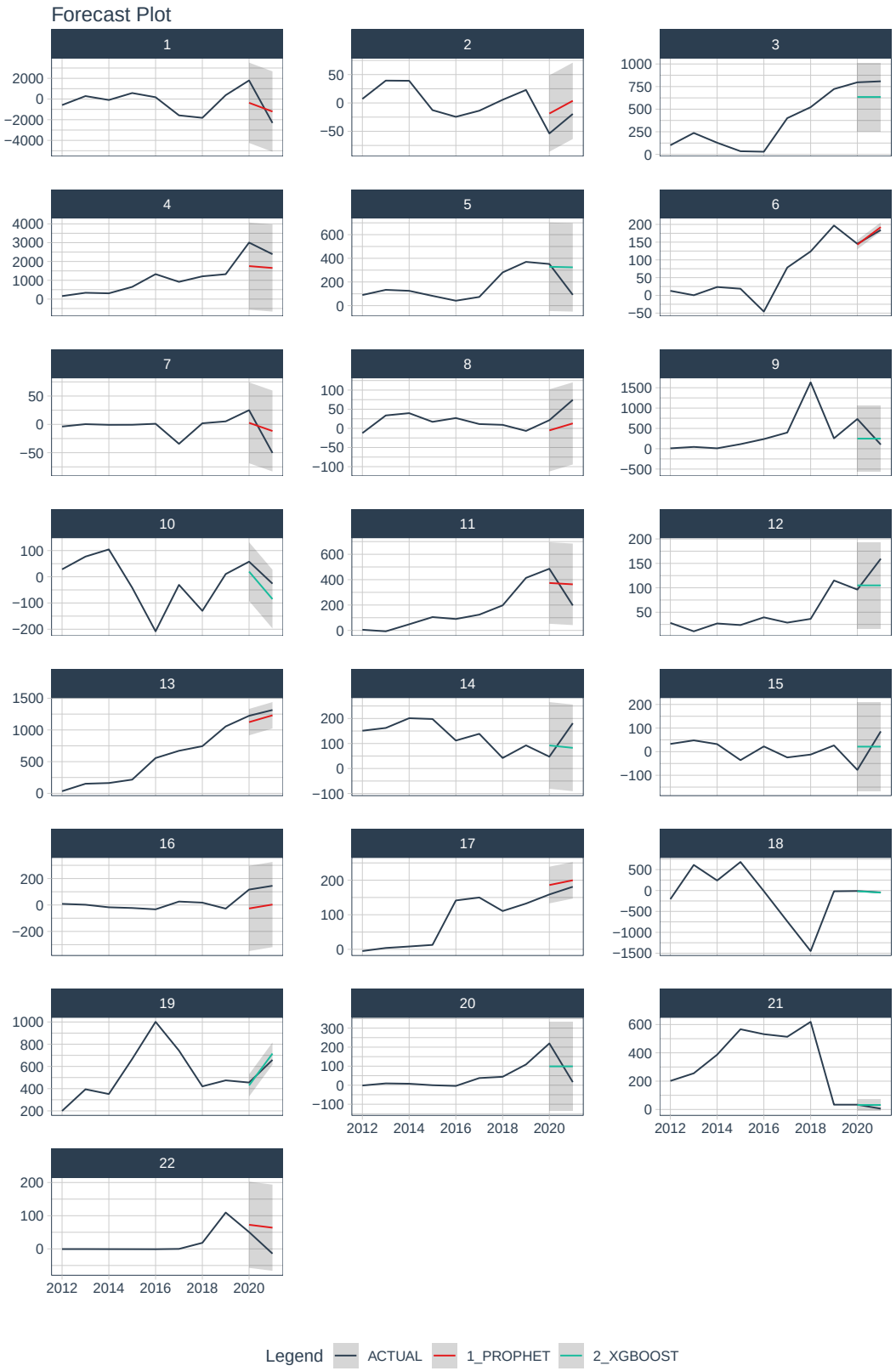

Figure B.3: Best Nested Model on Policyholders Net Cashflows Million TL. The red or green lines represent the test forecasts for the training set, black lines are actual cash flows. The light grey shade is 95% confidence interval around the test forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.

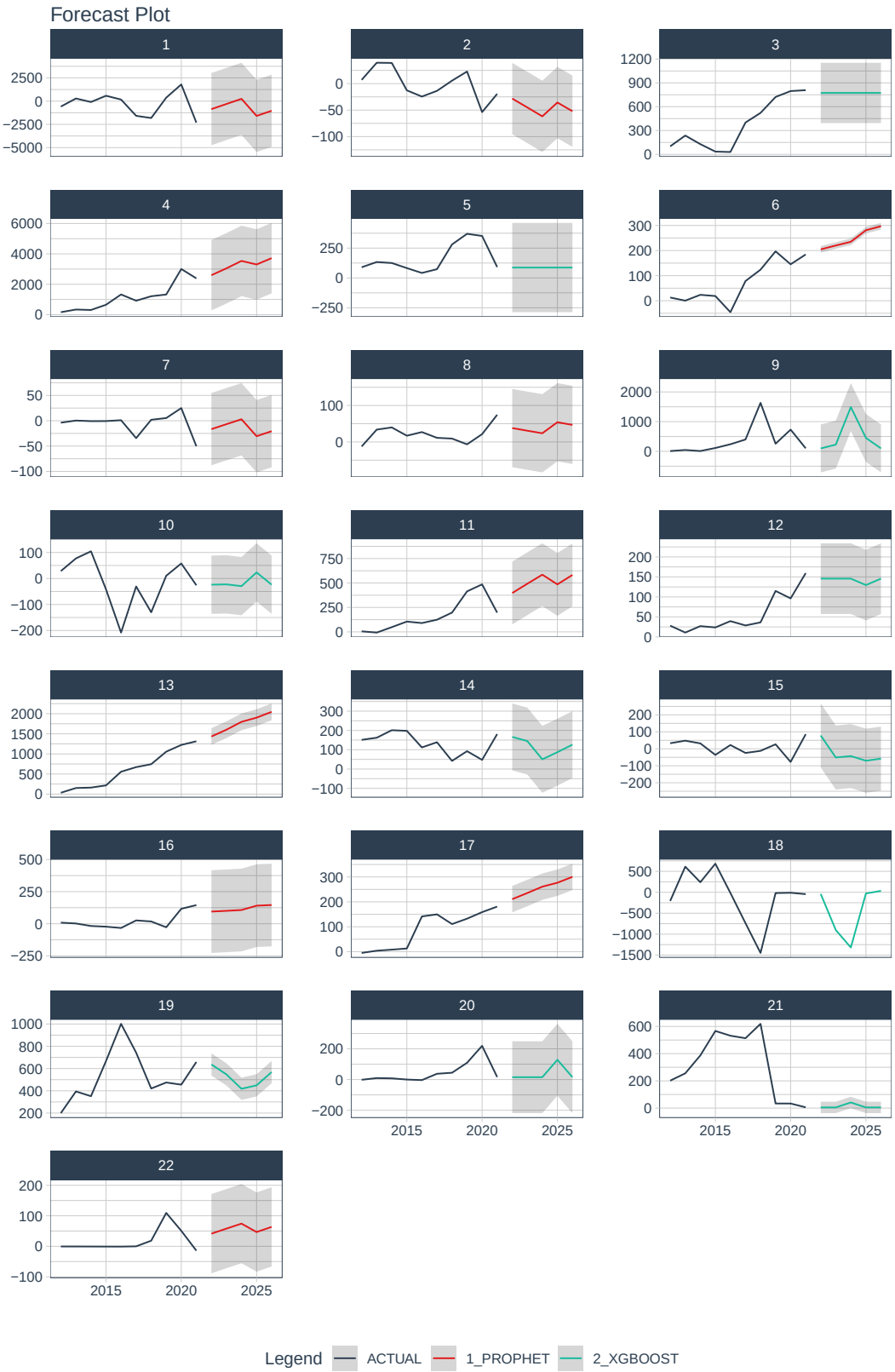

Figure B.4: Five years Future Forecasts for Policyholders Net Cashflow Million TL. The red and green lines represent the future forecasts, black lines are actual cash flows. The light grey shade is 95% confidence interval around the forecast. The uncertainty interval in this region is bounded by forecast['lower'] and forecast['upper'] values.