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Regional Dimension in European Union: Shaping Key Performance Indicators for Financial Institutions

Doctoral Thesis for obtaining the scientific degree
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Abstract

The rise of fintech, or the combination of digital financial services and technology, represents a turning point in the evolution of financial institutions in an ever-changing financial environment. This Thesis explores the operational aspects and regulatory frameworks in the European Union. Fintechs are able to effectively provide services across the EU market due to the modern EU legislation, the passporting mechanism, in particular. These services involve complex cross-border and interregional operations, which are associated with risks and connected to KPIs.

Chapter 1 presents the systematic literature review to determine the lacuna in the issue of KPIs formation for financial institutions. The genesis of fintech is also explored, with specific emphasis on the regional dimensions. The taxonomy of fintech is presented. The region of research application is identified. Special attention is paid to the operations of the European Central Bank (ECB) as a financial regulator in the EU region.

Chapter 2 reviews and analyses the impact of EU regional and national policies on financial institutions. The conditions for the functioning of fintech are compared, highlighting the regional peculiarities. The taxonomy of digital financial products and their representation in different EU regions is presented. The comparative analysis between e-money products and crypto-based assets demonstrates their characteristics and operating environment. The taxonomy and life cycle of digital assets are shown. It also identifies the pricing components for digital and cryptocurrencies.

Chapter 3 determines the KPIs and KRIs for financial institutions. This is done on the basis of the expert panel's estimates. The currently limited use of appropriate KPIS is discussed. In addition, the development of financial services in smart cities is shown and the regional aspect of fintech functioning in smart cities is specified. The opportunities for smart cities to use fintech and financial services as part of the sharing economy are also identified. In this chapter, two statistical models are presented. The PLS-SEM analysis is used to evaluate the relationships between the risks of internal processes and KPIs (Model 1) and the risk of compliance with regional legislation and KPIs (Model 2).

At the end of the study, conclusions are drawn and recommendations formulated.

Keywords: Regional economy, regionalisation, fintech, EU, KPI, risks, financial institutions, digital products

Anotācija

Galveno darbības rādītāju noteikšana finanšu iestādēm atbilstoši Eiropas Savienības reģionālajai dimensijai

Nepārtraukti mainoties finanšu situācijai, *fintech* – digitālo finanšu pakalpojumu un tehnoloģiju apvienojuma – augšupeja iezīmē kritisku posmu finanšu iestāžu pārveidošanā. Šajā promocijas darbā aplūkoti Eiropas Savienības darbības aspekti un tiesiskais regulējums. Mūsdienu ES tiesību akti, jo īpaši pārrobežu darbības atļauju ("passporting") piešķiršanas mehānisms, ļauj *fintech* uzņēmumiem efektīvi sniegt pakalpojumus visā ES tirgū. Savstarpēji apvienojot sarežģītas starpreģionu darbības un pārrobežu pakalpojumus, tie kļūst arvien sarežģītāki reģionālo atšķirību un ar tām saistīto risku dēļ, jo īpaši attiecībā uz galvenajiem darbības rādītājiem (*KPI*).

Promocijas darba 1. nodaļā sniegts sistemātisks literatūras pārskats, lai noteiktu finanšu iestāžu *KPI* atlases nepilnības. Veikta arī *fintech* pirmsākumu izpēte, pašu uzmanību pievēršot reģionālajām dimensijām. Sniegta *fintech* taksonomija, identificēts pētījuma piemērošanas reģions. Īpaša uzmanība pievērsta Eiropas Centrālās bankas (ECB) kā finanšu regulatora darbībai ES reģionā.

2. nodaļā aplūkota un analizēta ES reģionālās un valstu politikas ietekme uz finanšu iestādēm. Salīdzināti *fintech* darbības nosacījumi, akcentējot reģionālās īpatnības. Sniegta digitālo finanšu produktu taksonomija un to izplatība dažādos ES reģionos. E-naudas produktu un kriptoaktīvu salīdzinošajā analīzē atklātas to īpašības un darījumu vide, sniegta digitālo aktīvu taksonomija un dzīves cikls, kā arī identificēti digitālo un kriptovalūtu cenu veidošanas elementi.

3. nodaļā, pamatojoties uz ekspertu grupas aplēsēm, ir noteikti *KPI* un galvenie riska rādītāji (*KRI*) finanšu iestādēm. Apspriesta atbilstošu *KPI* pašlaik ierobežotā izmantošana. Papildus aplūkota finanšu pakalpojumu attīstība viedpilsētās, atspoguļojot *fintech* funkcionēšanas reģionālo aspektu tajās. Apzinātas arī viedpilsētu iespējas izmantot *fintech* un finanšu pakalpojumus kā daļu no koplietošanas ekonomikas. Šajā nodaļā ir izklāstīti divi statistikas modeļi. *PLS-SEM* analīze izmantota, lai novērtētu saistību starp iekšējo procesu riskiem un *KPI* (1. modelis) un atbilstības reģionālajiem tiesību aktiem risku un *KPI* (2. modelis).

Pētījuma noslēgumā izdarīti secinājumi un formulēti ieteikumi.

Atslēgvārdi: reģionālā ekonomika, reģionalizācija, *fintech*, ES, KPI, riski, finanšu institūcijas, digitālie produkti

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Abbreviations used in the Thesis

AI	Artificial Intelligence
AIS	Account Information Service
AML	Anti-Money Laundering
AROPE	Risk of Poverty or Social Exclusion
AVE	Average Variance Extracted
CRR	Capital Requirements Regulation
ECB	European Central Bank
EDP	Excessive Deficit Procedure
EIP	Excessive Imbalance Procedure
EU	European Union
GDP	Growth Domestic Product
GHG emissions	Greenhouse Gas Emissions
ICO	Initial Coin Offer
IDR	In-depth Review
IFRS	International Financial Reporting System
IPO	Initial Public Offering
ICT	Information and Communication Technology
KPI	Key Performance Indicators
KRI	Key Risk Indicators
MIP	Macroeconomic Imbalance Procedure
P2P	Person-to-Person
PIS	Payment Initiation Service
PLS-SEM	Partial Least Squares – Structural Equation Modelling
PSD2	II Payment Service Directive
ROA	Return on Assets
ROE	Return on Equity
RQ	Research Questions
SGP	Stability and Growth Packs
SME	Small and Medium-sized Enterprise
USDT (tether)	One of the most popular stable coins
VIF	Variance Inflation Factor

Introduction

Relevance of the research topic

Industry 4.0 is the shift from conventional approach to manufacturing and industry to a data-driven, technologically advanced one (Vaidya et al., 2018; Ardito et al., 2019; Tupa & Steiner, 2019). Manufacturers can acquire and analyse large amounts of data to improve efficiency and output.

The first three industrial revolutions involved significant changes in production methods. Industry 4.0 represents an additional shift towards a more connected world in which physical objects and digital systems become increasingly interconnected. This allowed the creation of new technologies such as 3D printing, robotics, and artificial intelligence, bringing numerous benefits for businesses and society (Alcácer & Cruz-Machado, 2019; da Silva et al., 2020; Williams, 2021). These changes can result in increased business efficiency and productivity.

The development of fintech as a business model for the financial institutions is one of the most significant changes that Industry 4.0 is bringing about (Fülöp et al., 2022). Fintech is an umbrella term for financial technology and it covers various technological innovations in the financial services industry, represented by the financial market players with different business models and regulation from the government, for example, mobile payments, online banking, and cryptocurrencies. The emergence of fintech has significant impact on the traditional financial institutions represented by banks, electronic money institutions and payment institutions. Financial institutions are increasing their competition with fintech. This is due to the fact that fintech can provide their services more efficiently and affordably than banks (Phan et al., 2020). Additionally, they can provide innovative products and services. Consequently, many institutions struggle to keep up with the rate of change in the era of Industry 4.0. The emergence of financial institutions is also causing a significant transformation in the delivery of financial services since they use various technologies to provide their services.

Adoption of the fintech business model allows the financial institutions to operate not only in the countries where they are registered, but also in other countries of the EU (Barroso & Laborda, 2022). These institutions always encounter a variety of regional economic conditions when they expand outside of their home markets. This diversity in regional economies can significantly influence the flexibility and responsiveness of fintech. Differences in regulation, financial literacy and consumer preferences across regions require adaptation of specific strategies.

Moreover, the economic factors associated with each region not only create the additional difficulties, but also serve as a rich source of knowledge. Unique economic

characteristics allow financial institutions to tailor their operations to local needs. Therefore, a successful fintech operating in EU member states requires deeper comprehension of and adaptation to the unique economic conditions of the target market. The European Commission, in collaboration with market participants, has issued the Guidelines for Financial Data Governance to further develop the cross-border operations of the financial institutions (Arner et al., 2022).

The driving force behind the financial data governance and technology in financial institutions is digitalisation. Digitalisation uses technology to change the internal operations of financial institutions, for example by automating tasks and using data more efficiently (European Commission, 2014; Spence, 2021; Verhoef et al., 2021). The advantages of digitalisation are evident. By increasing their efficacy and precision, financial institutions can reduce expenses and increase customer service and making better decisions. Digitalisation can help financial institutions stay ahead of the curve in an increasingly competitive environment. Nevertheless, these changes can be challenging for financial institutions and require time and resources to implement new technologies properly. It is also understandable that many organisations avoid the risk of changing their fundamental processes and systems. However, the situation is changing. Traditional financial institutions are under increasing pressure to stay competitive and adopt new cutting-edge technologies. A growing number of companies modernise their operations and this is becoming the driving trend in the sector.

With the revised Payment Services Directive (PSD2) fintechs receive the possibility of passporting and new opportunities in the regional economy. The concept of passporting allows financial institutions authorised in one EU member state to operate and offer services in other EU member states without additional licenses. They can provide services directly or open a branch or agent in another member state. It facilitates an integrated payment market, promotes equal conditions for competition, ensures high level of consumer protection and secure functioning of payment services across the EU. Furthermore, it encourages fintech and payment service providers to innovate and expand their operations across borders, contributing to the development of a single market for digital financial services (Grabowski, 2021).

There is a deep and complex relationship between passporting (registering the activity of financial institutions in a member states outside of their home country) and the local economy. Financial institutions can freely cooperate in provision of financial services throughout the EU. This increases the potential for regional economic development by promoting cross-border investment and improving financial inclusivity. In addition, the free movement of financial services among different regions promotes innovation and competition and can reduce costs for consumers. However, it also means that regional economies have to

manage the associated risks and monitor foreign service providers and their compliance with local and EU regulatory standards. The fundamental idea behind passporting is to create a complicated web of connections between financial service providers in the EU. This web has a direct impact on the regulatory environments, consumer experiences, and economic activity both inside and between the national economies.

Kerstin af Jochnick, Member of the Supervisory Board of the European Central Bank (ECB) emphasises the transformative potential of technology in the banking industry and highlights the changing risks for banks. As banks adopt digital business models, the importance of ICT systems becomes crucial, but it also increases the operational and cyber risks. Therefore, both banks and supervisors need to be prepared for these changes (Kerstin af Jochnick, 2020).

Customer trust is vital to the functioning of industry, so protecting customer data and all ICT infrastructure is of paramount importance. To ensure the stability of ICT systems and to minimise the risk of cyberattacks, financial market players must implement adequate security procedures at all levels. Regulatory and supervisory authorities monitor how financial institutions manage these risks. They are responsible for pointing out areas where financial market participants may be weak and for encouraging them to improve their deficiencies. This collaborative effort between financial institutions, regulators, and supervisors is essential to maintain a secure and trustworthy banking environment (Kerstin af Jochnick, 2020).

A financial institution encounters many challenges. Businesses must be online 24 hours a day, seven days a week to meet consumer expectations. This is a challenge for many fintechs because they lack the infrastructure and resources of traditional financial institutions (Bömer, 2020). Then, a financial institution must integrate in the existing payment systems to receive customer payments. This can be difficult because many of these systems are not intended for modern digital payments, or they are unwilling to collaborate with fintech (Uña et al., 2023). Regional economy adds additional dimension to this task, since different regions have different peculiarities in payments, and therefore in some regions integration in the local payment systems is necessary. Thirdly, cybersecurity is a significant concern for all businesses, but particularly for financial institutions that deal with sensitive customer information (Kerstin af Jochnick, 2020). Finally, anti-money laundering (AML) compliance is a serious challenge for a financial institution. Due to the nature of their business, fintechs are frequently required to follow stricter AML regulations than conventional financial institutions (Rupeika-Apoga & Wendt, 2022).

The ECB emphasises the importance of the successful resolution of the above-mentioned challenges.

Fintechs have a major impact on the banking sector, and the regulatory agencies such as the ECB Banking Supervision monitor the industry changes on a regular basis. Since 2015, ECB Banking Supervision has carried out thematic evaluations of banks' ICT infrastructure. In 2020, the identification of ICT and cyber risks was the top supervisory priorities. Studies revealed that a large number of banks continue to perform essential operations using outdated systems, and that some of them do not even include ICT risk in their overall risk management frameworks (Kerstin af Jochnick, 2020).

Referring to the AML issue, the technological progress not only introduces new risks but also presents opportunities for banking improvements. New technologies allow banks to reduce costs significantly, enabling them to allocate more resources towards long-term strategic objectives. With more realistic assumptions and accurate projections, banks can make better-informed decisions on risk-taking. Moreover, technology improves risk management through improved data aggregation capabilities. Technology has the greatest importance for fight against anti-money laundering (AML) and financing the terrorism. Artificial intelligence-based tools improve fraud detection practices, identify connections between related entities and so on, increasing the efficiency of measures for banks (Kerstin af Jochnick, 2020).

The challenges and possibilities of industry 4.0 in the financial market demand proper internal governance. Elderson (2022), member of the Executive Board of ECB, said – "good governance – its scope, what it looks like, and how the ECB goes about supervising it". Elderson develops the idea of good governance - the primary importance of a strong governance lies in providing essential checks in a bank. It serves to prevent excessive risk-taking and ensures sustainable decisions. Access to timely and accurate data is crucial for well-informed decision-making. Moreover, the management bodies of banks, both in their managerial and supervisory roles, also play a vital role in the bank's governance, performance, and sustainability (Elderson, 2022).

Despite the fact that banks were mentioned, the same approach is true for other financial market players, including financial institution. The ECB as regulator demands good financial institution governance. The metrics, which allow measuring the results of the financial institution governance represented by different internal processes are usually called Key Performance Indicators (KPIs).

The proper selection of KPIs is essential for all financial market players including financial institution. They use KPIs to measure and to monitor their progress. The ECB, within their supervision newsletter, identifies the certain issues with KPIs within the banking sector. KPIs are often unclear and lack transparency, with a great focus on financial performance rather than risk, control, and cultural aspects. This imbalance extends to employees in internal control

and chief risk officers as well (European Central Bank, 2023) (Detailed information is presented in Annex 1).

Regulators claim that there are some inconsistencies in how the KPIs relate to the amount of risk that is tolerated in organisations. Concerns exist regarding the introduction of sanctions for misconduct or irrational risk-taking. There is necessity of strengthening the links between KPIs and risk management procedures in order to guarantee efficient governance and risk management across a range of financial institution. The ECB highlights the need for these areas to be improved and requests supervisory attention to address these deficiencies (European Central Bank, 2023).

Risk value metrics are Key Risk Indicators (KRIs). Beside the regulatory requirements for risk management, KRIs give additional measures based on the objective events classification per risk parameters. Selecting appropriate KRIs measures involves a serious analytical process across multiple domains including technology platforms used by the company and its operational processes unique to each industry – this involves creating decision-making procedure, which integrates internal strengths/weaknesses versus external opportunities/threats (Rastogi et al., 2022).

The ECB emphasises the necessity to develop the new approach to KPIs selection in relation to KRIs, not only indicators of financial success.

Level of scientific development of the problem

Scholars all over the world study the issue of KPIs and their usage in the financial sphere. However, the level of scientific development of the problem still exists. Such prominent scientists as C. Kruger, J. Boyer, E. Fama and others have reached important results in examining KPIs, but the issue of the KPIs and KRIs interconnection, as well as the impact of regional trends still require exploration. The contribution of Latvian scholars, such as V. Dombrovskis, H. Skadina, and R. Rupeika-Apoga, is also significant, especially in the process of selecting KPIs.

The scientific publications mainly focus on a limited set of traditional KPIs. Nevertheless, such an approach can ignore other vital factors impacting performance. Financial institutions are very different by their activities, and they cannot have a one-size-fits-all set of KPIs due to their unique operations and objectives. Therefore, it is very important to develop the unified approach to selecting KPI, which could allow the individual financial institutions to tailor and adjust the specific KPIs to their performance taking into account existing risks and regional trends.

Aim of the Doctoral Thesis

The aim of the doctoral research is to develop the Key Performance Indicators based on Key Risk Indicators for financial institutions in the EU regional dimension.

Tasks of the Doctoral Thesis

1. To analyse the scientific publications on the selection of KPIs for financial institutions and to identify the research gaps and determine the approach to fintech and digital products assessment, taking into account the role of the European regulatory authorities in the operations of financial institutions as issuers of digital financial products.
2. To determine and analyse the impact of the EU regional dimension and regional economic trends on operations financial institutions as well as an assessment the sharing of financial services in smart cities in the EU.
3. To analyse the opportunity to use the traditional KPIs together with risk-based KPIs for estimating the performance on the spot.
4. To evaluate the criteria for selection of risk indicators considering digitalisation and regionalisation trends in the EU.
5. To construct and validate the statistical models for internal and compliance-related processes of the financial institutions for analysis of the interconnections of the KPIs and KRIs.
6. To suggest recommendations for selecting risk-based KPIs on the basis of the offered statistical models..

Object of the Doctoral Thesis

Financial institutions and their operations in the EU regional dimension.

Subject of the Doctoral Thesis

Formation of the Key Performance Indicators of financial institutions within the EU regional dimension on the basis of Key Risk Indicators.

Hypothesis of the Doctoral Thesis

1. The EU financial institutions can set up the Key Performance Indicators on the basis of the Key Risk Indicators for their financial governance.
2. The same set of KPIs is suitable for the financial governance of the EU financial institutions of different types.

Theses for the defence

1. Financial institutions should apply KPIs based on risks in addition to traditional KPIs.

2. The EU regional policy has an impact on national regulations and, accordingly, the risk structure of financial institutions operating in the EU.
3. The EU financial institutions of different types can use the same set of KPIs based on risks.

Research Questions

1. Does the comprehensive approach to selecting the proper KPIs in the financial sector exist in the EU?
2. Does the EU provide homogenous conditions for fintech as a form of a financial institution development across all countries considering economic policies implications, regulations, supervision, legislation?
3. Do the traditional KPIs cover all the requirements of the contemporary fintech company?
4. Does the suggested new approach to digital product within EU regional context affect the risk environment of a fintech company?
5. Does sharing economy create additional compliance and regulatory risks for the fintech company?
6. Do KRIs of the financial institution determine KPIs related to financial governance?

Research methods, data collection tools, and techniques

The analysis of primary and secondary data and the Delphi method were used for selecting risk indicators; the monographic method was applied to review the scientific publications and documents related to regional policies and normative regulatory acts; the qualitative and quantitative analyses were applied to risks assessment and development of classifications, taxonomies and algorithms; the case study method was employed for comparing the regulatory environment in different EU countries; the Cost-benefit analysis and the total cost of ownership methods were used to develop the cost functions; the Partial Least Squares – Structural Equation Modelling (PLS-SEM) method was employed for constructing and estimating the statistical models; the quality of the statistical models was assessed via item reliability, convergent validity, discriminant validity, coefficient of determination, standardised path coefficients, effect size, variance inflation factor (VIF), fit measures. The PLS-SEM analysis was carried out using SmartPLS software.

Research limitations

1. The study is based on operations of fintech as a form of financial institutions. Other forms of financial institutions were considered only in the theoretical part of the Thesis.
2. Limited representation of financial institution operating in businesses: the research is based on the data related to financial fintech, payment fintech and asset management fintech.

However, the findings might not fully cover the financial and capital adequacy risks faced by other types of financial institution.

3. Construct of the statistical model: The generated model is constrained by the factors included into its construction. The inclusion of other factors might result in different functional dependencies. Additionally, alternative methods of data analysis might potentially present different result.
4. Sample: The author assumes the sample to be representative; the model is built on the values of 217 threats and 78 vulnerabilities. In total, 2950 indicators for different financial institutions are considered. However, the results may not be fully representative for the entire population of financial institutions.
5. Used risk categories: The statistical models are constructed on the risk categories associated with internal and external processes, defined by the experts in the process of Delphi survey.
6. The study deals with the specific form of financial institutions commonly called fintech.

Scientific novelty of the Thesis

1. A new way to assess the EU financial institutions' KPIs with a regional focus is offered. The study shows the need for financial institutions to use risk-based KPIs in addition to the traditional ones.
2. A classification of fintech and the segmentation of digital products were developed. They allow revealing the related risk factors.
3. The taxonomy of digital products was developed for connecting the production of various digital products.
4. The classification of electronic money and crypto assets and taxonomy of money by law, as well as the algorithm for token classification was developed.
5. The pricing strategies for the digital products were offered. The risks inherent in the price formation methods were identified and analysed.
6. The factors of regional dimension which affect the fintech operations were identified. It is shown that the traditional resource theories are not applicable for the operations with digital products.
7. The new approach to the life-cycle and stages of production of the digital assets in the EU was developed. It is proven that digital assets production should be reflected in inventories but not in capital section in financial reporting, which contradicts the numerous scientific publications but supported by the approach of IFRS.

8. The comprehensive approach to the assessment of the inherent risk by determining the average likelihood and impact associated with each combination of threats and vulnerabilities contributing to the specific risk was developed.
9. The function of costs distribution between financial institutions and smart city administration for implementing of shared financial services was developed. The specific compliance and regulatory risks, based on market volatility, were defined.
10. The new approach to the selection of KPIs for financial institutions on the basis of risk indicators was proven by the statistical models.

Practical significance

1. The usage of traditional KPIs together with risk-based KPIs allows estimating the performance on the spot, which improves the decision-making process, covers the modern needs in risk control, facilitates the development of risk strategies for the EU financial institutions.
2. The developed classification of fintech types and generated digital products segmentation can be used by financial institutions for choosing those digital products, which fully match their functionality, as well as for decreasing compliance related risks.
3. The developed taxonomy of digital products allows connecting the production of various digital products and facilitating the activities of financial institutions.
4. The offered crypto assets and money by law taxonomies, classification of electronic money and algorithm for token classification can be used by the financial institutions for digital assets' issuance for decreasing the compliance-related risks for the financial institutions.
5. The developed characteristics of the EU regional fintech trends can provide the financial institutions with safe and well-controlled digital production. Moreover, these characteristics may provide benefits to other industries, working in the area of digital production.
6. The analysis of the EU regional trends and regulations relevant to the operations of financial institutions enables these institutions to select a jurisdiction that suits their digital production and distribution needs.
7. The offered KPI selection approach allows financial institutions to manage the operations more effectively.
8. It is proven that the digital assets production should be reflected in inventories but not in capital section in financial reporting. It allows improving the financial statements of financial institutions and decreasing the compliance-related risk.
9. The costs analysis and costs distribution functions can be used by smart cities for the development of financial services sharing.

10. The developed statistical models allow financial institutions to delegate the IT solutions to specialised businesses and to monitor the implementation of these operations with controlled risks.
11. The proposed approach to KPIs selection can be used by supervising authorities at the EU and national levels to monitor efficiently the internal and compliance-related processes of financial institutions considering the risk issue; it can be used by governance of financial institutions and by scholars for development of similar models in relation with specific risks, actual for each financial institution.
12. The EU and national supervising authorities can use the results of this study for assisting the financial institutions in the process of selecting the KPIs..

Evaluation of the research results

The author has widely disseminated the principal findings of the research and presented them to the stakeholders:

- 8 publications in the scientific journals indexed in Scopus and Web of Science, and 5 of them are in journals included in Q1;
- 12 international scientific conferences and symposia, including 3 presentations at the Plenary Sessions;
- lectures and seminars in financial institutions and associations;
- presentation of the research results related to financial institutions regulation to the Bank of Latvia as national representative of the ECB;
- presentation of the research results to the *Association of Financial Institutions of the Czech Republic*;
- presentation of the research results to the financial institution in Malta.

Recognition of the value of the Thesis by:

- Correspondence to the challenges stated by the ECB: in the Newsletter (Annex 1) the ECB emphasizes the necessity of the banks to improve the KPIs basis for estimating the banks performance and forestalls that it will assess the banks' progress in improving risk culture through peer benchmarking, sharing good practices and ongoing industry dialogue.
- Bank of Latvia has recognised the relevance of the Thesis, and emphasized that the developed techniques can serve as a knowledge basis for policy making to increase the efficiency of supervision, and has practical applicability for supporting integrity and sustainable development of local fintech sector (Annex 3).

- *Association of Financial Institutions of the Czech Republic* estimates the Thesis as relevant and potential and will be offered to the companies-members of the Association for practical implementation for more transparent, efficient, risk-aware financial management (Annex 2).
- Financial Institution in Malta notes the topicality of the study and the Board of Directors has taken a decision to start implementing some of the findings in practice (Annex 4).

Structure of the Doctoral Thesis

The Doctoral Thesis includes abstracts in English and Latvian, the list of abbreviations, introduction, three chapters, conclusions and recommendations, bibliography, and 11 annexes. The volume of the Thesis is 170 pages including the References, which comprise 316 sources. The List of author's publications consists of 8 publications in the scientific journals indexed in Scopus and WoS, and 5 of them are in journals included in Q1.

Introduction demonstrates the relevance and topicality of the theme of the Thesis, formulates the goal of the Thesis, determines object and subject, identified the research questions and hypotheses. There also evaluated the scientific novelty and practical importance of the research.

Chapter 1 presents the systematic literature review to determine the lacuna in the issue of KPIs formation for financial institutions. There also done the genesis of fintech with specific emphasis on the regional dimensions. The taxonomy of fintech is presented. The taxonomy of digital financial products and their representation in different EU regions. The comparative analysis between e-money products and crypto-based assets demonstrates their characteristics and operational environment. The taxonomy and life cycle of digital assets are shown. There also identified the pricing components for digital and cryptocurrencies.

Chapter 2 reviews the regional aspects of the markets of financial products and analyses the impact of regional and national policies of the EU on financial institutions. The conditions for fintech functioning are compared. The regional peculiarities are demonstrated. The special attention is paid to the operations of the ECB as a financial regulator in the EU region. The specific conditions of fintech operations in different EU member states are analysed on the basis of case studies of in-depth review reports.

Chapter 3 shows the development of financial services in smart city and specified the regional aspect of fintech functioning in smart city. There also determined the opportunities for smart city to use fintech and financial services as part of sharing economy. The procedure of determining the KPIs and KRIs for financial institutions is presented. It is done on the basis of estimations of the board of experts. The limited use of proper KPIs is discussed. Two statistical models are presented in this chapter. The PLS-SEM analysis is employed for evaluation the

relationships between risks of internal processes and KPIs (Model 1) and risk of compliance with regional legislation and KPIs (Model 2).

Conclusions summarise the research results.

Recommendations on adaptation of the offered approach to KPIs selection on the basis of risk indicators are done for financial institutions, for European regulatory bodies (the ECB, the European Commission and supervisors) and for national regulatory bodies (National central banks and national regulators). The recommendation relates only to the function of supervision of financial institutions. This function is implemented by all the above-mentioned bodies, and the recommendations were developed to all of them as supervisors. There also developed the recommendations for smart city authorities on the development and adoption of the shared financial services in smart city.

1 Theoretical Aspects of Selecting KPIs for Financial Institutions

The elaboration of the theoretical basis for this dissertation comprised several stages. The primary step was to define whether the requirements of the necessity to base the KPIs of financial institutions on risk indicators have the solid scientific fundamentals.

The second stage was developing the genesis of fintech as a form of financial institutions used for the development of new approach towards the KPIs based on KRIs.

All other stages of theoretical investigation are connected with digital products: defining the digital products, taxonomy and life cycle of crypto assets and pricing strategies of digital currencies and cryptocurrencies.

1.1 KPIs selection for financial institutions in the EU

The ECB has criticised the current state of fintech governance, particularly regarding KPIs, for its lack of connection with the inherent risks. The ECB emphasises the necessity of developing a clear and transparent methodology for selecting KPIs that directly correlate with the risks posed by fintech activities. Financial management linked to two primary risk categories: Financial risk and Capital adequacy risk (Elderson, 2022; Brigham & Ehrhardt, 2005; Schmid *et al*, 2011; Delkhosh & Mousavi, 2016; Ksyonzhik *et al.*, 2020; Bao, 2022; Zhang, 2022). It is vital for fintech companies to understand and manage these risks effectively to ensure their stability, compliance, and overall resilience. By establishing a risk-related metrics framework, fintech companies can improve both their governance practices and decision-making process.

KPIs allow the fintech companies to measure their performance and progress toward achieving their business goals. However, choosing the right KPIs can be challenging because many metrics are available. The researcher analysed whether the scientific articles cover the area of KPIs for financial institutions, whether these articles develop factors influencing the choice of KPIs by financial institutions, and whether the classification of KPIs for financial institutions exists. The purpose of this study is to analyse the literature to develop a taxonomy of KPI selection areas for fintech issues.

Industry 4.0 is the term used to describe the fourth industrial revolution (Vaidya *et al.*, 2018; Ardito *et al.*, 2019; da Silva *et al.*, 2019; Tupa & Steiner, 2019; da Silva *et al.*, 2020). This is transit from traditional manufacturing and industry to a more technologically advanced, data-driven approach (Horváth & Szabó, 2019; Williams, 2021), creation of more efficient business models and value propositions (Alcácer & Cruz-Machado, 2019; Vaidya *et al.*, 2018; da Silva *et al.*, 2019; Tupa & Steiner, 2019). The first three industrial revolutions considered major changes in production methods, starting with the use of water and steam power in the

first revolution, followed by electricity and mass production in the second, and then computerisation and automation in the third one. Industry 4.0 represents a further shift when physical objects are becoming increasingly interconnected with each other and with digital systems (Alcácer & Cruz-Machado, 2019; da Silva *et al.*, 2020). This has enabled the development of new technologies such as 3D printing, robotics, and artificial intelligence (AI). Society can gain through improved living standards due to better access to education and healthcare, among other things (Qin *et al.*, 2016; Alcácer & Cruz-Machado, 2019; Suleiman *et al.*, 2022). However, there are also some risks associated with Industry 4.0 that need to be considered. One of these is data privacy and security (Ruan, 2019); with so much data being collected and stored, there is a greater risk of it being leaked or hacked into.

One of the most important changes that Industry 4.0 is bringing about is the rise of fintech (Fülöp *et al.*, 2022). Fintech is a term used to describe financial technology (Still *et al.*, 2019; Allen *et al.*, 2021; Barroso & Laborda, 2022; Bhat *et al.*, 2023). It covers various technological innovations for financial services. This includes things like mobile payments, online banking, and cryptocurrencies. The rise of fintech has had a major impact on traditional financial institutions such as banks. Banks are facing increased competition from fintech companies in terms of price and efficiency (Armstrong, 2016; Dhar & Stein, 2016; Still *et al.*, 2019; Khan & Malaika, 2021). They can also offer innovative products and services that banks cannot match. As a result, many banks are struggling to keep up with the pace of change in the industry 4.0 era (Hon & Millard, 2018; Nobanee *et al.*, 2021; *Why RegTech is Becoming More and More Important for Compliance in Banks*, 2021; Cheng *et al.*, 2022). The rise of fintech is also leading to a major transformation in how financial services are delivered, for example, mobile payments (European Commission, 2017). Digitalisation is an urgent topic in the financial industry (Mentsiev *et al.*, 2019; Barroso & Laborda, 2022; Kasri *et al.*, 2022; Cernisevs & Popova, 2023; Popova & Cernisevs, 2023). Institutions are looking to fintech for answers on how to modernise their operations. The first question is: What is digitalisation?

At its core, digitalisation uses technology to change how financial institutions operate internally. This can be done in a number of ways, from automating tasks to using data more effectively (Spence, 2021; Verhoef *et al.*, 2021; Barroso & Laborda, 2022). By improving efficiency and accuracy, financial institutions can reduce costs and improve customer service, and make better decisions by providing solutions that would otherwise be unavailable. Perhaps most importantly, though, digitalisation can help financial institutions be highly competitive (Ertz & Boily, 2019; Kitsios *et al.*, 2021). However, the change to digitalisation can be difficult; it takes time and resources to implement new technologies properly. Additionally, many organisations are understandably risk-averse when it comes to making changes to their critical

systems and processes. However, more and more organisations modernise their operations (Romero *et al.*, 2019; Alvarenga *et al.*, 2020; Verhoef *et al.*, 2021).

In recent years, there has been a growing trend of financial institutions turning to digital solutions to solve various problems in innovative and cost-effective way (Barroso & Laborda, 2022; Kitsios *et al.*, 2021). However, there are still some challenges that need to be addressed for fintech to become a truly viable solution for all financial institutions. One of the biggest challenges financial institutions faces is the lack of standardisation across different platforms (Nelson & Shaw, 2003; Smart & Creelman, 2013). This makes it difficult for organisations to compare and contrast different solutions and ultimately choose the best one for their needs. There is also a lack of understanding among many decision-makers about how fintech works and what potential benefits it can offer. Therefore, more training is required inside the industry. Another challenge is the issue of security. While fintech solutions are often more secure than traditional methods, there have been instances where data breaches have occurred. This highlights the need for improved security protocols and measures to be put in place to protect both financial institutions and their customers (Amundrud *et al.*, 2017; Hon & Millard, 2018; Varga *et al.*, 2021). Ultimately, fintech digitalisation offers many potential benefits for financial institutions. However, these benefits can only come in practice if the challenges faced by these organisations are addressed properly (Dospinescu *et al.*, 2021; Popova, 2021; Barroso & Laborda, 2022; Fülöp *et al.*, 2022; Murinde *et al.*, 2022).

Financial institutions have been struggling to keep up with the pace of digitalisation while fintech adopts quickly the new technologies and provides innovative solutions to customers. However, fintech faces several challenges when it comes to digitalisation:

First and foremost, businesses need to be online 24x7 to meet customer expectations. This is a challenge for many fintech as they do not have the same resources or infrastructure as traditional financial institutions (Popova & Cernisevs, 2023).

Secondly, fintech must integrate into existing payment systems to accept customer payments. This can be a challenge as many of these systems are outdated and not designed for modern digital payments or would not like to cooperate with fintech's (Darolles, 2016).

Thirdly, cybersecurity is a major concern for all businesses, but especially for fintech who are handling sensitive customer data and must provide compliance with all relevant regulations (Scarlat *et al.*, 2011; Ruan, 2019; Khan & Malaika, 2021).

Finally, AML compliance is another challenge for fintech. Due to the nature of their business, fintech is often required to comply with more stringent AML requirements than traditional financial institutions (Al-Suwaidi & Nobanee, 2020; Faccia *et al.*, 2020).

Digitalisation has changed the business landscape, and to remain competitive, fintech must respond quickly and effectively to events; this requires the strong system of measurements to make informed decisions. With the right KPIs, businesses can measure their performance against others in the industry and make the necessary adjustments. This data is also very useful for identifying trends so that the company can anticipate future needs. Accurate measurements are essential for responding to events quickly and effectively. Fintech is one area where this is especially critical, but it is important to consider all aspects of the business when making decisions about digitalisation.

The appropriate selection of KPIs is important for any organisation, but especially for companies in the fintech sector. Fintech firms often rely on KPIs to measure their success and to track their progress. There are a few different factors to consider when selecting KPIs (Maté *et al.*, 2014; Siedler *et al.*, 2020).

Firstly, a business needs to consider the indicators for measurement, the company's goals and objectives, and the areas for improvement or changes. Once the company realises these issues, it can identify which KPIs are most relevant. Another important consideration is the available data. Not all companies have access to the same data, so it is important to choose KPIs that can be measured with disposable data. It is also worth considering whether the company can access more accurate data for certain KPIs through external sources. Finally, the company should consider the user and the purpose of KPIs utilisation. Different people within the organisation are interested in different aspects of the business, so it's important to choose KPIs that everyone can understand and use effectively.

Methodology of literature review

The study is devoted to analysing literature to create the taxonomy of areas of KPI selection for the fintech issues. The researcher assumes this area to be insufficiently covered by scholars in scientific literature. To confirm or reject this assumption, the following Research Questions (RQ) were set:

RQ1. The area of KPIs for financial institutions is well covered by the scientific articles indexed in Scopus and WoS databases

RQ2. The factors influencing the choice of KPIs for the financial institution are described in scientific articles.

RQ3. The classification of KPIs for financial institutions exists, and it is applicable for practical use for financial institutions.

The methodology of this research is described by such scholars as (Wee & Banister, 2016; Majuri *et al.*, 2018; Pavlyuk, 2019; Popova, 2020).

The preliminary stage comprises plan elaboration, determining the aim and objectives of the research, research questions, and the stages of the research. One of the most important operations for this study is creating the list of keywords. The next important operation is the choice of criteria for inclusion and exclusion of the scientific studies for consideration. After setting the RQ, the following keywords were determined: “fintech” OR “Financial institutions” AND “KPIs OR “metrics”. The query was applied to the titles and abstracts of the publications. The query to the databases took place from September 2022 – January 2023 for the period 2006 - January 2023. The period of study is 2006–2023. No articles published before the year 2006 were found in the databases. There were also specified inclusion and exclusion criteria. The inclusion criteria are articles in English in journals indexed in Scopus and WoS and available in full text. The articles not corresponding to these criteria are excluded from the study.

As a result, 590 articles were found corresponding to the inclusion criteria. At the next stage, 122 publications were excluded from the study in case of duplication, non-availability, or incompliance. The abstracts of the selected articles (No 468) were screened, and 347 articles were assumed to be irrelevant to the research topic, and correspondently, they were excluded from further analysis. The left 121 articles were subjected to full-text reading, and as a result, 112 articles were excluded as irrelevant to the study. Only 9 articles were left for detailed analysis. After snowballing, other 7 articles were added to the research. As a result, qualitative analysis was applied to these 16 selected articles. Next, after determining the parameters of the study, the analysis starts. The procedure is shown in Figure 1.1.

Further, qualitative analysis was applied. The area of study to which the selected articles belong was specified. Reading the selected articles in detail occurred in the third stage of analysis. At this stage, the researcher analyses the degree of topic elaboration in the scientific literature. This analysis allows the detection of the areas where the research does not cover the problem; this fact permits the researcher to concentrate on the specific study area in his work.

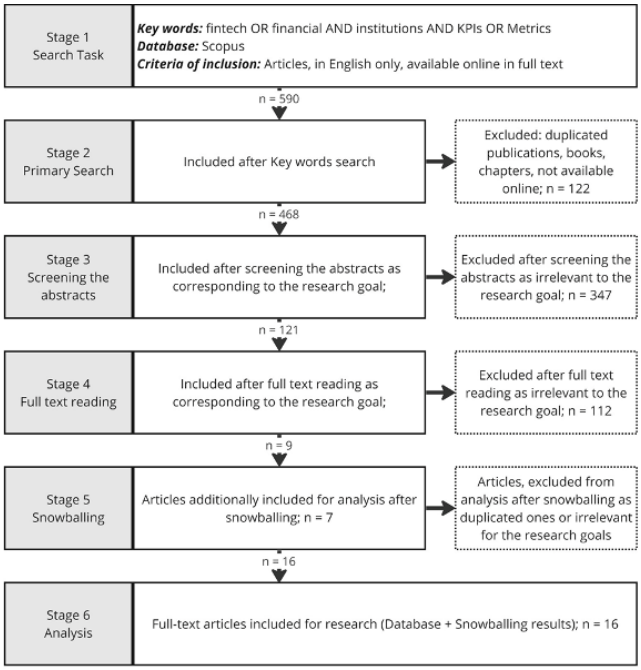

Figure 1.1 **The procedure of selecting the articles for qualitative analysis**

Source: Generated by the author

Literature review results

The detected articles were arranged by year of publication to reflect the trend in problem analysis. They are presented in Figure A5.1 of Annex 5.

The result of further analysis is quite disappointing. Only two areas can be specified with relative success: liquidity management (two articles) and cybersecurity (three articles). Other articles cannot be clearly referred to any peculiar area. The next group of results refers to the qualitative analysis of the selected articles. These results are summarised in Table A5.1 in Annex 5. There presented the review of each selected article and the research areas relevant to this study, covered (or not covered) by the corresponding article.

The analysis demonstrated that even these small number of articles selected as corresponding and relevant to this research do not come to the determination of KPIs for the financial institution.

While fintech companies identify and seise the opportunities in the digital economy quickly, traditional financial institutions are slow to adapt. This is largely due to the fact that most financial institutions are still relying on outdated KPIs to measure performance. And these indicators are not capable of solving the issue – demonstrating the level of company success. For example, such logical, easily applicable, and widely used metrics as ROE, quite successfully applied in traditional businesses, do not reflect the state of the financial company. The bad ROE indicator may even be in well-performing fintech companies just due to the fact that the company is oriented not on profit but on growth at the moment.

Further we can consider, for example, Return on Assets (ROA) and liquidity ratios, which also have implications for the assessment of fintech firms. For instance, ROA, which measures a company's profitability relative to its total assets, might not accurately reflect the efficiency of a fintech operation that heavily reinvests in technology and innovation for future growth, rather than immediate asset returns. Similarly, liquidity ratios, which assess a firm's ability to cover its short-term obligations, can be misleading in the context of fintech. These companies often prioritize strategic investments to capture market share over short-term liquidity. Consequently, traditional financial metrics must be carefully adjusted to the financial institution operations when evaluating the performance of fintech companies, where growth and market potential often take precedence over current profitability and liquidity.

Similarly, capital turnover – a measure of how effectively a company utilizes its capital to generate revenue – may not fully reflect the operational progress of a fintech. Given that such firms may reinvest revenues for company development, traditional interpretations of capital turnover ratios could under-value their strategic progress. In essence, the dynamic and forward-looking way of doing business fintech requires the modern approach to evaluating financial performance.

Including this additional consideration, it is also essential to acknowledge the limitations of operational metrics for real-time decision-making in the fintech sector. Traditional financial indicators like ROE, ROA, liquidity ratios, capital turnover while indicative of long-term financial health, may not facilitate immediate, on-the-spot decision-making due to their inherent delay in reflecting current operational data. This lag presents a significant challenge in the fast-paced fintech environment, where timely and agile decisions are crucial. Thus, it is imperative to refine or augment these metrics to ensure they are responsive to the dynamic operational needs of fintech enterprises, where strategic decisions often hinge on the latest operational insights rather than historical financial outcomes. Therefore, it is urgent for further development of the financial industry to develop the typology of KPIs applicable to all companies operating in the financial sector.

The existence of only a few articles written on the issue can be explained by the fact that the phenomenon of fintech company is rather new; the practitioners are just trying to implement the business with a brand-new type of KPIs, which scholars do not describe, while scholars do not know how the businesses in this new-born industry are working. This gap between the academicians and practitioners in this area is very big, and this article is one of the attempts to specify the peculiar areas for urgent cooperation to cover this gap.

Therefore, ***RQ1*** is answered: the number of studies in the area is so insignificant that it is possible to state that the field is not covered, and scholars have room for intensive research activity

Thus, ***RQ2*** is also answered: very few authors touch upon the factors of KPIs creation; some of them (Azeem & Shahbaz, 2008; Fayman & He, 2011) demonstrate the connection between risks and KPIs; however, the developed and elaborated system of factors determining the specific factors of KPIs formation are not considered in the scientific publications, and it is a great possibility for scientists to apply their efforts.

Another important point for discussion is the typology of KPIs. This block of issues is even more disappointing. The selected 16 articles state the problem of the necessity of determining KPIs; nevertheless, they do not offer any options for the traditional KPIs, used by the majority of businesses.

So, ***RQ3*** is also answered: this typology does not exist.

The scientific novelty of the research is the determination of the serious gap in contemporary studies of financial management and offers a prospective direction for further research. The practical novelty is even bigger since it shows the way of application of scientific research in the operations of financial institutions in the such vital sphere as KPIs.

Literature review limitations

The research has certain limitations:

- The author uses the determined list of operators (keywords) for search in databases; the changed list of operators/keywords will give another result of the search.
- The choice of databases is traditional for such a type of literature review; nevertheless, the search in other databases can significantly change the obtained results.

  The latest article considered by the author is from the year 2006. It is admissible that other scholars can use older articles for this type of study.

KPIs selection for financial institutions

The current state of research in the field of fintech is focused on a few key metrics or groups of metrics. This focus provides a more in-depth understanding of how these important factors facilitate the success or failure of fintech. However, it should be noted that this narrowness of focus may also have some drawbacks. In particular, it may limit the ability to identify other potentially important factors that could affect the performance of fintech.

There were set three Research Questions: RQ1. The area of KPIs for financial institutions is well covered by the scientific articles indexed in Scopus and WoS databases; RQ2. The factors influencing the choice of KPIs for the financial institution are described in

scientific articles; RQ3. The classification of KPIs for financial institutions exists, and it is applicable for practical use for financial institutions. As a result, all three research questions were answered negatively, scientific publications do not cover these areas.

According to the analysed articles, the two major issues impacting fintech are cyber security (n = 3) and liquidity (n = 3). Cyber security is a growing concern for businesses of all sises, but it is especially critical for fintech companies that handle sensitive financial data. It can not only damage a company's reputation but also result in heavy fines and legal penalties. Liquidity, however, is a key challenge for fintech startups who may not have the same access to capital as larger firms. This can make it difficult to scale up operations and attract new customers. These challenges must be addressed, especially considering, that the adoption of new technologies will contribute to growth of fintech companies.

The comprehensive analysis of literature does not allow determining how to select the exact KPIs for the exact business. By conducting research, businesses can determine which KPIs are most relevant and useful for their specific needs and make the decision-making process more effective.

fintech companies present different types of businesses, and it is impossible to find universal solution for all of them. Businesses will have different KPIs depending on their unique needs and goals. Nevertheless, the general approach to selecting KPIs could be elaborated. If the approach to the specific KPIs selection is worked out, each fintech business can develop a more targeted and effective strategy for measuring and improving its performance.

Some common KPIs that could be applied to many fintech businesses include measures of customer satisfaction, financial performance, operational efficiency, and growth.

Limitations of using KPIs in fintech in the EU

A systematic review of the literature regarding KPI selection for fintech shows that there is a lack of clarity and consistency applying KPIs to different types of fintech. The absence of a universally accepted framework for selecting relevant KPIs can lead to confusion and inefficiency in decision-making processes.

The traditional KPIs in the fast-paced world of fintech may not provide an accurate representation of a company's success. With new digital technologies and business models transforming the financial industry, it is important to revisit how to measure performance. Traditional KPIs are metrics that businesses use to measure their performance and progress toward achieving their goals. One of the most commonly used traditional KPIs is ROE (Nocini *et al.*, 2022; Timothy, 2022), measuring a company's profitability and efficiently of a company is using its resources to generate profits, or financial health. However, ROE is a controversial metric in the fintech industry. While many financial institutions use ROE as a measure of

profitability and value for shareholders, it is an outdated measurement that fails to show the true value of innovative fintech companies, ignoring many important factors such as customer satisfaction, innovation, and social impact. Fintech employ technology to create new products and services, and should be evaluated based on their ability to drive positive change rather than just financial metrics like ROE. By focusing exclusively on ROE, investors may miss out on promising new fintech start-ups with great potential but lower returns at early stages of growth. Then, ROE measures profitability only in relation to shareholders' equity, it does not reflect such critical factors as risk management and capital allocation strategies. Additionally, ROE may motivate for short-term objectives at the expense of long-term investments and sustainability. Therefore, there is a need for alternative metrics that can provide a comprehensive view of a company's financial health while aligning with its strategic goals and values. Fintech balance multiple objectives such as growth, profitability, risk mitigation and social responsibility when governing modern businesses today.

Another widely used metric – DuPont analysis – offers possibility to assess the efficiency of using assets to generate revenue and aligning investment strategies with goals. The approach to the financial health of a company is different from ROE, DuPont analysis is a more comprehensive method (Scarlat *et al.*, 2011; Maté *et al.*, 2014), but it also lacks the necessary dynamics. Non-traditional KPIs such as customer engagement, user experience, and product feedback can offer more valuable estimations of fintech performances rather than conventional KPIs. DuPont Analysis and ROE remain relevant tools for comparing companies and evaluating financial performance (Maté *et al.*, 2014; Siedler *et al.*, 2020); however, it is necessary to monitor non-traditional KPIs as well. The emerging technologies employed by fintech are complex and heterogeneous, and require the proper selection of metrics. To address this issue, various measurement frameworks based on key factors are proposed. One of them is KPIs based on risk measurement.

The research question of the Doctoral Thesis – *Do we have the comprehensive approach to selecting the proper KPIs in financial sector?* – **answered**. The is no a comprehensive approach for selecting the proper to financial sector KPIs.

1.2 Fintech genesis

The emergence of Industry 4.0 has paved the way for a new era in financial services, where financial technology or fintech is at the forefront of innovation. The combination of finance and technology allows streamlining the business processes, enhancing customer experience, and optimizing decision-making process based on data analysis. Fintech solutions such as mobile payments, peer-to-peer lending platforms, robo-advisors, and blockchain-based

digital currencies provide fast and reliable solutions with minimal costs. By leveraging cutting-edge technologies like AI, IoT, and Big Data Analytics, fintech start-ups are building intelligent systems that can predict market trends accurately while improving risk management practices across different industries.

The history of fintech dates back to at least the nineteenth century. In 1860, a device known as the Pan-telegraph was created to verify bank signatures. Historians consider 1866 to be the year of fintech's first appearance and the beginning of the era of global network infrastructure and communications. Fedwire's development of electronic funds transmission via telegraph and Morse code in 1918 marked the beginning of the digitisation of money. During the two world wars, a new generation of programmers and codebreakers emerged, primarily for military purposes. 1919's publication of The Economic Consequences of the World is regarded as the first sign of a future driven by fintech.

The Diner's Card, introduced in 1950, is typically neglected by fintech historians as fintech 1.0. It was the first attempt to accept cashless payments. This was followed by the 1958 introduction of American Express credit cards. In 1960, when Quotron brought stock data to the screen, the financial market advanced significantly.

It is believed that fintech 2.0 began in 1967 with the introduction of Barclay's ATM. A year earlier, in 1965, Telex replaced the Telegraph as the global information carrier, starting a new era of financial transactions and communications. In 1971, when the NASDAQ became the world's first electronic stock exchange, financial technology grew significantly. This has greatly simplified the initial public offering (IPO) process and changed the trade procedure.. This is regarded as one of the most significant fintech developments ever. This was followed in 1973 by introducing another revolutionary service standard, SWIFT. The 1980s were characterised by the development of electronic trading and online finance systems. Electronic Commerce was first introduced by Tradeplus (Electronic Commerce) in 1982. 1983 saw the introduction of the first mobile phone. Complex computer systems have facilitated introducing new, more dynamic processes and products. The evolution of e-commerce in the mid-1990s was one of the most significant advancements, as it made the dependence on digital finance much more significant. PAYPAL was introduced in 1998, paving the way for contactless transactions in later years. The Y2K bubble burst in 2000, and technology in the financial sector advanced significantly in the years that followed, with traditional banks primarily using technology to support their primary channels. The 2008 financial crisis caused a fundamental shift in how we perceive the fintech industry, and the need for innovation sparked a real boom in the subsequent years.

The 2008 financial crisis led, among others, to the following demands:

- Post-crisis reforms have necessitated more stringent regulatory measures for conventional banks and created a new market for smaller companies. This was also facilitated by the population's mistrust of large financial institutions; the role of financial technology in transforming the financial industry and enhancing economic efficiency.
- The primary objective of the industry was to reduce operating expenses through the application of technology. These demands and developments started the current era of financial services and fintech. In 2009, Bitcoin was introduced as the first cryptocurrency, and in 2011, a person-to-person (P2P) payment system was introduced. Since then, hundreds of new unicorns and new developments have appeared in the Western world. RegTech, digital lending, InsurTech, wallets, and many other segments exhibit growth and innovation daily.
- Since 2014, China and India, the two most populous countries in fintech, have experienced exponential growth. Due to the absence of extensive networks of complex physical and financial infrastructures, the fintech sector expanded rapidly in these two nations. This, along with fintech developments in Africa, is regarded as the growth catalyst for the period 2014–2018. This is made possible by SaaS innovations such as financial software developed by Indian ICT companies, M- Pesa in Africa, payment banks in India, and Alipay in China, to mention a few.

Numerous aspects of society, including the financial services industry, have become historically receptive to new technologies due to the digitalisation process. Despite the fact that the combination of technology and finance is not a genuine novelty, the recent increase in investment in digital technology and the massive acceleration of the pace of innovation have given birth to a controversial phenomenon known as fintech that many consider revolutionary.

fintech is a term with a broad meaning that refers to the use of a variety of advanced technologies in the financial and banking sectors, but it lacks a single, widely acknowledged concept even at the level of regulation. Each body, institution, or organisation that has contributed to the fintech research path by investigating its potential and characteristics has its own definition.

The detailed classification of fintech is presented in Figure 1.2.

Figure 1.2 **fintech segmentations**

Source: generated by the author (Cernisevs & Popova, 2023)

The Financial Stability Board defines fintech as "a technological innovation in the financial services industry that can lead to new business models, applications, processes, or products with a correspondingly significant impact on the provision of financial services" (Financial Stability Board (FSB), 2017). Recognizing fintech as a subset of broader financial innovation, Armstrong (Armstrong, 2016) defines it as "a subset of financial innovation whose functioning is dependent on information technology, i.e. the Internet." Internet, cloud technologies, etc., and this may lead to the emergence of new business models, applications, processes, products or services with concomitant impact on financial markets and institutions and the provision of financial services." Instead, the European Commission defines fintech as "a technological innovation in financial services, regardless of the nature or size of the service provider." (European Commission, 2017) It seems early to try to precisely define the boundaries of a phenomenon that is still developing. In this context, fintech means any company that employs technological systems to directly provide financial services or enhance the efficacy of the financial system. It comprises many services and products (cashless payments, instant payments, P2P lending platforms, advisory algorithms, cryptocurrencies, crowdfunding, etc.) that might grow in the near future (Karakas *et al.*, 2017).

The opportunities and benefits of new digital applications are undeniable: lower costs, faster and more personalised financial services, increased competition, and greater accessibility are just a few advantages that can be garnered by utilizing technology. Nevertheless, big opportunities always involve great risks.

fintech presents a number of challenges and critical issues that pose a threat to the traditional banking and financial system and necessitates substantial regulatory adjustments.

Currently, it is difficult to quantify the scope and effects of digitalisation's influence precisely. Electronic payments encompass fintech and even transactions involving crypto assets.

fintech licensing

The necessity for supervising fintech in the EU arises from the rapid growth and widespread adoption of digital financial services. While fintech offers promising opportunities for financial inclusion and efficiency, it also brings forth significant risks and challenges that warrant careful oversight (Ahern, 2021).

One of the primary reasons for supervision is to protect consumers and investors, as fintech services involve the handling of sensitive financial data and transactions; ensuring data privacy and security is very important. Supervision helps establish robust cybersecurity measures and safeguards against potential breaches or fraudulent activities, thereby fostering trust in digital financial services (Tsai & Peng, 2017; Rupeika-Apoga & Wendt, 2022).

Maintaining financial stability is another key driver for regulation. Fintech's disruptive nature can impact traditional financial institutions and markets. Effective supervision helps monitor potential systemic risks and vulnerabilities, ensuring the overall stability of the financial system in the face of technological advancements.

Furthermore, regulation is essential to promote fair competition. Fintech startups and established financial institutions compete in the digital sphere; adequate supervision prevents any anti-competitive practices, providing healthy market dynamics.

By fostering a harmonised regulatory environment, supervisory efforts also aim to prevent regulatory arbitrage and promote consistent standards across the EU. This cohesive approach reduces regulatory complexities for fintech firms operating across multiple jurisdictions and encourages cross-border innovation and collaboration (Athanassiou & Mas-Guix, 2008; Armstrong, 2016; Buchak *et al.*, 2018; Richter, 2020).

Ultimately, the necessity for fintech supervision lies in striking the right balance between fostering innovation and managing potential risks. Supervisory authorities, like the European Central Bank (ECB), play a pivotal role in implementing regulatory frameworks beneficial for the interests of consumers, investors, and the broader financial system in the EU.

Institutions offering financial products in the EU have experienced a major shift towards digitalisation (Agarwal & Zhang, 2020; Richter, 2020; Murinde *et al.*, 2022). This has been driven by the increasing demand for convenience and accessibility among customers (Darolles, 2016; Kryvych & Goncharenko, 2020), In response, institutions are adopting innovative

technologies to offer digital financial products that meet customer needs while complying with relevant laws and regulations governing the EU market. The introduction of new legislation, such as PSD2 is aimed at fostering competition, innovation, and security in electronic payments across Europe. Under these laws, institutions offering digital financial products must adhere to strict data protection rules designed to safeguard customer information from unauthorised access or misuse. These measures ensure that customers can trust their online transactions without fear of fraud or cyber-attacks.

There is a diverse range of institutions that offer digital financial products to individuals and businesses. These financial products satisfy the specific needs of various consumer segments, including retail customers, private investors, small and medium-sized enterprises (SMEs), and multinational corporations. A taxonomy of such institutions includes traditional banks, digital-only challenger banks, fintech start-ups specializing in payment solutions or credit scoring algorithms, insurance companies offering coverage for cyber risks or identity theft protection services, investment firms providing robo-advisory platforms or algorithmic trading tools, and peer-to-peer lending platforms facilitating loans between borrowers and investors through online marketplaces. Moreover, some public authorities also offer digital financial products such as e-government portals for tax payments or social security contributions.

1.3 Digital financial products within EU region

The introduction of digital financial products in the EU has brought about a great shift in the traditional banking system. Digitalisation is a key aspect of modern banking, allowing more efficient and cost-effective delivery of financial services, such as payments, investments, and lending activities. The emergence of innovative technologies like blockchain, AI, Big Data analytics, and cloud computing permit banks to offer personalised products. These technologies improved regulatory compliance by providing better monitoring and supervision across member states. Consequently, with the increasing demand for digital solutions among customers and government policies towards fintech innovation within their jurisdictions, digitalisation will grow.

Financial institutions operating within the EU offer a wide range of financial products to individuals and businesses. These financial products include traditional banking offerings such as checking accounts, loans, mortgages, credit cards, insurance policies, and investments in stocks or bonds. In recent years, fintech introduces innovative digital solutions for payment processing, peer-to-peer lending platforms, robo-investment advisors, and mobile banking applications (Dhar & Stein, 2016; Agarwal & Zhang, 2020; Boyer, 2021; Barroso & Laborda,

2022). For example, Revolut offers spending analytics and foreign exchange services; fintech N26 provides customers with real-time notifications on their transactions; TransferWise allows users to transfer money abroad at low rates; Funding Circle connects investors with small business borrowers online; Scalable Capital uses algorithms to optimise portfolios based on customer risk preferences; BlackCatCard uses data analytics, machine learning, and blockchain to create cutting-edge solutions that meet modern consumer needs with maximum efficiency and security. The list of available financial products is growing together with the technological progress; these solutions are offered by fintech in order to remain competitive while providing greater convenience, security, and value for their customers. Fintech contributes to strategic collaborations between traditional financial institutions and innovative technology firms.

The digital financial products taxonomy allows defining the various categories of financial products available in the market and providing standardised terminology for digital financial products, including mobile payments, electronic wallets, virtual currencies, peer-to-peer lending platforms, and robo-advisors. It also categorises each product based on its features, such as ease of use, cost-effectiveness or security measures. The technological progress makes fintech the player in the financial market; it requires to use the universal terminology in this market for facilitating effective collaboration among different players operating under different regulatory regimes or jurisdictions worldwide.

Digital financial products taxonomy

The taxonomy of digital financial products can be broken down into several categories. The first category is digital payment systems (Szumski, 2020), which include products like PayPal, Venmo, and Apple Pay. These systems allow users to make secure and convenient digital payments using their mobile devices or computers.

The second category is digital banking products (Khanboubi *et al.*, 2019; Windasari *et al.*, 2022), which include online banking services, mobile banking apps, and digital wallets. These products allow users to manage their finances, make transactions, and access financial services anywhere in the world.

The third category is digital investment products (Lisin *et al.*, 2021), which include robo-advisors, digital trading platforms, and cryptocurrency exchanges. These products allow users to invest their money in a wide range of assets, including stocks, bonds, and cryptocurrencies, using automated algorithms and advanced analytics.

The fourth category is digital insurance products (Srivastava *et al.*, 2022), which include products like digital health insurance, travel insurance, and car insurance. These products allow users to purchase insurance policies online, manage their policies, and make claims using digital platforms.

The fifth category is operations with crypto assets (Bech & Garratt, 2017; ESMA, 2018; Hacker & Thomale, 2018; EU, 2020; Giudici *et al.*, 2020); more and more people turn to crypto assets as an alternative to traditional investment forms. This category includes services such as crypto assets exchanges, crypto assets wallets, and crypto assets trading platforms, which allow users to buy, sell, and trade crypto assets.

The taxonomy of digital products their interconnections are presented in Figure 1.3.

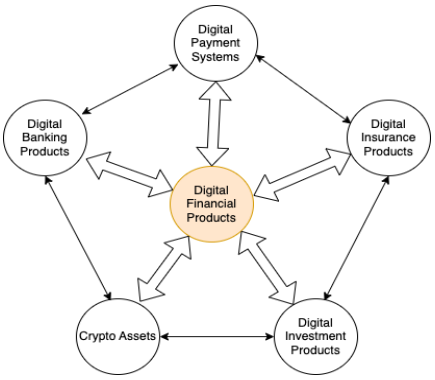

Figure 1.3 **Digital Products Taxonomy**

Developed by the author.

The interconnections between these products indicate the integration and collaboration among various digital financial services in the modern financial ecosystem. For example, digital banking may facilitate access to cryptocurrency investments, while e-wallets can be linked to Digital Investment products for automated investment funding.

Digital payment systems

Digital payment systems allow individuals to transfer money instantly without visiting a bank. This gave rise of various digital payment systems, such as PayPal, Google Pay, and Apple Pay, among others (Bansal *et al.*, 2015; Soe & Mikheeva, 2017; Brener, 2019). One of the most popular digital payment methods is mobile payments, which allows users to pay for goods and services using their smartphones. Mobile payments use Near Field Communication (NFC) technology to tap the phone against a point-of-sale terminal instead of swiping a credit card (Greenacre & Buckley, 2014; Al-Saedi *et al.*, 2019). Another popular form of digital payment is e-wallets which store all user's debit/credit card data and personal details securely in one place. E-wallets like Amazon Pay and Samsung Pay have become increasingly common in recent years due to their convenience and security features (Salloum *et al.*, 2019).

Digital payment systems offer many benefits over traditional forms of payment, such as speed, convenience, and security. They are convenient, secure and fast. Digital payment systems are distinguished from other types of payments, they do not safeguard customers' funds but process payment instruments issued as another type of financial product.

Digital banking products

Digital banking products changed the way how their clients manage their finances. With digital banking, customers can access various financial services anywhere in the world at any time of day or night. One of the main advantages of digital banking is that it allows customers to check their accounts and make transactions immediately. Customers can monitor their spending habits, analyse their expenses, apply for loans and credit cards online. Digital banking products transformed traditional banking by making financial management more convenient, accessible and intuitive. Finally, digital banking products increased the security of financial transactions by introducing encryption techniques.

Digital banking products are offered individually or as part of the following product package:

- Customer's payment Account and linked to the account different types of payments
- Payment Cards
- Electronic Money operations
- Different types of credit products
- Different types of term deposit products
- Derivatives
- Forex
- Other alternative payment products

Digital investment products

Digital investment products allow investors to access a wide range of investment opportunities without going to traditional financial institutions or brokers. One of the most popular digital investment products is robo-advisors. Robo-advisors use algorithms and machine learning to create personalised portfolios for investors based on their risk tolerance, financial goals, and other factors. They offer low fees compared to traditional advisors and can be accessed easily through mobile apps or websites.

Another popular option is peer-to-peer lending platforms. These platforms connect borrowers directly with lenders without the need for a bank as an intermediary. Investors can earn interest by investing in loans that match their preferences regarding borrower creditworthiness, loan term, and interest rate.

Cryptocurrencies are also considered digital investment products since they are traded on online exchanges like stocks or bonds. However, investments in cryptocurrencies carry high risks due to market volatility and lack of regulation (Hacker & Thomale, 2018).

Digital investment products give individual investors more control over their investments, lower fees and greater accessibility than traditional methods.

Digital insurance products

Digital insurance products are very popular. These products are designed to cover a range of risks, from personal accidents and illnesses to property damage and liability (Abrol, 2016; Marano, 2021; Srivastava *et al.*, 2022). The major advantages of digital insurance products include the possibility of online purchase, flexibility offered by these products (choosing from various options such as deductibles, limits, and additional riders).

In addition, many digital insurance providers offer innovative features like real-time claims processing and automated payments. This streamlines the entire claims process, allowing customers to receive fast pay-outs.

Crypto assets

The rise of cryptocurrency resulted in a new kind of financial asset that offers a secure and decentralised alternative to traditional currencies (Giudici *et al.*, 2020; Yarovaya & Zięba, 2020; Mohsin, 2021; Cernisevs & Popova, 2023)

One benefit of using crypto assets is the ability to make fast and low-cost transactions around the world. Unlike traditional banking systems, cryptocurrency transactions are processed within minutes with fees significantly lower than those charged by banks.

However, there are still some challenges in operating with crypto assets. One major concern is security, as cryptocurrencies are vulnerable to hacking attacks and thefts from online wallets. Another challenge is regulation; the different countries have different rules regarding the use of cryptocurrencies. To address this issue, the EU developed a set of standards for blockchain-based tokens that aims to create interoperability between different networks.

Crypto-assets also known as cryptocurrencies emerged as new digital financial products in the contemporary financial landscape. These assets are based on blockchain technology, a decentralised and immutable ledger system that ensures secure and transparent transactions. Unlike traditional financial products, such as fiat currencies or stocks, crypto-assets operate independently of central banks or regulatory authorities, offering a new level of financial freedom and autonomy to users, rapidly growing market, diverse investment opportunities. The blockchain technology allowed the development of innovative financial applications, such as decentralised finance (DeFi) platforms and non-fungible tokens (NFTs). Cryptocurrencies continue to develop, taking its place among digital financial products. In light of the aforementioned considerations, a comprehensive assessment of crypto-assets was undertaken.

1.4 Crypto-asset taxonomy and life cycle

The financial assets within the EU are in transformation. New innovative technologies come to the industry. Distributed Ledger Technology (DLT) is used by both financial and nonfinancial entities (Hashimy *et al.*, 2021). DLT permits the direct online settlements between parties without any intermediaries. Before introduction of DLT such direct settlements were only possible through cash payments (Eymundsson, 2014). A fundamental component of DLT-based payment systems is the blockchain, which is a ledger containing a chronological list of executed transactions. While cryptocurrencies serve as assets within the blockchain, their utility is limited solely to payment purposes without offering additional benefits (Giudici *et al.*, 2020).

Blockchain technology allows the registration of diverse types of assets, therefore, a comprehensive classification of these assets and their life cycles are necessary. (Bech & Garratt, 2017) have proposed a classification for money based on specific parameters, including its widespread availability, electronic nature, issuance by central banks, and the ability to conduct settlements without involving financial institutions. This classification uses a structured approach to DLT and blockchain. Figure 1.4 illustrates these classifications.

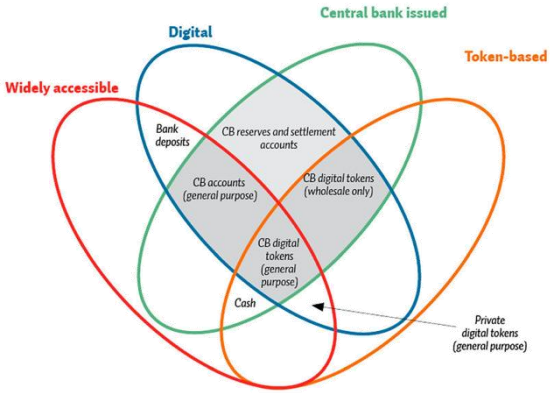

Figure 1.4 **The money flower: a taxonomy of Money**

Source: developed by author based on (Bech & Garratt, 2017)

This study focuses on classification of electronic money only. This narrowed scope allows in-depth analysis and classification of electronic money within the DLT (Mohsin, 2021) (Table 1.1).

Table 1.1

Comparison of electronic money and crypto assets

E-money		**Crypto assets**
Issuance type	Electronic	Electronic
Denomination	Fiat currencies (e.g., Euro, ASV dollars)	Own denomination (e.g., BTC, USDT)
Customer due diligence	Full AML norms applicable	Full AML norms applicable
Method of issuance	Digitally issued equivalent to fiat currency de- posited by the issuer	Developed/created mathematically
Issuer	Officially established by the issuer of electronic money (which may be a financial institution)	Community of people/miners or legal entity (within the ICO model

Source: created by the author

Based on the criteria of electronic money and crypto assets, the assets outlined by (Bech & Garratt, 2017) can be legally classified, as illustrated in Table 1.2.

Table 1.2

Taxonomy of money by law

Universally accessible		**Method of issuance**	**Classified by law**
Financial institution	No	Issued internally	E-money
Legal entities (all types)	Yes	Blockchain	Crypto assets
Central Bank	No	Official fiat issuance	Settlement and reserve money
Central Bank	Yes	Issued internally	Deposits in fiat currencies
Central Bank	No	Issued internally	E-money
Central Bank	Yes	Blockchain	Crypto assets
Peer-to-peer	No	Blockchain	Crypto assets
Peer-to-peer	Yes	Blockchain	Crypto assets

Source: created by the author

According to the auditing company PricewaterhouseCoopers (PWC), these assets can be legally classified as crypto assets. The next step is determining the cryptocurrency as a "coin" or a "token"; there is a lack of differentiation between them in the legal framework, but according to PWC (Tucker, 2017): a "coin" typically denotes a cryptographic asset intended for use as a medium of exchange, whereas a "token" refers to an asset that offers additional functions or utility to the holder.

Consequently, the classification proposed by (Bech & Garratt, 2017) refers exclusively to assets as means of payment. Other types of crypto assets fall outside this taxonomy.

Crypto-asset classification in the EU

The Proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-Assets, and Amending Directive (EU) 2019/1937 (2020) introduces three distinct crypto-asset subtypes:

The proposed regulation designates three distinct crypto-asset subtypes:

1. Utility tokens: These crypto assets are issued for access to electronic services or digital platforms.
2. Asset-referenced tokens: These crypto assets can be linked to a single currency, a group of currencies, a collection of other crypto assets, one or more exchange-listed commodities, a single share, or a basket of shares. In some EU countries, local regulations for ICOs were adopted before the publication of the proposal, where tokens associated with assets were referred to as security tokens.
3. Payment tokens (coins, electronic money tokens, e-money tokens): These crypto assets are primarily intended as means of payment. Their function closely resembles that of electronic money, as defined in point 2 of Article 2 of Directive 2009/110/EC of the European Parliament and the Council (2009). Similar to electronic money, these crypto assets serve as electronic substitutes for physical coins and banknotes, facilitating payment transactions.

The European Commission initiative outlines three subgroups of crypto assets. However, if a proposed target product incorporates functionalities inherent in multiple token subgroups, it is classified as a hybrid token. Subsequently, based on the combinations of intended use, such tokens are attributed to one of the subgroups. (Progress of the Plan for Removal of Capital Controls, 2017) For each subgroup of crypto assets, the EC initiative further specifies the requirements for applying other legislative norms, as illustrated in Table 1.3.

Table 1.3

Requirements for licensing crypto assets by types

Licensing requirements		**Application of other legal provisions**
Utility tokens	Crypto-asset service providers	Local requirements for the implementation of the norms of the Prevention of Money Laundering Local requirements concerning Safeguarding Funds
Asset-referenced tokens	Crypto-asset service providers If a product based on a crypto asset carries the signs of a financial instrument in accordance with MIFID II (Directive 2014/65/EU), then an appropriate license is also required that meets local legal requirements	Local requirements for the implementation of the norms of the Prevention of Money Laundering Local requirements for Safeguarding Funds. Local legislative acts to meet MIFID II requirements
Payment tokens (coins)	Crypto-asset service providers / e-money financial institution	Local requirements for the implementation of the norms of the Prevention of Money Laundering Local requirements for Safeguarding Funds

Source: created by the author

(Giudici *et al.*, 2020) adopted the same classification for the intended use of crypto assets. However, in the regulatory documentation of the EC initiative, the name of the cryptocurrency subgroup was replaced with "e-money tokens". In general, the algorithm presented in Figure 2.3 can be applied. This algorithm provides a structured approach for various types of crypto assets and their intended uses and within the EC regulatory framework.

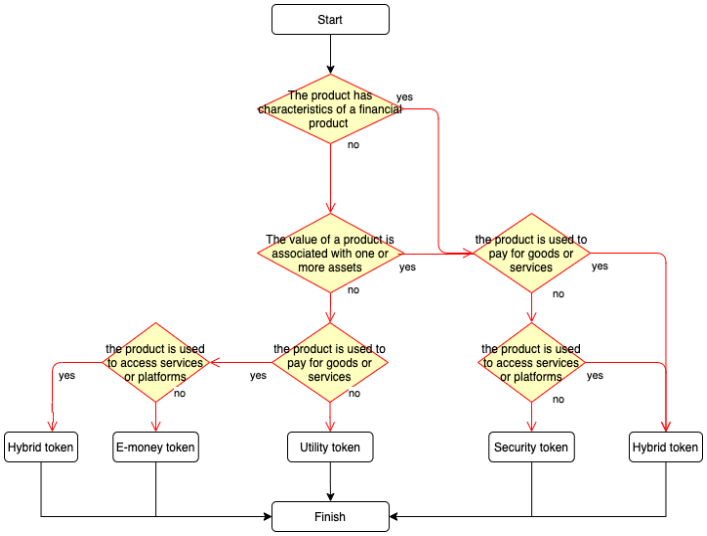

Figure 1.5. **Token classification algorithm**

Generated by author

Figure 1.5 shows the legal requirements corresponding to each type of crypto asset. In the case of hybrid tokens, an assessment to identify and determine the applicable legal regulations is required. Figure 1.6 provides a diagram illustrating the process of applying regulations specifically tailored to hybrid tokens to ensure proper compliance.

The "stablecoin" mitigates price volatility by incorporating a stability mechanism of a specific fiat currency. The EC initiative admits the stablecoins but does not impose special regulations on stablecoins. Even if stablecoins are linked to fiat currency values, they are not classified as e-money tokens (Dargahi *et al.*, 2019; Berentsen & Schär, 2019).

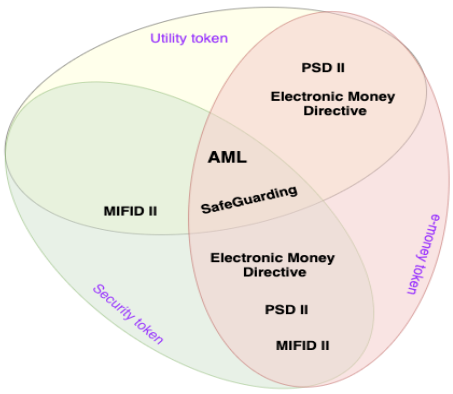

Figure 1.6 **Legal acts for regulating the tokens by type**

Generated by author

Life cycle of crypto assets by type

The life cycle of each type of crypto asset is based on its unique characteristics, and every stage in this life cycle corresponds to a transaction involving the crypto asset. This is true to all types of crypto assets. The issuance of crypto asset considers the key parameters:

- The method of issuance, either through mining or emission.
- The blockchain to be used for the crypto asset's issuance.
- The intended use of the crypto asset: utility, security, e-money, or hybrid token.
- Legal requirements based on the specific type of crypto asset.
- Specific attributes of the crypto asset, such as security tokens with assets and determining issuance limits or additional issuance mechanisms.
- Whether the crypto asset is divisible or indivisible.
- Any other unique parameters specific to the planned crypto asset.

Smart contracts in blockchain technology facilitate agreements between untrusted parties without a trusted intermediary. The technical documentation of the selected blockchain determines the presence and structure of smart contracts. When planning smart contract parameters, the aspects requiring software-level control are determined independent of the issuer or other parties involved in transactions with the crypto asset. These parameters are translated into objective program code, leveraging transaction data and blockchain information (Yarovaya & Zięba, 2020).

Before issuing a crypto asset, the party must test its compliance with regulatory requirements. Regulatory requirements encompass statutory laws adapted into national legislation based on Figure 1.6. The compliance check includes verifying the legal type of the issuer, capital adequacy, required licenses or permits from regulatory authorities, internal regulatory processes, and whether the issuer's managers meet MIFID II requirements. Additionally, for security tokens, the number of tokens issued must correspond to the assets associated with the enterprise (Yarovaya & Zięba, 2020).

Registering a new crypto asset in the blockchain is a one-time action, allowing for the linkage of smart contract parameters. After registration, these parameters generally cannot be changed throughout the life of all issued crypto assets tied to the smart contract. This ensures predictability and independence from the issuer.

The issuance of a crypto asset triggers the blockchain procedure, analysing data for the entire existence of the asset. If the smart contract verifies the data according to its rules, new units of the crypto asset are registered in the blockchain and confirmed in the same manner as other blockchain operations. For crypto assets using mining, the issuance is completed after the

first block is registered in the blockchain (Cernisevs & Popova, 2023). If mining is not involved, the issuer can issue any amount of the crypto asset, limited only by the smart contract terms.

Semantic differences exist in the transfer/sale operations of utility, e-money, security, and hybrid tokens. Utility tokens provide access to electronic systems or programs, while e-money tokens are used for payment. Security tokens are associated with specific enterprise assets but do not involve the transfer of those assets during transactions. The price of a crypto asset is determined by supply and demand mechanisms.

Due to the nature of DLT, information about transactions is permanently stored and cannot be destroyed. Demission of a crypto asset, achieved by zeroing balances from the blockchain, is impossible for all types of crypto assets. However, the concept of "burning" crypto assets (token burning) involves moving tokens designated for "incineration" to addresses without access keys. While the tokens are no longer in circulation, their presence is recorded in the DLT, maintaining the total amount of the crypto asset in the blockchain as initially issued (Cernisevs & Popova, 2023).

Identifying different types of issued crypto-assets within regulatory frameworks has led to a better understanding of the requirements for issuers, including capital adequacy, licensing, and regulatory compliance. As a result, a preliminary assessment of planned crypto assets becomes crucial to ensure compliance with regulations and readiness from a legal and supervisory standpoint. Determining each type of crypto asset makes clear differentiation between crypto assets and electronic money.

The developed classification algorithm offers a framework for determining any new crypto asset. Utilizing the life cycle analysis tailored to each classification type allows for preparing a list of mandatory tasks when dealing with these crypto assets. Additionally, the life cycle model of crypto assets can facilitate the identification and analysis of risks associated with each process, including Anti-Money Laundering (AML) risks. This, in turn, enables efficient allocation of resources based on goals and assessed risks, ensuring a well-balanced and risk-aware approach to handling crypto assets.

1.5 Pricing digital currencies and cryptocurrencies

Identifying all procedures of crypto assets is related to the need to classify crypto assets and differentiate them from electronic money. The processes that constitute the life cycle of crypto assets, which are compiled in the workflow, are fundamental to the digital economy (Kraus *et al.*, 2022). Electronic Money Directive 2000/46/EC ("EMD1") of 2000 was the first regulatory document to describe e-money. It was criticised for its inadequacies, which led to

varying interpretations in national law (Athanassiou & Mas-Guix, 2008). There were established the foundation for the second Electronic Money Directive:

- Definitional clarification of digital currency
- Examining how this directive applies to mobile payments and other hybrid products
- Clarification of capital requirements for companies that issue digital currencies and reduction of initial capital requirements for such companies
- Elimination of restrictions preventing companies that issue digital currency from engaging in other activities.

The European Commission reviewed the ECB's proposals and developed the second Electronic Money Directive based on them. Directive 2009/110/EC ("EMD2 went into effect in April 2011 and replaced the former.

According to Directive 2007, "Electronic money" is defined as money that is accepted and is stored electronically, including magnetically. It is issued for the purpose of conducting payment transactions. The Electronic Money are issued by the Electronic Money Institution. The authorisation to issue electronic money is governed by the national laws of the EU member states.

When discussing the platformisation of financial transactions (Westermeier, 2020) from the perspective of financial management and accounting, transparent approaches are required when classifying funds within an enterprise. Since the Electronic Money Institution is not a lending financial enterprise, there are restrictions on transactions with digital currencies in various EU countries that can have a significant impact on the financial management. The European Parliament indicated that control measures should be applied to the Electronic Money Institution and operations in digital currencies in accordance with the AML directives. The electronic Money Institution should apply the IFRS 15 standard in accounting and financial accounting of income went into effect.

Identification of pricing factors affecting financial products

The identification of pricing factors affecting financial products in the digital economy is highly important (Verhoef *et al.,* 2021). This transformation put pressure on traditional firms. Customers now expect round-the-clock availability of products and services in the digital economy (Williams, 2021). As the digital financial products become increasingly prevalent, identifying measurement is necessary for management of fintech risks and pricing strategies.

Financial management is the practice of managing a company's finances to ensure its success and compliance with regulations (Bajgoric & Moon, 2017).

The pricing factors in the field of crypto asset management are determined on the basis of the theory of capital market efficiency. One of the prominent scholars contributing to the

field is Eugene F. Fama, the Nobel prise winner of 2013. First, (Fama, 1970) proposed three kinds of effectiveness, distinguished by the type of information incorporated into the price: (i) strong form, (ii) semi-rigid form, and (iii) poor performance. The weakest form of efficiency is merely a collection of historical price data that can be predicted as a trend of historically collected prices. A medium form of efficiency assumes that all publicly available information, such as official company information or annual profit data, is already reflected in prices. Strong form of efficiency takes into account all information, comprising the private information included in the price; it states that no monopoly information can be profitable; in other words, insider trading cannot be profitable in a market with strong efficiency.

Second, Fama demonstrated that the notion of market efficiency cannot be rejected without rejecting the market equilibrium model (such as the price-setting mechanism). This concept is known as the "joint hypothesis problem." (Fama, 1970) emphasises that the market efficiency hypothesis must be tested in the context of expected returns. The joint hypothesis problem states that when a model yields a return that differs significantly from the actual return, it is impossible to determine whether the model is flawed or the market is inefficient.

Since its inception, the foreign exchange market (FOREX) has been used to test the efficient market hypothesis (Grobys *et al.*, 2020).

The objective of Market Efficiency within the Digital Economy should evaluate all factors associated with the digital provision of services, including information factors. The determination of such factors in relation to digital financial products is not made, and it is necessary to determine the factors affecting pricing within the framework of the fiat currency. The information technology as a production process requires transparent metrics to evaluate the effectiveness of this process. The Fama capital market efficiency theory provides comprehension of the price formation for fintech products. According to this theory, financial markets are highly efficient and reflect all available information in the current prices. Thus, new information about a particular product will be quickly incorporated into its price, leaving no opportunity for investors to earn excess profits. This is particularly relevant in the case of fintech products. Therefore, as new technologies emerge or regulatory changes occur in this industry, the impact on product prices will be immediate due to the high level of capital market efficiency observed by Fama's theory. Firms operating within this sector must remain competitive by improving their offers through research.

Financial Management should consider the wider list of metrics including the metrics of the technological level of development, all types of regulatory changes, company strategy and governance. The approach for this metrics selection and assessment of their influence to the KPI of the company should be developed.

Digital financial product price in a closed-loop environment

The process of defining the price of crypto assets within a closed-loop environment directly impacts the fintech risks. The closed-loop system, primarily facilitated through cryptocurrency exchanges, serves as a central hub where the price determination of these assets takes place (Cernisevs *et al.*, 2019). As the prices of crypto assets fluctuate within this closed-loop setting, various fintech risks appear, influencing the behaviour of investors, traders, and stakeholders. Pricing of crypto assets within the closed-loop creates potential risks such as volatility, liquidity concerns, security vulnerabilities, and regulatory uncertainties.

The world's expectations of money shifted as a result of cryptocurrencies. The dynamic market for cryptocurrencies exists. To establish cryptocurrencies as legitimate financial assets, the capacity to value them is becoming increasingly important. (Hacker & Thomale, 2018; Perez, 2019; Giudici *et al.*, 2020) It is important to identify the variables that impact the present price (rate) formation as a result of the cryptocurrency stock market and high demand for such services. Despite the market's rapid rise in recent years, there is still lack of theoretical foundation for estimating bitcoin prices. Therefore, the Thesis presents the method setting the spot price for cryptocurrency stock exchanges.

A lot of contemporary economic study is devoted to understanding how bitcoin prices are formed (Bemelmans, 2018). Additionally, many nations, including the US, Japan, Finland, and Germany, started taxation of cryptocurrencies. Countries with strong capital controls like China and Iceland make it impossible to get around the limits on money movement. To ensure the success of cryptocurrency issuance, it is necessary to determine how to account for its value. While there aren't many theoretical studies in this area, the market may be increasingly interested in using blockchain as the primary cryptocurrency pipeline.

(Val Srinivas *et al.*, 2014) speak about necessity to determine pricing for currency exchangers or cryptocurrency stock exchanges, there are many attempts to define methods of pricing for digital assets (Ciaian *et al.*, 2016; Hayes, 2017; Bemelmans, 2018; Parashar & Rasiwala, 2019), but they are not applicable in practice.

Another significant development is the recent exploration of the use of cryptocurrencies and blockchain technologies for small-value and large-value payments by central banks. If the risk is effectively controlled, Bitcoin may be investigated as a potential virtual currency in e-commerce transactions. It is a digital currency that can be exchanged, purchased, and sold on exchanges (Grinberg, 2012).

This Thesis presents an approach to calculate the demand and supply of cryptocurrency, and to calculate the price of crypto assets as an exchange rate on the basis of the taxonomy of crypto assets.

(Böhme *et al.*, 2015) stated that Cryptocurrencies are software protocols that include such features as instant payments, secure payments, smart contracts, record-keeping, and daily transactions. Their decentralisation distinguishes them from the conventional currencies (Nakamoto, 2009; Böhme *et al.*, 2015; Hayes, 2017; Blau, 2018). Cryptocurrencies are extremely volatile and have experienced numerous bubbles (Cheung *et al.*, 2015; Blau, 2018). There is no scientific model with sufficient predictive capacity to forecast how cryptocurrencies will respond to specific circumstances. Surprisingly little was written about cryptocurrencies in the academic literature (Cheung, Roca and Su, 2015).

According to (Kristoufek, 2013), the price formation of Bitcoin cannot be explained by conventional economic theories because supply-and-demand fundamentals are absent in Bitcoin markets. First, since a central bank or government does not issue Bitcoin, it is not connected to the economy. Second, the demand (and supply) for Bitcoin is also influenced by the speculative conduct of investors, as there is no interest rate for digital currencies and thus, profits can only be made through price fluctuations. According to (Hanley, 2013), the value of Bitcoin fluctuates against other currencies as a purely market-based valuation with no underlying fundamental value. According to (Woo *et al.*, 2013), Bitcoin may have some equitable value due to its money-like properties as a medium of exchange and a store of value, but it has no other foundation. (Bouoiyour & Selmi, 2014) characterise the value of bitcoin by regressing its market price against a number of independent variables, such as the market price of gold and occurrences of the word 'bitcoin' in Google search queries. (Polasik *et al.*, 2014) conclude that the price formation of Bitcoin is predominantly the result of its popularity and its users' transactional needs. (Gandal & Halaburda, 2014) examine the competition between a limited number of cryptocurrencies on the market and four online exchanges. They discovered that arbitrage opportunities exist infrequently. All cited authors compare the cryptocurrency prices to the dollar rather than using Bitcoin as the comparison standard. As a result of a number of frictions in transactions between cryptocurrencies and national fiat currencies, markets tend to be more efficient and less volatile.

Much of the conducted economic research has sought to determine the "moneyness" of Bitcoin or whether it is more comparable to fiat versus commodity money, such as “digital gold” (Gertchev, 2013; Bergstra, 2014; Harwick, 2016). The Australian Taxation Office does not consider cryptocurrencies to be money or a foreign currency, but rather a commodity that is an asset that can be used to calculate income and capital gains tax (Pascoe & Scott, 2018).

Digital currency is a term used to characterise electronic money, including virtual currency and cryptocurrencies. It can be governed or ungoverned. Virtual money is a form of digital currency that is controlled by its creators and acknowledged by the members of a

particular virtual community (Perez, 2019). Cryptocurrency is "digital money" secured by cryptography and operating on a "blockchain". It requires the solution of complex cryptographic tasks and the use of powerful computers (Val Srinivas *et al.*, 2014).

Electronic instances of cash are not digital currencies. Retail Bank's Customers' accounts, available online, represent leaving cash in the electronic form. On the other hand, digital currency is a form of exchange that only exists digitally and is unrelated to corporeal currency. Electronic money (e-money) is broadly defined as an electronic store of monetary value on a technical device that can be extensively used to make payments to entities other than the issuer of the e-money.

Cash is declared as legal tender by a government decree (also known as fiat money). A tangible asset does not support fiat currency. The value of fiat currency is determined by the relationship between supply and demand. Historically, most currencies were backed by physical commodities like gold or silver, but fiat money is backed solely by the economy's faith and credit. In a similar manner, the digital currency is neither backed by a physical commodity nor exists in physical form. It is also not linked to any physical currencies, although it is frequently quoted on exchanges against other currencies. Like fiat currency, its value is determined by the supply and demand relationship. Digital currencies are not supported by any government, central authority, or legal entity (Bamert *et al.*, 2013; Sunderland, 2013).

A financial instrument is any contract that creates a financial asset for one entity and a financial liability or equity instrument for another entity. The requirement towards the financial instrument to correspond to a digital currency must be a contractual relationship. Digital currency does not present a contractual right or obligation to receive cash or another form of payment. Therefore, it does not result from a contractual relationship and does not meet the definition of a financial instrument. "Digital currency would be closer to an intangible commodity than to a financial instrument" (Venter, 2016). Therefore, cryptocurrency does not meet the definition of a financial instrument; it is an intangible asset or inventory.

Correct cryptocurrency classification is necessary because not all digital currencies can be treated as currency. The definition of electronic money represents it as a financial instrument. Financial instruments are tradable assets, or they may be viewed as tradable capital products. Most financial instruments facilitate the efficient transmission and circulation of capital among the world's investors. These assets may consist of cash, a contractual right to deliver or receive cash or another form of financial instrument, or proof of ownership of an entity. Certain financial instruments resemble currency. In other terms, they are nearly equivalent to cash.

Cryptocurrency must be accounted as exchange company's inventory; therefore, cryptocurrency is a commodity. Another assumption (McConnell *et al.*, 2002) states that the

definition of price is directly related to the precise market model where the commodity is traded. It is assumed that the market for cryptocurrency exchanges is a relatively competitive one. In such situations, the price is determined by the equilibrium between supply and demand.

Close-loop cryptocurrency stock-exchange

The close-loop stock-exchange means that the price of a cryptocurrency is determined by analysing its own stock-exchange data, the quantity of cryptocurrency available for sale and the asset's cost. Cryptocurrency exchange does not produce cryptocurrency. Therefore, the price for the cryptocurrency must be determined as the asset's purchase price. Due to the nature of the product, precise lots cannot be separated, so the cost price is calculated as a weighted average of the current own assets.

Another assumption is that this product's price is characterised by substantial volatility. Consequently, the current price should be discussed. This implies that the price must be set for a brief period of time before the primary influence factors (demand and supply) changed. Demand is the quantity of cryptocurrency that a consumer desires and has possibility to buy, supply is the quantity of available cryptocurrency for sale. The issue is how to measure both in order to determine the spot price under close loop conditions. This refers to the entire amount of cryptocurrency in stock. It means that it is necessary to use the short-time historical deals data and the short-term trends based on these data. It is necessary to identify which price is attributed to historically recorded pairs of demand and supply.

Based on this, a trend analysis based on the current spot quantity demanded and supplied values is constructed; it determines the spot price of cryptocurrency. Open loop in this case refers to a method that adjusts the spot price using data from other market participants. This method adjusted the ultimate spot price based on market supply and demand data. Such correlation is required if, for instance, the volume of transactions on a new cryptocurrency stock exchange is minimal. This indicates that demand and supply data collected at this intensity level are irrelevant to the market values of demand and supply. For instance, if the difference between the calculated spot price and the average spot price on the market is greater than 15 %, the market price will be used.

Analysing the character of cryptocurrencies allows concluding that, from a microeconomics perspective, cryptocurrencies are commodities. This idea is supported by international groups working on IFRS-compliant accounting issues for cryptocurrency transactions. However, real cryptocurrency stock exchanges can use the methods described in this document when determining the current price for their customers. This method can also be applied to all cryptocurrency transactions. The price can be determined not only in fiat currency, but also in other cryptocurrencies or virtual currencies.

Fintech licensing per digital financial products types

Providers of digital financial products within the EU must follow the EU and national regulations. The compliance depends on the category of the product: payment systems, banking products, investment products, insurance products, or cryptocurrency exchange. Each of these categories has its own unique set of rules and requirements. Meanwhile, providers of digital banking products must comply with PSD2 and the Capital Requirements Regulation (CRR). The CRR sets out minimum capital requirements for banks operating within the EU in order to ensure their solvency during economic downturns. It is essential for providers of digital financial products within the EU to stay up-to-date on relevant regulations and take steps towards full compliance to create a safe and secure financial environment. The providers also required to implement strict anti-money laundering procedures, secure data protection measures, consumer protection including transparent pricing policies, clear terms and conditions of use and easy-to-use dispute resolution mechanisms.

The EU has established a unified set of standards and regulations for digital payment systems providers to protect both customers and businesses. Providers must continually monitor their operations and assess any new risks that may arise in order to maintain compliance with the applicable regulations. According to the EU regulations, these companies must be licensed as electronic money institutions or payment institutions. Compared with banks these license holders prohibit the sale of derivatives, crediting, letters of credit, and similar products to customers (Athanassiou & Mas-Guix, 2008; Faccia *et al.*, 2020).

There are legal requirements for the ***providers of digital banking products*** in the EU.

Providers of digital banking products must obtain a license from the relevant authorities. The licensing process involves demonstrating compliance with various regulations, including those related to data protection and anti-money laundering (Faccia *et al.*, 2020; Cristea, 2021; Mursalov, 2021; Popova & Sproge, 2021; Kasri *et al.*, 2022; Murinde *et al.*, 2022). They must ensure the security of users' information. This includes implementing measures such as two-factor authentication and encryption of sensitive data.

One of the primary regulations for the ***providers of digital investment products*** is Markets in Financial Instruments Directive II (MiFID II). Under MiFID II, providers of digital investment products must ensure that they have adequate policies and procedures for managing conflicts of interest. They must also provide clients with a clear breakdown of all costs associated with investing, including any fees or charges.

The digital investment product providers may be subject to other regulations, such as the Alternative Investment Fund Managers Directive (AIFMD) or the Undertakings for Collective Investment in Transferable Securities (UCITS) directives. They also subjected to

anti-money laundering regulations under 4AMLD and its revisions under 5AMLD. It requires financial institutions operating within Europe to identify suspicious transactions through stringent due diligence measures (Faccia *et al.*, 2020).

By following these regulations, these providers can provide a safe and secure digital banking experience for their customers (Ruan, 2019).

Digital insurance products are subject to strict rules and guidelines set by the EU. Providers of these products must obtain a license from the regulatory authority. They also need to conduct background checks on their customers and maintain proper records of all transactions. They are also subjected to data protection regulations under GDPR and safeguarding sensitive data against cyber-attacks or unauthorised access. In addition, digital insurers are required to explain clearly the terms and conditions of policies offered through online channels. Customers should know the covered risks and any exclusions that may apply.

These legal requirements ensure trust between customers and providers and promote fair competition within the industry (Abrol, 2016; Marano, 2021; Srivastava *et al.*, 2022).

The EU imposes legal requirements on ***providers of cryptocurrency exchange services*** within its member states (Bech & Garratt, 2017; ESMA, 2018; Hacker & Thomale, 2018; EU, 2020; Tana & Breidbach, 2021; Cernisevs & Popova, 2023). One of the main legal requirements is compliance with Anti-Money Laundering (AML) legislation based on the type of Crypto assets (Hacker & Thomale, 2018). Cryptocurrency exchanges must implement adequate measures to prevent money laundering and terrorist financing activities on their platforms (Faccia *et al.*, 2020). They are also subjected to Know Your Customer (KYC) regulations by verifying user identities before allowing them to trade or make transactions on their platforms, to data protection laws such as GDPR.

There is no uniform method for implementing these legislative acts across the EU, but obtaining a license is a requirement for this activity in all EU countries. In some countries, local law requires financial institutions to be licensed, while in others, registration with organisations combating financial crime is sufficient.

There are various types of digital financial products available to consumers in the EU. These products can be broadly categorised into five groups: digital payment systems, digital banking products, digital insurance products, digital investment products, and crypto assets.

Digital payment systems are electronic systems that allow individuals and businesses to make transactions using digital currencies. They are typically issued and processed by financial institutions such as banks and payment processors.

Digital banking products are financial products that allow customers to manage their accounts and transactions online. These products include digital wallets, mobile banking apps,

and online banking services. They are typically issued by banks and financial institutions and are processed through their respective platforms.

Digital insurance products provide coverage for various types of risks. These products are typically issued by insurance companies and are processed through their online platforms. Examples of digital insurance products include travel insurance, car insurance, and health insurance.

Digital investment products allow individuals to invest in various financial instruments such as stocks, bonds, and mutual funds online. These products are typically issued and processed by investment firms and brokerages. Examples of digital investment products include robo-advisors, online trading platforms, and investment apps.

Crypto assets are digital assets that use cryptography to secure and verify transactions and control the creation of new units. Examples of crypto assets include Bitcoin, Ethereum, and Ripple. These assets are typically issued and processed through blockchain technology and are not regulated by traditional financial institutions.

The EU has a regulatory framework to ensure that these institutions operate in a safe and sound manner and provide consumers with transparent and fair services.

One of the main regulators overseeing the digital financial sector in the EU is the European Banking Authority (EBA). The EBA is responsible for ensuring the safety and soundness of banks and other financial institutions in the EU. The EBA sets standards for the prudential regulation of banks and works with national authorities to ensure the effective implementation of these standards.

In addition to these regulators, there are also national regulatory bodies in each EU member state that oversee the operations of financial institutions. These bodies are responsible for ensuring that financial institutions comply with local regulations and operate in a manner that is consistent with national laws.

The regulation of digital financial products is particularly important given the risks that these products can pose to consumers. These risks include the potential for fraud, money laundering, and the misuse of personal information. To address these risks, the EU has regulations governing the use of digital financial products

Financial institutions play a crucial economic role by providing financial services to individuals and businesses. However, they are exposed to risks that can have significant consequences if not properly managed.

2 Regional Aspects of Financial Products Market

The research focuses on businesses registered within the EU member states (European Union, 2022). This collective region forms an internal market that facilitates the free movement of goods, services, people, and capital. The harmonisation of legislative frameworks is ensured through agreements that involve EU legislation's ratification by the EU member countries. This chapter analyses the regional aspect of the financial institutions functioning in the EU, regional and national policies in the EU and their impact on fintech, the ECB as a regulator of financial market in the EU, fintech as a trend, and case studies of regional principles application.

2.1 Regional aspect of financial institutions operations in the EU

The contemporary conditions increase the number of interconnections and introduce new variables in socio-ecological systems (Armitage & Johnson, 2014) and impact all types of fintech. Markets are a visible aspect of fintech with increased financial diversity, financial inclusion, optimised digital ownership, improved capital allocation with social responsibility, robust digital ethics programs, and human-cantered design.

The financial inclusion is a priority for many organisations. A recent report on financial inclusion and diversity from the World Bank states that the global goal is to give one billion people access to a transaction account. The nation's financial inclusion index is largely determined by the level of financial access, which also serves as the basis for both economic growth and the reduction of poverty. Another essential component of success is digital fluency, which is made up of digital competency, digital literacy, and digital proficiency. "Companies must adapt to new technological contexts and paradigms, using internal resources and external opportunities offered by innovation ecosystems, particularly at the regional level," (Boyer, 2021).

Fintech could benefit from dividing their workflows among a group of companies located in different regions. This is the second intangible characteristic of fintech. Fintech internal processes use the regional resources, for example, call centres and messaging services, Know Your Customer services, card personalisation services, etc.

Assessing the economic policies of EU countries is essential for ensuring sustainable economic growth and stability of the financial system. With the rise of fintech, it is crucial to understand how these policies impact the development and growth of the fintech industry. Fintech has the potential to revolutionise financial services and improve access to finance, but it also poses new challenges and risks, that policymakers must address. By assessing economic policies, regulators can identify areas where policy changes or improvements may be needed to support the growth of the fintech industry while minimizing potential risks. Furthermore,

monitoring fintech developments can help identify emerging trends and challenges that must be addressed.

Regional economy factors application

In the digital economy, financial services enable businesses to operate smoothly and efficiently. By providing access to capital, financial services allow businesses to invest in new products and technologies, expand their operations, and hire new employees. In addition, financial services help businesses manage risk and protect themselves from potential financial losses.

Without access to financial services, many businesses cannot stay stable in the digital economy. Financial services provide the liquidity that businesses need to survive during periods of economic turbulence. They also enable businesses to take advantage of new markets for selling products and services or investing in innovative technologies.

Digital economy business models are often built on trust less interactions between parties. For example, when two businesses agree to trade goods or services using a blockchain-based platform, they can do so without needing to know or trust each other. This type of trust less interaction is only possible because of the security provided by financial institutions and other intermediaries. Without these intermediaries, conducting business in the digital economy would be far more complicated and riskier.

Overall, financial institutions play a vital role in the digital economy by providing the capital that businesses need to grow and flourish. They also help businesses manage risk and protect themselves from potential financial losses.

From Adam Smith's "The Wealth of Nations" (Smith, 1776) to modern-day theories, how regions function and thrive economically has been a subject of deep study. But with the advent of technology and globalisation, these theories have had to adapt to keep up with rapidly changing times.

In economic geography, location theory is a theoretical framework that explains the distribution of economic activity across space (North, 1955). The main objective of this theory is to identify the factors that influence the location decisions of firms and households. One of the most important aspects of location theory is market access. This refers to the ability of firms and households to reach their markets for goods and services. Market access can be limited by a number of factors, including transportation costs, trade barriers, and geography. Another important aspect of location theory is agglomeration economies. This refers to the positive externalities that firms and households have when they are located close to one another. These externalities can take the form of lower transportation costs, improved communication and information exchange, and increased innovation. Location theory is used to explain a wide

range of phenomena in economic geography, including the distribution of industries across space, the growth of cities, and the patterns of international trade.

Financial services are fully digital products, and therefore, the main question is whether the digital economy has any regional economy aspects.

Regional economy aspects affecting the fintech as the subject of the digital economy

According to (Pilat, 2020), “the digital economy includes all economic activities that depend on digital resources or are significantly improved through their use, including digital technologies, digital infrastructure, digital services, and data. It applies to all producers and consumers, including the government, who use these digital resources in their economic activities". Only firms providing financial and insurance services operate completely in the digital field. This means that production, distribution, and customer communication occur entirely in the digital space.

(Williams, 2021) analysed the multiple definitions of the digital economy. Based on (Cernisevs *et al.*, 2022), the following important characteristics of the digital economy were identified: the digitalisation of goods and services using technologies that combine creativity, knowledge, and intelligence by users. Thus, goods and services and the environment for their delivery from physical space are transferred to cyberspace. (Shibusawa, 2000) identified the following: in cyberspace, labour, goods, and services are transformed into electronic information and traded through a telecommunications network; in the physical world, these goods are transported utilizing the transport system.

Modern trends in trade assign great importance to exports in regional development and determine the importance of the benefits in the world economy obtained from trade relations between countries, including those at different stages of development. Accordingly, the basis of the regional economy in the modern world is the specialisation of various regions in resources (represented by production factors), which they export to other regions. Consequently, there are indications of regional factors in the economic trade of both finished goods and raw materials between regions.

Financial services which include transactions with digital assets are fully digital. Financial services are the processes by which consumers and businesses purchase financial products. According to (Pilat, 2020) financial services operate entirely in the digital field, so they were chosen to consider aspects of the digital economy. The digital economy affects various aspects of economic interaction in society, in particular the procedure for the exchange of labour, which is carried out on digital platforms (International Labor Organisation, no date; Drahokoupil & Jepsen, 2017). The use of digital platforms and remote work burrs the concept of labour export. The International Labour Organisation (International Labor Organisation, no

date) sees digital platforms as a significant change in the modern economy, considering both the ability to work remotely in freelance at special remote workplaces and the use of regional applications that anyone can join (for example, Uber). Considering the above, there is the absence of a migration factor or manifested regional interaction in the use of labour resources in the digital economy.

(Ruan, 2019) believes that the current value theories are no longer applicable to products and services within the digital economy. The reason for this is the nature of digital products and services – digital goods are goods that can be fully expressed in bits so that a complete business cycle can be done on an electronic infrastructure such as the Internet (Wagner, 2020). Accordingly, the regional component in the production of these goods is not manifested, since the regions themselves participating in its production are also not manifested.

Therefore, the traditional factors of production in the digital economy have the following features:

- The regional component in these factors of production is not expressed. Since access to the digital platform is unlimited, there is no clear regional preference or choice. At the same time, work resources from different regions can take part in the creation of a product or service, as well as in their sale. Moreover, some goods or services can be created and implemented without human intervention at all, but only with the help of artificial intelligence, represented by cloud solutions (Wagner, 2020). Thus, this factor may not be involved in production at all, or its role may be very limited.
- Land as a factor of production: within fully digital products and services, there are no explicit raw materials. And accordingly, the regional component is absent.
- Capital as a factor of production during the pre-digital economy always has regional affiliation, since regions with more developed economies usually served as sources of this capital. However, crowdfunding has changed this situation since a lot of small investors can serve as a source of capital for production without a distinct belonging to one or another region (Mollick, 2014).
- Entrepreneurship: this factor of production in the digital economy has one of the key values. Since entrepreneurship as a category of the economic theory refers more to active, risky, and profitable activities and less to activities that provide a sustainable competitive advantage, while (Makarov *et al.*, 2020) indicate that the development of the entrepreneurial function and the related implementation of new opportunities to increase the competitiveness of entrepreneurial structures. This factor also has no regional features.
- Information is a key factor in the digital economy. It displays the information itself, used for production and sale, as well as the solutions based on artificial intelligence. Information

in the digital economy is usually located in telecommunication networks and therefore also does not have a pronounced regional component.

Thus, there is a certain problem in applying the current theories of regional economics is the lack of physical/geographical distances between the subjects of economic relations.

Regional characteristics of the digital economy

The interconnection between fintech and the digital economy provides the integration of financial services and technology (Cernisevs *et al.*, 2022). Fintech refers to innovative technological solutions and applications that enable the delivery and management of financial services in a more efficient, convenient, and accessible manner.

The digital economy, on the other hand, encompasses the entire economic ecosystem driven by digital technologies, such as the internet, mobile devices, cloud computing, artificial intelligence, and big data. (European Commision, 2014; Serrano, 2018; Panov *et al.*, 2019; Pilat, 2020; Spence, 2021)

The globalisation of the economy is one of the most important factors to consider. Globalisation led to international integration into a single system of labour, information, technology, goods, and assets (Khizbullin *et al.*, 2017). Theories of regional development of the late 19th and early 20th centuries identified the increase in GDP and GDP per capita as the main indicator of the region's development. At the same time, it was believed that economic growth, measured in GDP, must necessarily lead to an increase in production and an increase in the welfare of the inhabitants of this region.

Theories of regional development in the 21st century are the continuation of the theory of regional development by Joseph Schumpeter (Schumpeter & Opie, 1934) and Zeibote (Zeibote *et al.*, 2019). According to Schumpeter, progress is driven by the use of innovation/knowledge by entrepreneurs, the very factor of the neo-economic factor of production – information. It is this, in his opinion, that disturbs the equilibrium described in the works by (Walras, 1890). This creates new opportunities for economic entities and increases their income. At the same time, Schumpeter was not limited only to technical improvements and talking about innovations but also proposed to revise and create new markets, new needs, and forms of doing business.

In parallel with the development of the regional development theory, regional economics appeared. Regional economics focuses on the economic aspects related to territorial space, and by its nature, it is the economics of territorial development (Zeibote *et al.*, 2019). Based on Schumpeter's theory, not only the distance between economic entities is involved in the formation of equilibrium between regions, as Walras pointed out, but competence, the potential for innovation, and the ability to do business in a new way.

Globalisation has largely changed the regional division, which was more fragmented in the middle and late 20th century and mostly coincided with the borders of countries. Moreover, globalisation is the final stage of economic integration. (Balassa, 1961) described the stages of integration, the introduction of which could be observed throughout the end of the 20th century. These include the development and ratification of free trade agreements by countries, which removed tariff barriers between regions, and then the creation of customs unions and common markets. These processes can still be observed. The (World Trade Organisation, 2023) monitors the conclusion of regional trade agreements and their dynamics.

The existence of regional trade agreements and the innovations of the 21st century have had a significant impact on the development of fintech. The interconnectedness facilitated by regional trade agreements has created more opportunities for cross-border trade and investment, leading to an increased need for efficient and seamless financial services.

As businesses and individuals engage in international transactions, the demand for fast, secure, and cost-effective payment and money transfer solutions has grown. Fintech companies respond to this demand by developing innovative digital payment platforms and remittance services, making it easier for people to transfer money across borders and conduct international business transactions. The digitalisation of various industries led to the generation of massive amounts of data, which can be leveraged by fintech companies to provide data-driven financial solutions and personalised services.

The innovations of the 21st century shaped the digital economy. Traditionally, the factors that shaped the digital economy include the development of telecommunication networks, as well as the Internet (Khizbullin *et al.*, 2017). The individual services, including public ones, were the drivers of the movement towards the digital economy:

- The development of communication as such – the emergence of emails, Skype, and then communicators, first on stationary computers and then on mobile phones – significantly increased the density of communication between representatives of economic entities and, as a result, increased economic ties between the regions.
- The development of automatic translators (free and publicly available) made it possible to establish communication and economic ties between regions, communication between which was limited by language barriers.
- The ability to receive services, including legal services, in other regions remotely opened up new opportunities for doing business in other regions
- All this led to the fact that entrepreneurs within the digital economy could conduct business and organise business processes simultaneously in several regions.

Digital economy in the context of the new theory of regional economics

The early theories of regional development were associated with the physical characteristics of the location of regions and their interaction. According to Schumpeter's theory for the digital economy, the interaction of regions is based on the principle of the presence of innovations in them or unique characteristics related to the production factor information (Cernisevs *et al.*, 2022). In cyberspace, interactions are organised with regions that have the best from the point of view of information production proposals (Shibusawa, 2000). The main difference between the provision of digital services within the digital economy and the classical one is the order of interaction with customers. Since the end of the 20th century, the financial services industry has migrated to cyberspace, as all stages of their production have moved to the digital format. At the same time, the only element that required work in the physical world was customer service, when clients came to financial institutions to receive these services. However, in the last 10 years there is a revolution in the provision of financial services: fintech, by optimizing internal processes for the provision of financial services, allowed clients to receive these services, including complex ones, directly, without physical interaction with a financial institution.

Thus, financial services became available cross-regionally. Moreover, if, for example, in the EU and the common market for financial services based on their passporting (Polasik *et al.*, 2020) they are provided based on the developed legislative rules, then clients not located in the EU can also receive these services if their local legislation does not prohibit it. For customers, in most cases, there is no difference in regions because financial services are mostly the same in all regions and are equally available. It is necessary to make only one digression: this theory may be relevant in all types of collateralised lending. At the moment, there is still no effective cross-territorial control over collaterals, and therefore, services in which collateralised lending are involved will adhere to territories where their collaterals are located.

Thus, it is necessary within the framework of existing theories to reduce the number of factors that are relevant to the economy in physical space.

Ecosystems as an implementation of the theory of production localisation

fintech plays a crucial role in ecosystem businesses within the financial services industry. According to (Moore, 1999) description of ecosystem businesses, companies collaborate and compete to develop opportunities around innovations, supporting new products and meeting customer needs to drive further innovation. In the context of the regional economy, fintech facilitates the implementation of production localisation theory within the financial sector's ecosystem.

In this ecosystem, fintech and traditional financial institutions work together to provide comprehensive and integrated solutions to customers. Clients can access a range of related financial services from different entities within a single application or platform. Furthermore, fintech often collaborate with traditional financial institutions or other entities from various regions to create innovative financial products and services.

(Still *et al.*, 2019) consider the ecosystems from the point of view of innovative interaction, ecosystems have a more pragmatic goal – as efficiently as possible, in terms of achieving the goal, managing taxes, providing the highest possible level of services, and organizing a business. At the same time, the provision of services is divided into chains, which can be located in different regions, which allows each of the production chains and the entire process to be more efficient. This considers the characteristics of the regions.

The digital economy has allowed new methods of organizing business. For example, entrepreneurs who plan to provide financial services can choose the most suitable jurisdiction (a region based on a country or a separate zone in a country) to provide a service and register a financial institution there. The selection criteria are as follows:

- Financial Services Regulations. Even on the territory of the EU countries, where the regulations of the European Parliament mostly harmonies the legislative acts, the methodology for their regional implementation may contain differences that are not critical for the implementation of regulations of the European Parliament but are essential for the provision of services and give entrepreneurs additional advantages on the market.
- Regional tax legislation: the tax component is significant both in the structure of the cost of financial services and an emotional component for clients if these taxes directly affect the financial services received by the client (for example, capital gains tax).
- AML legislation of the region: in particular, this applies to a part of the onboarding of new customers. A remote onboard of clients is important for the digital economy and, accordingly, the requirements for such an onboard (their completeness of description in the legislation, the practice of the regulator to control the onboard) are essential when choosing a region for registering a financial institution.
- Regulatory requirements for personnel.

Financial services provided by several companies located in different regions are the ecosystem. For example, within the framework of one fintech application, the client receives services for the execution of bank transfers and operations with crypto assets. At the same time, these services are provided by a financial institution registered in one region and a crypto exchange institution registered in another region. Moreover, within the framework of the theory of production localisation, each production element is located in the most efficient place.

If we separately refer to the work with crypto assets in the example of the EU, then they most clearly characterise the theory of production localisation. When planning the provision of the combined services, considering the absence of an approved normative document of the European Parliament on organizing the work of crypto exchange companies, the difference in the regulatory framework in the EU countries is enormous. Accordingly, when planning to work with crypto assets, it is necessary to carry out the same analysis as for a financial institution.

The absence of the space factor for the digital economy, its regional component does not disappear, and it can be modelled easily. At the same time, the resources that began to characterise the regions can be attributed to non-mobile resources as in the Richardson model (Richardson, 1964; Richardson, 1972; Richardson, 1990), but their presence and change are determined by the views of Schumpeter, who referred innovation to this resource. All this led to the development of regions in the digital economy associated with ineffective or balanced use of resources or production and with conscious planning and creation of these resources as innovations. Moreover, after their creation and implementation, these resources behave within the framework of the regional economy in the same way as classical resources.

The model simplifies a specific scenario in the regional economy where all regions are equally distant from each other. Instead of forming rigid crystal lattices for interaction, it takes the shape of a ball with production at the centre and the product located outside any region. Surrounding the product, at the same distance, are resources located in regions with zero distance. However, even with zero distance between resources and production, there are delivery costs to the production point, represented by the tax characteristics of the region.

In the context of fintech, this eco-system highlights the importance of considering taxes and duties when conducting cross-border transactions. When fintech operate in a global or regional market, they may pay additional taxes and duties, such as excise taxes and VAT, which can affect their costs and pricing. Managing these taxes is highly important for fintech to optimise their operations and provide cost-effective services to their customers in different regions. By taking into account these tax characteristics, fintech companies can control the cross-border transactions and serve better their customers within a globalised economy.

As in the classical theory, the regions are characterised by specialisation: for example, Crypto Valley in Switzerland, Lithuania's specialisation in financial institutions, and Estonia's specialisation in crypto exchange institutions are the typical specialisations in the provision of financial services. Thus, a modern financial product can be based on local industries located in different regions but united by one production eco-system.

2.2 Regional and national policies in the EU: impact on fintech

Any economic shifts the business practices (Kurpayanidi, 2020; Kurpayanidi 2021). The trajectory of the financial industry's development is determined by a combination of environmental factors, which are currently characterised by instability and increased risk. Customers' requirements are the primary determinant of the paradigm shift in the activities of financial institutions. Generations Y and Z are more loyal to digital companies than traditional competitors. To guarantee their long-term survival in the market, financial institutions transit to a new format of their activities, introducing breakthrough technologies and innovative approaches to management. Globally dominant financial and credit institutions are taking active steps to respond to new conditions, thereby establishing new banking industry standards (Kryvych & Goncharenko, 2020; Cristea, 2021; O'Leary *et al.*, 2021; Murinde *et al.*, 2022; Windasari *et al.*, 2022).

The rapid development of digital and electronic is a significant factor in the transformation of the economy (Panov *et al.*, 2019). As a result of analysing the impact of digital and electronic technologies on economic processes, a significant change in the economy is identified (Sukhorukov *et al.*, 2018). The OECD presented a report on the digital economy at the G20 summit in Saudi Arabia 2020. In the preceding report, the following definition of the digital economy was provided: "The digital economy comprises all economic activities that rely on digital resources or are significantly enhanced by their use, including digital technologies, digital infrastructure, digital services, and data." This applies to all producers and consumers, including the state, who use digital resources in their economic activities" (Pilat, 2020). According to the same report, only firms providing financial and insurance services operate in the digital field.

The digital economy creates the additional benefits through the expansion of sales markets and the use of the Internet as an open platform with a large audience (Mentsiev et al., 2019). However, the digital economy carries new risks and challenges.

(Pilat, 2020) determined that only financial and insurance services are completely digital. Thus, these two industries are the most prospective for assessing the impact of the digital economy on the internal financial management processes of service providers. In this instance, the processes associated with the non-digital delivery of services will not distort the analysis of digital processes further.

The following ICT technologies have been developed within financial institutions over the past decade:

1. The development of Big Data technology reduces the amount of time required to evaluate loan applications and assess the creditworthiness of customers, manage financial crime risk,

and control cyber risk. This technology appeals to financial institutions and enables them to combat plastic card fraud, monitor compliance with laws and requirements of the regulator, and provide risk management and client management (Computation and Big Data for Transport, 2020; Nobanee et al., 2021).

2. Cloud computing is an instrument for processing and categorising the incoming data. Cloud technologies include official software, licensed hardware, binding tools, channels, and technical support for all user groups, as well as significant savings on software acquisition costs and a reduction in the risk of data loss (Hon & Millard, 2018; Kumar & Jaisankar, 2020; Cheng *et al.*, 2022).
3. The Internet of things is technologies allowing the physical objects to communicate with each other and the outside world (for example, smartwatches). This innovation permits the banking sector to assess the requirements of their customers in the future and, as a result, provide them with the specific services they require, thereby expanding the commercial bank's customer base and increasing brand loyalty (Khanboubi *et al.*, 2019; Bhat *et al.*, 2023).
4. With the proper maintenance of the bank's information profile, social networks can contribute to constructing a group of highly loyal customers (Atmaca *et al.*, 2020; Naeem & Ozuem, 2021).
5. Blockchain technology is the foundation of the cryptocurrency. Cryptocurrency is the implementation of specific algorithms in a consistent manner by a cryptographer. Blockchain transactional blocks work as a technique for constructing distributed databases (in the absence of a common centre). Each record in the transaction block comprises information regarding all owners. This characteristic explains the low likelihood of information falsification by third parties. In the currency systems of the virtual world, Blockchain is extensively used to perform operations related to the issuance and/or transfer of monetary units, as well as to store their histories (Ertz & Sarigöllü, 2019; Mentsiev *et al.*, 2019; Alahmadi *et al.*, 2022; Cernisevs, 2021). Blockchain characteristics determine the most important characteristic of cryptocurrencies, namely the impossibility of forgery. In addition, cryptocurrencies have open-source software code, no need for external regulation, a single emission centre, cross-border accessibility, and low transaction costs. On the one hand, the introduction of Blockchain and other technologies increases the trustworthiness of virtual currencies at the state level; on the other hand, such use is contrary to the crypto space's ideology, which is based on the principle of decentralisation. The exchange of cryptocurrencies and other transactions involving crypto-assets are not considered financial

services under the EU law, but they can be categorised as services provided solely in the digital space (Ertz & Boily, 2019).

6. Electronic payment systems, mobile payments and e-wallets are penetrating into various spheres of people's lives. Maintaining stable operation and high reliability of electronic payment systems (including mobile applications of Internet banking and SMS banking systems) allows commercial banks to remain competitive. (Mustapha, 2018; Kasri *et al.*, 2022)
7. The consecutive application of successive iterative methodologies of software development and design is an example of agile technologies. Agile methodology requires adaptability of requirements at all stages of software technology development. The task is divided into stages (or sprints). At each stage, the new product is tested and then adapted to customer needs at the micro level and economic conditions at the macro level (Berkani *et al.*, 2019; Dewantari *et al.*, 2021; Indra *et al.*, 2021). Implementing agile technologies allows the bank to increase its competitiveness by establishing a clear structure for business processes and issuing modern banking products with high-performance metrics and to accelerate the digital transformation (Dewantari *et al.*, 2021; Indra *et al.*, 2021).

fintech refers to transformed financial institutions utilizing advanced ICT technologies (Dhar & Stein, 2016; European Commission, 2017; Agarwal & Zhang, 2020; Boyer, 2021). Fintech enhances and automates the provision and utilisation of financial services, helps companies, business owners, and consumers manage better their financial transactions, and processes through specialised software and algorithms. (Silva & Di Serio, 2016)

However, fintech represents the final evolution of financial services. Initially, the first impulse of the digital transformation of the fifth wave of technological innovations, known as Industry 4.0, transformed the internal processes of financial institutions (Vaidya *et al.*, 2018; Alcácer & Cruz-Machado, 2019; Ardito *et al.*, 2019; Tupa & Steiner, 2019; da Silva *et al.*, 2020; Suleiman *et al.*, 2022). Consequently, fintech is not only a solution to enhance and simplify the consumer experience with financial products but also a solution that transforms all aspects of financial services, including internal processes.

The technology becomes a crucial component of economic strategy. (Lamba and Malhotra, 2009) Current financial services and crypto asset management are products of digital transformation (Kitsios *et al.*, 2021). Their production is also digital since crypto-asset-based products are entirely digital (Qin *et al.*, 2016; da Silva *et al.*, 2019).

The growth and success of fintech companies are impacted by a range of factors, including national policies and regulations. There are many economic and financial policies

implemented across the EU member states. The national policy differences can have a significant impact on the development and growth of fintech companies.

Effect of economic policy on fintech

The economic policies of the EU can have a significant impact on fintech risks within the region. The economic integration fosters a conducive environment for fintech companies to operate and expand their services across borders:

1. Regulatory Framework: The EU economic policies influence the regulatory framework for fintech companies. Harmonised regulations and standards within the EU promote consistency and clarity in compliance requirements for fintech firms. This can help reduce regulatory complexities and risks associated with operating in multiple jurisdictions (Armstrong, 2016; Richter, 2020; Ahern, 2021; Rupeika-Apoga & Wendt, 2022).
2. Access to Markets: The EU economic policies facilitate access to a larger market for fintech companies. This increased market size allows fintech firms to scale their operations and reach a broader customer base, potentially leading to more opportunities for growth and revenue generation. (EU, 2020)
3. Capital Flows: Easy access to capital and funding sources can enable Fintechs to invest in technology, innovation, and risk management practices. On the other hand, restricted capital flows or economic downturns may pose challenges for fintech firms in terms of securing funding and managing financial risks (von Luckner *et al.*, 2021).
4. Digital Infrastructure: The EU focus on digitalisation and technological advancements positively influences the digital infrastructure available to fintech companies. Improved digital infrastructure, such as high-speed internet and secure payment systems, enhances the efficiency and reliability of fintech services, reducing operational risks (European Commision, 2014; Venkatraman Venkat, 2017; Serrano, 2018; Verhoef *et al.*, 2021; Windasari *et al.*, 2022).
5. Cybersecurity Measures: The EU economic policies also impact cybersecurity measures and data protection regulations. Robust cybersecurity policies and data privacy laws play a crucial role in mitigating cyber risks for fintech companies operating in the region (Khan & Malaika, 2021).
6. Economic Stability: The economic stability and growth prospects of the EU member states influence the financial and market conditions for fintech. Economic downturns or financial crises may introduce new risks and challenges for fintech such as increased credit and liquidity risks (Mursalov, 2021; Pesch *et al.*, 2021; Kasri *et al.*, 2022).

The economic policy of the EU can significantly influence the risk environment for fintech operating within the region. The EU provides a supportive economic framework, and

fintech can navigate the potential risks effectively. However, changes in economic conditions or regulatory policies can also introduce new challenges for fintech.

Despite growing interdependence and pressure towards the common EU policy patterns, it is evident that socioeconomic diversity within the community cannot be ignored. The EU faces the emergence of new international governance structures and application options (Telò, 2002); therefore, there is a need in specially developed coordination mechanism.

Gradually, coordination mechanisms between the EU nations have been developed and implemented:

- In the sphere of economic policy – Broad Economic Policy Guidelines – within the framework of the 1992 Maastricht Treaty
- In the sphere of employment policy – the European Employment Strategy – within the context of the 1997 Luxembourg Summit
- Structural reforms – in the context of the 1998 Cardiff summit
- Formation of the macroeconomic dialogue between the countries – within the context of the 1999 Cologne summit
- In terms of fiscal policy, the Stability and Growth Pact of the 1999 Amsterdam Summit

The open method of coordination was used to coordinate the correction of the asymmetry between the monetary union and the social union, as well as the implementation of the Lisbon strategy and the common social model (CSM) (Lomakina, 2009).

The elements constituting the open technique of coordination:

- the formulation of short-, medium-, and long-term directives and timetables for the EU member states' achievement of the set objectives;
- the development of quantitative and qualitative indicators and the implementation of benchmarking in order to compare the policies pursued with the world's best indicators in these categories;
- the transformation of the principles developed at the European level to the level of national and regional policy with the setting of specific goals and objectives and consideration of national and regional differences;
- periodic monitoring, evaluation, and analysis organised as a process of mutual learning (European Council, 2000).

The European Parliament authorised a new development strategy – Europe 2020 – that outlined the following priorities (European Commission, 2010):

- Intelligent development: the expansion of the economy based on knowledge and innovation.
- Sustainable growth: fostering a more resource-efficient, environmentally-friendly, and competitive economy.

- Inclusive Growth: Promoting a high-employment, socially and territorially cohesive economy.

The strategy also aims for the following:

- 75 percent of those aged 20 to 64 should be employed.
- percent of the EU's GDP should be invested in R&D.
- The 20/20/20 climate/energy targets must be attained (including an up to 30 % reduce emission if conditions are favourable).
- Less than 10 % of students should drop out of high school, and at least 40 % of the younger cohort should hold a college degree.
- The prospect of poverty should affect 20 million fewer people.

The achievement of these objectives was intended to be accomplished by coordinating the policies of the EU member states. Therefore, the EU member states, particularly those that use the euro, coordinate their economic and fiscal policies throughout the year to ensure that they are consistent with shared objectives and responsibilities. The objective of the EU economic governance system is to monitor, prevent, and correct problematic economic trends that could undermine the national economy or negatively impact other EU nations.

The European Commission monitors prospective issues such as risky or unsustainable policies or a decline in competitiveness by:

- routine analysis of national and international economic indicators, including GDP growth, inflation, and unemployment
- budget projections for national governments
- assessment of stability or convergence programs and national reform

In addition, the European Commission generates annually two key economic reports that aid in the identification and resolution of economic issues:

- Annual growth survey
- Control procedure report

The annual growth survey examines the EU's progress in achieving its long-term strategic priorities and provides a comprehensive assessment of employment and macroeconomic trends. Consequently, the annual growth survey establishes the EU's priorities for the following year. The control procedure report identifies countries that may experience imbalances, such as decreased competitiveness or asset markets, that could be detrimental to individual member states or the European Economic and Monetary Union if not corrected.

To prevent economic problems, the EU governments introduce various rules to ensure the quality and consistency of their economic policies. The goal of the imbalances control is to reach similar development of all EU members. The imbalances determine the sectors of

countries' processes, which may impact the digital products distributed by companies in this segment of the EU "single" market

Stability and Growth Pact (SGP)

According to the SGP, all EU Member States must support the predetermined financial goals, as they are a crucial prerequisite for sustained economic growth and financial stability.

The SGP in the EU is primarily focused on fiscal discipline and macroeconomic stability. While the SGP does not directly address fintech risks, its implementation and impact on the EU economic environment can have implications for the fintech sector:

1. Economic Stability: The SGP aims to ensure economic stability by setting fiscal targets for member states and promoting responsible fiscal policies. A stable economic environment can positively impact the fintech sector by reducing overall business and financial risks. When economies are stable, fintech companies may face fewer uncertainties related to market volatility, inflation, and interest rates, which can mitigate certain risks.
2. Regulatory Environment: The SGP's requirements for fiscal consolidation and coordination among member states can influence the overall regulatory environment within the EU. While the SGP itself does not directly regulate fintech activities, it can indirectly shape financial and technology-related regulations in member states. A harmonised and consistent regulatory framework can create a more predictable environment for fintech companies, reducing regulatory risks.
3. Access to Funding: The SGP focus on maintaining fiscal sustainability can impact access to funding for fintech. When member states implement responsible fiscal policies, it can lead to favourable economic conditions, including lower interest rates and a stable credit market. Improved access to funding can help fintech manage financial risks and support their growth and innovation initiatives.
4. Market Sentiments: The SGP's implementation can influence market sentiments and investor confidence within the EU. A positive economic outlook and confidence in the region's financial stability can attract more investments to the fintech sector. On the other hand, any challenges or concerns related to fiscal discipline in member states could create uncertainties in the market, affecting investor confidence and increasing certain risks.
5. Financial Inclusion: The SGP's emphasis on sustainable growth and economic development can also have implications for financial inclusion. Policies and initiatives aimed at promoting inclusive growth can align with fintech's goals of reaching underserved populations. Improving financial inclusion can contribute to the growth and expansion of fintech services but may also introduce unique risks related to serving diverse customer segments.

Overall, while the SGP does not directly address fintech risks, its influence on the EU's economic stability, regulatory environment, access to funding, market sentiments, and financial inclusion can have varying impacts on the risk for fintech operating within the region. It highlights the interconnectedness of the macroeconomic environment and financial technology, and how economic policies can indirectly shape the risk area for the fintech sector in the EU.

The EU member states establish budget targets, also known as medium-term targets, to keep national fiscal policy on track and to assure the long-term sustainability of public finances and public debt. All EU member states submit to the European Commission in April the budgetary measures they propose to implement to meet their obligations. Those who use the euro as their currency do so via stability programs, whereas others implement the convergence programs. In their National Reform Programs, all EU Member States also outline the structural reforms they intend to implement to stimulate economic growth and job creation. The Commission analyses two programs in each nation and then makes policy recommendations specific to each. Governments debate these recommendations with the Commission before incorporating them into their national policies.

To resolve the economic risks and challenges identified by the European Commission, the EU member states base their budgets on a set of common, agreed-upon priorities. This coordination and monitoring are even stricter with regard to the Euro area member states, which submit their preliminary budget plans for the following year to the Commission and their Euro area partners. If such a budgetary policy is impracticable or poses a significant threat, they may be required to submit a revised budget plan.

To possess accurate data, the EU regulations ensure that governments collect reliable statistics by establishing requirements for methodology, quality, transparency, and impartiality. The implementation of the EU economic governance system is structured as an annual cycle comprised of the European semester, the national semester, and numerous control procedures. Additionally, the EU has regulations that promote economic stability by preventing the emergence of dangerous macroeconomic imbalances (MEIs). The MEI ensures that governments address and discuss with the Commission and other EU member states any national economic trends that may constitute a threat to the economies of other EU countries. The overwhelming majority of the EU member states have signed the Stability, Coordination, and Governance Treaty (TSCG or "fiscal compact"), which enshrines the goal of balancing national budgets. It requires automatic policies to correct significant deviations and caps the annual deficit at 0.5 % of GDP for all governments.

The Excessive Deficit Procedure (EDP) is a set of rules that member states must adhere to if they run excessive budget deficits of more than 3 % of GDP or cannot reduce their

excessive debts (greater than 60 % of GDP) at an adequate rate. In accordance with the EDP, member states are obligated to return their excessive deficits or debts to secure levels. If they fail to take the necessary steps to eliminate their deficits or debts, they face the possibility of receiving warnings and eventually sanctions, such as fines of up to 0.2 % of their GDP. In such instances, regional subsidies from the EU "cohesion fund" may also be terminated.

In accordance with the Excessive Imbalance Procedure of the EU macroeconomic imbalance procedure, the European Commission may recommend to the Council that member states experiencing excessive imbalances be required to submit corrective action plans to rectify their circumstances. Member states of the Eurozone that repeatedly fail to submit or implement corrective action plans deemed sufficient by the Council may be subject to sanctions, including fines. The macroeconomic imbalance procedure seeks to identify, prevent, and resolve potentially harmful macroeconomic imbalances that could have a negative impact on the economic stability of a member state, the eurozone, or the EU as a whole. Macroeconomic imbalances are monitored annually as part of the EU's economic surveillance and guidance cycle (European Semester). The in-depth analysis seeks to identify and quantify any macroeconomic imbalances. A country may be deemed to have "no imbalances," "imbalances," "excessive imbalances with corrective action," or "excessive imbalances with corrective action with corrective action," which can initiate an over-imbalance procedure.

In the country-specific recommendations, countries with imbalances or excessive imbalances can receive policy advice on reducing them. Depending on the nature and severity of their imbalances, their political commitments will be monitored via ad hoc monitoring, including dialogue with national authorities and progress reports.

The Alert Mechanism Report (AMR) analysis is founded on an economic interpretation of a table containing 14 core indicators covering the most significant macroeconomic imbalances, competitiveness, and adjustment challenges. In addition to these 14 indicators, 25 supporting indicators provide additional information. The indicators are intended to capture the most significant internal and external aspects of macroeconomic imbalances using a small number of relevant, high-quality indicators.

The core indicators of the primary sources of macroeconomic imbalances:

- Three-year moving average of the current account as a percentage of GDP, with +6 % and −4 % thresholds
- Net international investment position as a share of GDP, with a minimum threshold of −35 %
- Value-based 5-year percentage change in export market share, with a threshold of −6 %

- Three-year percentage change in the nominal cost of labour per unit of output with +9 % and +12 % thresholds for the euro area and non-euro area countries, respectively
- Three-year percentage change in real effective exchange rates based on HICP/CPI deflators relative to 41 other industrialised nations, with thresholds of −/+5 % for euro area nations and −/+11 % for non-euro area nations.
- Consolidated private sector debt as a percentage of GDP, with a threshold of 133 %
- Credit Flow of the Private Sector as a Percentage of GDP, with a 14 % threshold
- Annual variations in housing prices relative to the Eurostat consumption deflator, subject to a 6 % threshold
- General government debt as a percentage of GDP with a 60 % threshold
- Inverse three-year moving average of the unemployment rate with a 10 % threshold
- Change in the financial sector's total liabilities compared to the same period last year, with a 16.5 % threshold
- Interest rate change over three years of activity, with a −0.2 % threshold
- Change in interest rate over three years of the long-term unemployment rate, with a +0.5 % threshold
- Change in interest rate over three years of the juvenile unemployment rate, with a threshold of +2 %

2.3 The ECB operations within the regional financial policy

ECB as a financial regulator

The ECB plays a crucial role as a financial regulator for fintech in the EU. With the rapid growth and innovation in the fintech industry, the ECB recognised the importance of providing a regulatory framework that fosters innovation while ensuring financial stability and consumer protection.

The ECB's involvement in regulating fintech is essential for several reasons. First, it helps to maintain the integrity and stability of the financial system in the face of emerging risks and challenges posed by new technologies. By setting the standards, the ECB helps to mitigate potential risks associated with fintech activities, such as cybersecurity threats, data privacy issues, and operational vulnerabilities. Secondly, the ECB as a pan-European regulator ensures fair competition and harmonizing regulatory practices across member states and fintech operating in the EU. Moreover, the ECB regulation contributes to consumer protection in the fintech sector. It sets standards for transparency, customer data protection, and dispute resolution, thereby safeguarding interests of consumers and trust in digital financial services. The ECB also plays a proactive role in monitoring and understanding the impact of fintech on

the broader financial ecosystem. By conducting research and analysis, the ECB identifies potential implications for monetary policy, financial stability, and macroeconomic conditions.

In conclusion, the ECB as a financial regulator for fintech promotes a balanced approach to innovation and risk management, and contributes to the sustainable growth and development of the digital financial services sector in the EU.

The ECB provides a single monetary policy in the Eurozone since January 1, 1999. The primary responsibility of the Eurosystem under the Treaty on the European Union is to maintain price stability. The ECB strategy allows keeping the compromise between decision-making efficiency and accountability to the public, and guarantees the credibility of the ECB and Euro (European Central Bank, 2004).

The ECB maintains the favourable financing conditions during crises times, for example, the pandemic, for achieving monetary policy goals (European Central Bank, 2020). The ECB stabilises markets, reassures potential borrowers, limits the potential of real financial loop.

In general, the ECB maintains favourable financing conditions by:

- Maintaining the already low level of the discount rate (deposit rate);
- Guiding on the future path of the discount rate;
- Providing a wide range of refinancing operations to ensure liquidity (first and foremost, a program of targeted long-term refinancing operations);
- Continuing asset purchases under the ECB's asset purchase program (supported by the expectation that net purchases under the program will end soon);
- During the post-pandemic period, the ECB intends to address the following tasks (Lane, 2021) :
- As part of the perpetuation of fiscal and monetary policies, analysing the impact of low equilibrium real interest rates is of the utmost importance.
- Analysis of the conditions for financial sustainability and the respective function of fiscal policy in macroeconomic stabilisation in relation to fiscal policy (Blanchard, 2019; Furman & Summers, 2020; Orszag *et al.*, 2021)
- Reducing the equilibrium real interest rate is the ECB's most important monetary policy objective.

Role of ECB in ensuring the monetary autonomy of EU within the global economy

According to (The Economist, 2019), close economic and financial connections between nations make inflation more global than domestic, and the ability of national central banks to regulate the conditions of domestic financing decrease. In line with the political

response to these manifestations (Panetta, 2021), the ECB believes that globalisation impacts inflation and financing conditions in the euro area. The ECB's responsibility is to keep the monetary independence of Eurozone. For example, the pandemic has increased the need for consolidation of monetary and fiscal policies, thereby reducing the risk of inflation.

The ECB regulates financial sector as a supervising institution for the national financial regulated institutions; it monitors and supervises these regulators for compliance with EU standards and regulations, identifies the potential risks and vulnerabilities in individual countries' financial systems and takes necessary action to prevent them from spreading across borders. Moreover, acting as an independent supervisor, it ensures transparency and accountability in Europe's financial system and promotes stability and confidence among investors. Overall, the ECB contributes significantly towards maintaining a sound economic environment within Europe and protects its interests in the global arena.

Inflation as a significant indicator of the Stability Pact

The Stability Pact places certain requirements on the level of inflation that national governments must maintain. The globalisation turned inflation as a global phenomenon (Monache *et al.,* 2016; Kamber & Wong, 2020). The Stability Pact places requirements on the level of inflation that national governments must maintain, and it affects the fintech risks. The Stability Pact aims to ensure fiscal discipline and economic stability within the EU, while the global component of inflation poses challenges for fintech. Fintech companies often operate across borders and are influenced by global economic trends, including inflation rates. The links between the financial markets and the global nature of fintech operations mean that fluctuations in inflation rates can have great effects on fintech, influencing interest rates, borrowing costs, and investment decisions, affecting the overall profitability and financial health of fintech. Globalisation adds complexity to the risk area for fintech. Deflationary pressures can lead to decreased consumer spending and investment, impacting fintech services that rely on consumer demand and investor confidence.

Additionally, fintech dealing with digital financial products and services may face unique inflation-related challenges. For instance, fluctuations in energy and commodity prices can affect the cost of data storage, cloud computing, and other technology-related expenses, impacting fintech operational costs. Inflation can also influence regulatory policies and consumer behaviour. As national governments respond to inflationary pressures, they may implement monetary and fiscal policies that impact fintech regulations and compliance requirements.

Trade integration can cause deflation due to lower import prices, lower production costs, and the forced exit of less productive domestic producers (Guerrieri *et al.,* 2008; Auer *et al.*,

2013; Amiti *et al.*, 2019; de Soyres & Franco, 2019). Increase in the supply of labour in the world could create a "global shortage" (Forbes, 2019). Growing international competition may limit the ability of companies to shift the growth of domestic costs to consumers (Fabio Panetta, 2021).

The ECB takes responsibility to solve these issues for Eurozone.

There are two approaches to the coordination of economic policy between EU nations:

- Coordination of diverse aspects of economic policy based on imbalances analysis
- Use of the bodies for the implementation of economic policy elements, such as the ECB

These unified bodies are influential not only in national economies but also in globalisation conditions.

In conclusion, the ECB function as a regulator for fintech is crucial for fostering a safe, secure, and innovative financial ecosystem in the EU and ensuring that fintech and new technologies comply with stringent regulatory requirements.

The ECB monitors and assesses the potential hazards that fintech may introduce. By employing comprehensive risk assessment methodologies and KPIs based on risk appetite and values, the ECB can accurately assess the impact of fintech operations on the stability of the global financial system. In addition, the ECB harmonises regulations for fintech across all EU member states. This ensures that all European citizens, regardless of location, have access to innovative financial solutions. Consumer protection is included in the ECB's regulatory function, as fintech services frequently interact directly with end-users. By establishing stringent standards for data privacy, cybersecurity, and transparency, the ECB fosters a climate of confidence and encourages the widespread adoption of these new technologies. In addition, the ECB's regulatory function requires collaboration and cooperation with national supervisory authorities and other EU institutions, supporting adaptable, responsive to market changes, and harmonised at the EU level environment. In addition, it promotes a more cohesive and effective regulatory framework by facilitating the exchange of knowledge and best practices between regulatory bodies.

2.4 Fintech as a development trend: international nature

In the context of international development, fintech plays a significant role in the transfer of new technologies from advanced economies and the employment of skilled labour, which is principal for adoption of technology transfers (Samimi & Jenatabadi, 2014).

The following features of globalisation are the most important ones for fintech development:

- Countries with higher levels of human capital are better equipped to adopt and implement technology transfers from advanced economies.
- Well-functioning financial systems play a key role in attracting foreign capital into productive and compatible sectors of developing nations, fostering economic growth.
- Globalised nations with higher levels of human capital and stronger financial systems can leverage the expansion of globalisation to their advantage, benefiting from increased connectivity and access to global markets.

In this context, fintech facilitates the integration of technology, talent, and financial resources across borders. By providing innovative financial services and solutions, fintech contribute to the economic development worldwide. Fintech is a technological representation of Internet-delivered financial services; therefore, fintech can recruit skilled employees from countries with higher human capital levels without relocating them. Fintech applies technology not only to customer-facing applications but also to internal processes. Therefore, fintech contributes to the globalisation of human capital.

(Fatima, 2017) demonstrates that external investors are less likely than local investors to invest in innovative industries. The innovation-driven globalisation processes, such as fintech, are financed by local funds. This is another example of the nature of globalisation, which is the tendency towards global convergence and integration. To see the difference in functioning of fintech in different national environments, cases of Estonia and Germany were considered.

Their policies related to innovations and crypto assets adoption were analysed on the basis of the "Digital Economy and Society Index (DESI) 2022, Integration of digital technology". For instance, if a fintech company is based in Germany and utilises German federal programs, it is considered to be located in Germany. On its website, the German Federal Finance Advisory Service published that the federal government provides funding for research through direct project funding, technology-based funding programs, and grants. German-licensed fintech company can receive private funding from a variety of foundations as well as government funding. This involves covering their expenses for remote personnel in other nations or regions.

(Arjona & Ravet, 2020) implies that the existing research does not adequately emphasise the role of firm dynamics (entry and exit) as the primary channel through which regulatory reforms can boost productivity growth by enhancing knowledge diffusion. This tendency of regulatory reforms to influence the dissemination of knowledge has had a significant effect. Differences in the national laws of the EU member states can exemplify the regulation of

cryptocurrency transactions in the EU. The EU employs multiple directives to regulate transactions involving crypto assets (see the List of Directives in Annex 6).

These directives outline the fundamental principles by which national legislators within the EU should approach crypto-asset transactions, and national laws are developed on their basis. These directives are equally applicable across Europe. However, certain implementation details within the national law can present the national advantages and disadvantages. The advantages and disadvantages of local legislation are not only associated with legislative standards for the administration of crypto assets but also with the digitalisation of the entire interaction process between an entrepreneur and the government. In addition to the digitalisation of infrastructure, these advantages or disadvantages are also affected by regulated forms of entrepreneurship.

Another global fintech trend is digitised public services (Alvarenga *et al.*, 2020), which should support remote staff administration, calculate and pay taxes, submit reports to regulators, etc. There are certain obstacles for digitising public services:

- Governmental expertise
- Legislative competence
- The structure of the fundamental legislation ought to be taken into account.
- State policy

Different implementations are illustrated by case study of Germany and Estonia in regulating crypto assets. Table A7.1 in Annex 7 presents comprehensive comparison of Germany's and Estonia's approaches to regulating crypto assets.

There is a significant difference for conducting business:

- The need to implement MiFID II, the regulations applicable to equity management firms, requires the additional measures for managing the capital adequacy.
- In the case of financial services, passporting does not provide an advantage over companies that cannot obtain passporting. Financial institutions are licensed for the territory in which they conduct the majority of their operations. Passporting in the EU allows extending this activity without a license to other EU countries. In the case of Estonia, there is no clearly defined territory, which can be viewed as an advantage.
- The German regulator requires certification for ICT security in accordance with ISO 27001, which increases the costs and requirements to staff competency.
- Opening a business in Germany presupposes the assistance of attorneys. Estonia has distinct advantages over Germany in terms of online company registration.
- The possibility to run the company online is also a distinct advantage in global market.

These differences result from the legal framework. Both countries in case study are entirely compliant with the EU directives, but their regulatory principles are distinct despite this fact.

Countries started competing with one another. Competition is distinguished by:

- Lowering the threshold
- Legislation and government positions that are lucid (for example, we support cryptocurrency)
- Digital government administration
- The efficacy of regulatory sandboxes

This occurred because the company can select the nation that best meets its requirements. This is another consequence of globalisation, to which fintech also contributes in this instance. This supply is provided by countries that offer their infrastructure for fintech development in response to demand.

The fact that the introduction of radical innovations can lead to the displacement of existing businesses and the emergence of new companies, as mentioned by (Silva and Di Serio, 2016) , has significant implications on fintech risks.

1. Changes in Established Players: fintech innovations can dismiss traditional financial institutions and services, challenging market leaders' positions and business models. Established banks and financial companies face the risk of losing their competitive advantage as fintech start-ups offer more efficient and customer-centric solutions.
2. Market Instability: When new fintech companies enter the market, it can result in market turbulence and increased volatility as traditional players and fintech fight for market share.
3. Regulatory Challenges: The emergence of new technologies and business models in the fintech sector often poses regulatory challenges to ensure consumer protection, data privacy, and financial stability.
4. Cybersecurity Risks: fintech companies handle sensitive financial data, making them potential targets for cyberattacks and data breaches.
5. Uncertain Market Acceptance: There is a risk that certain fintech products or services may not gain widespread adoption, leading to financial losses for the involved companies.
6. Rapid Technological Change: fintech operates in a fast-paced and rapidly evolving technological environment. The solutions that are cutting-edge today may become outdated in a short period, requiring constant innovation and adaptation.

Overall, while fintech offers significant opportunities for financial inclusion, efficiency, and innovation, it also presents risks that need to be carefully managed. Regulatory oversight,

cybersecurity measures, and the ability to adapt to changing market dynamics are essential factors in mitigating these risks and ensuring sustainable growth in the fintech industry.

There are following positive effects of globalisation on fintech:

- Access to additional markets and expansion of customer base.
- Reduced expenses by employing personnel from regions where labour is less expensive.
- Having global technology suppliers and using technologies which already exist.
- The availability of legislative and public sector incentives in other regions.
- Both negative and positive effects of globalisation influence market conditions, and fintech must consider them when planning and conducting business.

Ecosystems in financial technology

(Moore, 1999) described the business ecosystem as follows: "Companies co-develop opportunities around innovation: they collaborate and compete to support new products, meet customer needs, and ultimately drive the next round of innovation."

From the perspective of the regional economy, the financial services ecosystem is the application of the localisation of production theory, when a client receives services from multiple entities as part of a single solution or application or when the capabilities of two or more companies from different regions are utilised to create a particular service and product.

The concept of a business ecosystem, as described by (Moore, 1999), and its application in the financial services industry has implications for fintech risks:

1. Collaboration and Competition: In a financial services ecosystem, fintech collaborate and compete with traditional financial institutions and other fintech start-ups to offer innovative products and services. This dynamic environment can lead to increased competition, driving companies to take risks to stay ahead and differentiate themselves.
2. Complexity and Interdependence: fintech ecosystems involve multiple entities working together to provide comprehensive solutions. This complexity and interdependence can create risks in terms of coordination, data sharing, and ensuring seamless integration of services.
3. Regulatory Challenges: The regulatory compliance becomes more complex when multiple entities involved in offering financial services. Fintech companies follow the different regulations and rules in different regions, which can pose compliance risks.
4. Cybersecurity and Data Privacy: As fintech companies collaborate and share data, the risk of cybersecurity breaches and data privacy violations increases.
5. Market Acceptance: There is a risk that the complexity of multiple companies working together may lead to service inefficiencies, affecting market acceptance.

6. Financial Stability: The interconnectedness of various entities in the ecosystem can have implications for financial stability. If one entity within the ecosystem faces financial challenges or operational issues, it could affect the stability of other involved companies.
7. Technological Risks: fintech ecosystems heavily rely on technology and digital infrastructure. The reliance on technology introduces risks related to system failures, outages, or vulnerabilities, which could affect services and impact customer trust.
8. Customer Experience: The seamless integration of services is crucial for a positive customer experience. Any inefficiencies in the ecosystem may result in dissatisfaction among customers, affecting retention and brand reputation.

The ecosystem of financial services always provides not only innovations and comprehensive solutions, but also new risks. Fintech and traditional financial institutions must address these risks through effective risk management strategies, collaboration with regulators, and robust cybersecurity measures. According to (Still *et al.*, 2019) ecosystems must manage taxes as efficiently as possible and provide the highest level of service. Simultaneously, the provision of services is divided into chains that can be located in various regions, thereby increasing the efficiency of each production chain and the entire process. In addition, the characteristics of the regions must be taken into account.

The digital economy has made it possible to organise businesses in novel ways. Fintech can select the most suitable jurisdiction and register a financial institution there. Criteria for selection are as follows:

- Regulation of the financial services industry - On the territory of the EU financial intuitions operate on the harmonised legislative acts; however, the regional implementation may differ, and it is important for the provision of services and additional market advantages.
- Regional Tax Laws - The tax component is significant both in the cost structure of financial services and the affective component for clients if these taxes directly impact the financial services the client receives (for example, capital gains tax).
- Anti-money laundering legislation in the region - for the digital economy, the remote customer board and the requirements for such a board are important when selecting a region for registering a financial institution.
- Regulatory requirements for personnel

An ecosystem comprises the financial services provided by multiple companies located in various regions. A client may, for instance, receive services for making bank transfers and working with crypto assets as part of one fintech application. Simultaneously, a financial institution registered in one region and a cryptocurrency exchange institution registered in another region provide these services. Moreover, each production element is situated in the

most efficient location. Fintech ecosystems are transforming the consumer experience. Market participants offer their own methods for managing multiple services within a single application or any other channel of client interaction, such as financial and insurance services or marketplaces. Other market leaders will then replicate the most successful model using the benefits of globalisation.

2.5 Case Studies: In-Depth Review Reports

In-Depth Reviews are analytical documents written by the Commission to identify and assess the severity of macroeconomic imbalances. The annual review report determines the countries where the Commission prepares in-depth evaluations. They can also be prepared for unforeseen significant economic events requiring urgent analysis.

The purpose of the in-depth analyses is to determine the nature and severity of macroeconomic imbalances in EU nations. Since 2015, the IDRs have been incorporated into the European semester country reports.

There is a case study of IDR presented in this Thesis. The IDRs for only two countries are presented here for demonstrating the difference in IDRs of two European countries. It is important since it may affect the distribution of digital financial products There were chosen the countries with comparable economic development and similar position within the EU: Italy as the region where hypotheses were tested, and Rome in particular as the smart city, and France. Italy and France share a number of key characteristics (Maradana *et al.*, 2019). For one thing, both countries are members of the EU and have benefited from integration into the larger European market. They also have strong manufacturing sectors that produce high-quality goods for export worldwide. Both countries also rely heavily on tourism to drive growth. Finally, both Italy and France have an ageing population and declining birth rates which has implications for long-term economic stability.

These country differences can have implications for the risks faced by fintech companies operating in Italy and France. For instance:

1. Regulatory Environment: Despite both being EU members, Italy and France may have specific regulatory frameworks governing fintech activities that differ from each other and impacting compliance risks and the cost of doing business.
2. Market Demand: The differences in the export industries and reliance on tourism between Italy and France can influence the demand for specific types of digital financial products. Fintech firms targeting these markets must consider the varying consumer preferences and needs, which can affect market risk and product viability.

3. Economic Stability: The economic stability of each country, influenced by factors such as manufacturing exports and tourism, can impact fintech revenue flows and growth prospects. Economic fluctuations can introduce financial risks for fintech firms operating in these markets.
4. Demographic Trends: The ageing population and declining birth rates in Italy and France can have implications for the demand for certain financial products and services, particularly those catering to retirement planning and wealth management. Fintech need to adapt their offerings to address the needs of different age groups, which can affect operational and strategic risks.
5. Competitive Landscape: for fintech it may vary between the two countries, with different local players and market dynamics. Responding to the competitive environment is crucial for managing competitive risks and gaining market share.
6. Technology Infrastructure: Differences in technology infrastructure and digital readiness can influence the ease of conducting fintech operations in Italy and France. Fintech must assess the readiness of the digital ecosystem, which can impact operational efficiency and cybersecurity risks.

The country differences between Italy and France can contribute to unique risk profiles for fintech operating in each market. Tailoring strategies to address country-specific risks is essential for successful market penetration and growth in the digital financial products sector in these countries.

Case Study I. In-Depth Review of Italy 2020

The part of the Report on Italy authorised on February 26, 2020 was prepared in accordance with Article 126(3) of the Treaty on the Functioning of the European Union (European Commission, 2020b); it is presented in Annex 8.

The European Commission identified the following macroeconomic imbalances as part of its analysis of Italy's macroeconomic imbalances:

- ensuring that an active labour market and effective social policies reach vulnerable populations;
- the concentration of investment-related economic policy on research and innovation and infrastructure quality;
- the improvement of the efficacy of public administration;
- assistance in the restructuring of the bank balance;
- the enhancement of non-bank financing for small and innovative businesses.
- shifting taxation onto the labour force, reducing tax expenditures, and reforming the cadastral system;

- the presence of illicit work;
- supporting women's labour force participation through a comprehensive strategy;
- enhancing educational outcomes, including through adequate and targeted investment, and promoting professional development.
- reducing the duration of civil litigation by enforcing and expediting due process;
- increasing the efficacy of the fight against corruption by reforming procedural rules to shorten the duration of criminal proceedings.
- decreasing the proportion of public spending allocated to old-age pensions and making space for other social and growth programs-increased expenditure;
- removal of restrictions on competition, including the passage of new competition law.

As evidenced by the preceding list of imbalances, these are the policies that the Italian government must improve in order to harmonise its economic and social policies with those of the EU. And despite the fact that a number of imbalances are social and not economic in nature, they are just as significant as purely economic imbalances because they are directly related to the implementation of policies against competing social systems that could result in the social decline of the inhabitants of one of the participating countries in comparison to another.

The achievement of the strategic goals of Europe 2020 and national goals as well as their impact on fintech is presented in Table A8.1 in Annex 8. If to discuss the impact of these imbalances on fintech, they are as follows:

- The decrease in the employment rate can introduce both challenges and opportunities for the fintech industry. Fintech need to closely monitor economic trends and adapt their strategies to navigate through these changes successfully. This may involve adjusting product offerings, managing credit risk, exploring new market segments, and staying abreast of evolving regulatory and economic conditions.
- Increased investment in research can stimulate innovation, enhance competitiveness, and foster sustainable growth in the fintech industry, contributing to overall economic development and financial inclusion.
- fintech companies can address climate change, enter the emerging markets and meet the specific consumer demands by developing innovative green solutions and joining the sustainability initiatives.
- The rate of students who do not finish the education may not have a direct impact on the day-to-day operations of fintech, but it can influence the availability of skilled talent, innovation, financial inclusion efforts, and consumer behaviour.

- The fact that the country has a lower proportion of 30 to 34-year-olds with tertiary education compared to the EU average can have implications for the availability of talent, innovation, financial literacy, policy decisions, and global competitiveness in the fintech sector.
- The high percentage of people at risk of poverty in Italy compared to the pre-crisis level and the EU average indicates the presence of significant economic challenges in the country. Fintech operating in Italy need to develop strategies that address the financial needs of vulnerable populations.

Case Study II. In-Depth Review of France 2020, Focus on Economic Policy Coordination

The part of the Report on France authorised on February 26, 2020 was prepared in accordance with Article 126(3) of the Treaty on the Functioning of the European Union (European Commission, 2020a); it is presented in Annex 8.

The European Commission identified the following macroeconomic imbalances as part of its analysis of France's macroeconomic imbalances:

- excessive public debt;
- weak competitiveness dynamics in the context of low productivity growth.

Comparing the imbalances in France and Italy as two representatives of the so-called "powerhouse countries" of the EU economy, it is evident that the national characteristics of Italy's social character do not permit achieving the objectives of bringing Italy closer to other EU nations. The imbalances in the French economy are indicative of ineffective economic policy measures in the areas of managing the country's public debt and enhancing its competitiveness, which is of interest to the French Ministry of Finance. Moreover, Italy's imbalances result from deficient integration of intra-social processes into the "family" of the EU nations.

The achievement of the strategic goals of Europe 2020 and national goals as well as their impact on fintech is presented in Table A8.2 in Annex 8. If to discuss the impact of these imbalances on fintech, they are as follows:

- The employment rate can influence various aspects of the fintech industry in France, and fintech need to remain attentive to its impact on customer behaviour, market conditions, hiring strategies, and regulatory developments.
- fintech operating in a country with higher R&D investment may have access to advanced technologies and research partnerships, giving them a competitive edge in the global market. On the other hand, fintech in countries with lower R&D investment might face challenges in keeping pace with technological advancements.

- The fact that emissions reduction targets are expected to be narrowly missed can have significant implications for the fintech industry. It may influence the regulatory environment, investor preferences, risk assessment, financing decisions, innovation opportunities, and a country's international reputation.
- The stable but concerning early education dropout rate in France, particularly with regional disparities, can have implications for the fintech industry in terms of workforce skills, regional access to services, social and economic inclusion, opportunities in educational technology, impact on entrepreneurship, government initiatives, CSR efforts, and consumer behaviour. By recognizing these factors, fintech companies can proactively address challenges and leverage opportunities to contribute positively to educational and economic development in the regions they operate.
- The higher tertiary completion rate and the academic performance of women in France can positively influence the fintech industry by providing access to a skilled workforce, fostering innovation and research, promoting gender diversity, encouraging entrepreneurship, expanding the customer base, fostering collaboration with academic institutions, and facilitating regulatory compliance. Fintech companies can leverage these advantages to stay competitive, drive innovation, and meet the evolving needs of customers.
- The reduction in the number of individuals at risk of poverty or social exclusion can influence the fintech industry in various ways, such as by expanding market potential, influencing consumer behaviour, shaping risk assessment strategies, promoting social impact investments, fostering collaboration opportunities, and impacting regulatory considerations. Fintech should be aware of these changes in the socio-economic landscape and adapt their strategies to effectively address the evolving needs and demands of a changing customer base.

The examination of France and Italy's performance demonstrates the significant challenges and the complexities of harmonizing policies and strategies faced by the EU member states (Bandola-Gill *et al.*, 2022). The analysis reveals that the regional disparities existing within national economies present a multifaceted set of challenges for various sectors of economies including fintech. As fintech plays an increasingly crucial role in transforming financial services, these regional discrepancies can influence not only the strategies and preferences of fintech suppliers but also the financial behaviour and access to services for end customers across different regions (Lavrinenko *et al.*, 2023). Embracing innovative solutions and fostering cooperation among member states will be vital in achieving the objectives of financial inclusion and stability.

The EU Cohesion Policy, as the tool to decrease these regional differences, defines the existence of socio-economic vulnerabilities between countries, which forms the additional risks for fintech (Sánchez and Jiménez-Fernández, 2023).

Research question of the Thesis – *Does the EU provide the homogenous conditions – economic policy, regulations, supervision, legislation – for fintech development across all countries?* – answered. As the result of the case study 1 and case study 2 and assessment of the globalisation impact to fintech was defined that EU does not provide the homogenous conditions to fintech.

3 Fintech Financial Governance Based on KRIs Typical for the EU

This chapter is devoted to the analysis of fintech activities in the EU and determining their relationships with risks. Operations of fintech in smart city are analysed from the point of view of regional aspect. The shared financial services are considered from cost approach. The selection of risk groups and risk indicators is based on the interviews with experts via Delphi survey. The indicators are estimated and used as variables in PLS-SEM models for determining the KPIs based on KRIs for internal and compliance-based processes.

3.1 Fintech operations in smart city: regional economic aspect

This Thesis section focuses on the relationship between financial metrics and compliance risks to substantiate the hypotheses effectively.

First, the sharing economy connected to regulatory aspects (Leoni & Parker, 2019; Ryu *et al.*, 2019) is analysed for links between financial metrics and compliance risks.

Then the integration of fintech in a smart city exemplifies the regional economy aspect, emphasizing the mutual relationship between technological advancements and urban development. When fintech operates within a smart city, it facilitates the seamless flow of financial services and transactions, advanced digital platforms, real-time payments, streamlined banking services, and access to various financial products and improved financial inclusion. The regional economy aspect of a smart city emerges when fintech stimulate economic activity, attract investment and growth of local start-ups, creates employment opportunities, enhances human capital in the region reduce income disparities and promote inclusive growth.

fintech's focus on innovation and technologies often encourages collaboration between public and private sectors within the smart city ecosystem. This collaboration improves business environment, attracts multinational companies and increases foreign direct investment and international recognition for the region.

ICO as Crypto-assets Manufacturing within Smart City

The advent of Industry 4.0 has revolutionised manufacturing, and digital technologies blurred the boundaries between physical, digital, and biological domains. In this era of transformation, fintech reshape the financial and driving economic progress (Qin *et al.*, 2016). Smart cities are the centres of digital revolution, and integration fintech is logical, demonstrating the regional economy aspect in action.

Smart cities use advanced technologies and data-driven solutions to optimise urban environments, promoting efficiency, sustainability, and livability. Fintech seamlessly contributes to the smart city concept, facilitating real-time financial services and transactions (Vaidya *et al.*, 2018; Alcácer &Cruz-Machado, 2019; Ardito *et al.*, 2019; da Silva *et al.*, 2019;

Tupa & Steiner, 2019; Suleiman *et al.*, 2022). This synergistic relationship between fintech and smart cities generates a ripple effect that positively impacts the regional economy.

fintech transforms the traditional manufacturing processes, adapting them to changing customer demands, product compositions, and supply chain dynamics. become essential as Customers choose personalisation and customisation and using into "smart" platforms and services (Hagel III *et al.*, 2015). Digital manufacturing has transitioned from discrete technologies to integrated systems (da Silva *et al.*, 2020). The digital technologies like automation, robotics, and data analytics change the production processes, and smart cities become hubs of innovation and progress (Georgiou *et al.*, 2020; Rejeb *et al.*, 2022).

In this context, the distributed ledger technology, also known as blockchain, plays a crucial role. The distributed ledger acts as a secure and decentralised database that underpins crypto assets, intangible digital assets with encrypted issuance, sale, or transfer. Crypto assets have emerged as standard tools for digital transformation (Bartolucci & Kirilenko, 2020).

The concept of Initial Coin Offerings (ICO) becomes more and more popular (Hacker & Thomale, 2018; Fahlenbrach & Frattaroli, 2020; Momtaz, 2020; Hsieh & Oppermann, 2021; de Andrés *et al.*, 2022; Tao & Peng, 2022). ICOs are blockchain-based fundraising mechanisms allowing the entrepreneurs to issue tokens and attract external funding without intermediaries. However, conflicting definitions of crypto assets create challenges. It is important to develop an accounting approach for events related to crypto asset issuance (Procházka, 2018; Bartolucci & Kirilenko, 2020; Xiong *et al.*, 2022; de Andrés *et al.*, 2022). It classifies the issuance of crypto assets as a manufacturing process within Industry 4.0 and evaluates it from an IFRS perspective. The theoretical aspect lies in defining ICOs as manufacturing processes within Industry 4.0 and exploring the potential of smart cities as issuers of crypto assets. The practical value lies in developing a comprehensive accounting procedure for events related to crypto asset issuance within the EU.

Digital products manufacturing

Industry 4.0 is not only transforming the manufacturing process but also raising important questions about the products, including their components and characteristics, especially when utilizing distributed ledger technology in their production. There is a lack of comprehensive assessment of the entire production process and distribution (Mayer *et al.*, 2021). Formalisation becomes a critical element in developing digital products or services (Pesch *et al.*, 2021). (Mäntymäki *et al.*, 2020) revealed that cryptocurrencies present various challenges to conventional currencies and pose a systemic change threat to established businesses and organisations. It is necessary to account the diverse range of available crypto assets and consider the possibility of self-consumption when manufacturers use these assets.

Additionally, precise classification of all events related to issuing crypto assets is vital for accurate accounting. These events may occur simultaneously or in different orders. It is important to classify the issuance of crypto assets as a manufacturing process and to determine the applicable IFRS standards for each type of cryptocurrency, to assess the costs, revenues, and leverage associated with crypto assets.

Evolution of Product Concepts

The advent of digitalisation in the economy has transformed the concept of products, introducing three potential components in their composition:

- non-digital,
- digital, and
- crypto-assets.

If the product is sold only in a traditional store, it consists solely of non-digital components. However, if it is also available on an e-shop, it includes both non-digital and digital elements. Furthermore, if the e-shop accepts crypto assets as payment, the product encompasses all three components. This approach allows the existence of fully digital products, such as financial and insurance services, where non-digital components are absent (Pilat, 2020).

While digital manufacturing and its integration into Industry 4.0 have been widely explored in the literature (Paritala *et al.*, 2017; Vaidya *et al.*, 2018; Alcácer & Cruz-Machado, 2019; Suleiman *et al.*, 2022); nevertheless, little attention has been given to the manufacturing process and distribution of fully digital products and, consequently, crypto-assets-based products.

Crypto assets, when they attract external funding or serve as objects for sale, raise questions about their classification. To develop an accounting procedure for crypto asset issuance within the EU, it is necessary to determine the order of accounting events related to the issuance of crypto assets. The majority of researchers (Hacker & Thomale, 2018; Fahlenbrach & Frattaroli, 2020; Momtaz, 2020; Hsieh & Oppermann, 2021; de Andrés *et al.*, 2022; Tao & Peng, 2022) consider ICOs as a set of actions, with one of them being the issuance of crypto assets, aimed at attracting external funding for the issuer. On the other hand, the International Accounting Standards Board (IASB) and researchers focusing on accounting classify crypto assets issued for distribution as accountable under inventory goods. Organisations, both financial and non-financial, widely use ICOs as a tool and face a fundamental question in developing accounting systems for companies: is ICO classified as a token or a coin?

Although there is currently no official regulatory division between "coin" and "token," according to PWC (Tucker *et al.*, 2017), "token" refers to an asset providing additional

functionality or utility, while "coin" typically refers to a cryptographic asset intended for use as a medium of exchange.

The European Parliament distinguishes three categories of crypto assets in legislative recommendations (EU, 2020):

1. Utility tokens: Digital assets granting access to digital services or platforms.
2. Asset-referenced tokens: Digital assets linked to currencies, other digital assets, commodities, or stocks traded on exchanges. Some EU nations' local legislation refers to tokens linked to assets as security tokens.
3. Payment tokens: Crypto assets designed primarily for use as a form of payment (coin, electronic money tokens, e-money tokens).

The classification of crypto assets into these groups forms an ecosystem within the smart city (Pellicano *et al.*, 2019; Rotună *et al.*, 2019; Gupta *et al.*, 2020). However, the lack of precise definitions and classifications for smart city manufacturers (smart industries) resulted in discrepancy and discordance.

Digital Manufacturing relies on digital supply chains. Digital services forming the supply chain for smart manufacturers may originate from other smart manufacturers or smart consumers. For instance, the value of the TripAdvisor application lies in the ratings provided by final consumers for the companies listed. As the line between manufacturers and consumers blurred, participants within the smart city ecosystem are referred to as smart users.

Capital increase method vs manufacturing for further sale

ICO as capital increase method

(Duma & Paun, 2011) defined the following capital increase methods:

- Increase of the capital through the issuance of shares
- Increase of the capital by incorporating reserves
- Increase of the capital by debt conversion
- Initial Public Offer (IPO) and further shares value on the stock exchange changes

Various methods have been explored with a focus on two approaches: increasing the number of issued shares of a company or enhancing the value of its existing shares. Comparisons between ICO and IPO were made by some researchers (Hashemi *et al.*, 2019; Wis, 2019). In IPO, the number of shares is increased and subsequently sold to the public, whereas in an ICO, new crypto assets are issued and offered to the public. It is important to note that while an investor acquires a firm's share in an IPO, they receive a token that does not represent any ownership in the company during ICO (Procházka, 2018; Bartolucci & Kirilenko, 2020; Xiong *et al.*, 2022). When considering the accounting approach for crypto assets, it is apparent that these assets should be recorded on the issuer's balance sheet as inventory,

indicating that they are products for sale. This further emphasises that the issuance and distribution of crypto assets do not serve the purpose of increasing the company's own capital.

ICO as manufacturing

Traditionally, manufacturing referred to the process of transforming raw materials into finished goods for sale in the market; nowadays manufacturing has the integrated features of various levels (Esmaeilian *et al.*, 2016). The constant emphasis on product innovation led to reduced product differentiation, making it challenging for companies to stand out in the competition (Shelton, 2009). As businesses progress, they prioritise higher levels of customer service and sophisticated problem-solving approaches. Customers now perceive products and services as integrated solutions for all their needs, rather than individual items (Shin *et al.*, 2022).

Management of digital manufacturing extends to managing digital processes related to crypto-assets-based products (da Silva *et al.*, 2019). By applying business process management principles to crypto-assets manufacturing, it can be determined whether the same approach is suitable for the issuance of crypto assets (Table 3.1).

Table 3.1

Business process management steps for the crypto-assets issuance

The process	Crypto assets issuance stage
Analysis of the processes	Definition of the: General product features Distribution channels Blockchain type or exact blockchain The limitations if any
Definition of structure between processes	Definition of the legal and technical structure as interaction between issuer-distributor-buyer
Choice of the management method	Definition – how the total issuance and its quality will be controlled.
Modelling and optimizing the processes	Product testing in accordance to the Product Oversight and governance principles (Asante *et al*., 2014)
Performance measurement and diagnostics system	Product Monitoring in accordance to the Product Oversight and governance principles (Asante *et al*., 2014)

Source: Generated by the author (Cernisevs and Popova, 2023)

The ECB emphasises the implementation of product oversight and governance principles among asset management (Asante *et al.*, 2014; Marano, 2021). As a result, these principles have become integral to the manufacturing process of crypto assets and financial products. The stages involved in the issuance of crypto assets align with the typical cycle of business processes in manufacturing. Therefore, it is possible to determine ICO as a manufacturing method.

The emergence of "Industry 4.0" (Vaidya *et al.*, 2018; Alcácer & Cruz-Machado, 2019; Ardito et al., 2019; Horváth & Szabó, 2019; Tupa & Steiner, 2019; Williams, 2021; Suleiman

et al., 2022) changes the traditional manufacturing processes. This transformation affects all crypto assets issuers, though issuers can apply the same business management methodologies (Durante & Turvani, 2018). The scholars actively discuss the cryptocurrencies and crypto assets (Bech & Garratt, 2017; ESMA, 2018; Hacker & Thomale, 2018; Bartolucci & Kirilenko, 2020; Giudici *et al.*, 2020; Grobys *et al.*, 2020; Gowda & Chakravorty, 2021; Ramos *et al.*, 2021), and it seems interesting to estimate the stages of crypto-assets manufacturing. There are following stages of the crypto-assets-based product or service:

- Defining a subgroup of crypto assets and developing the parameters of a smart contract;
- Determining the method of issuance;
- Issuing crypto assets using the specified smart contract parameters;
- Establishing the distribution model for crypto assets (e.g., payment in fiat currency or other crypto assets);
- Managing the circulation of the crypto assets;
- Determining the disposal method of crypto assets.

Research question – *Does the new approach to digital product manufacturing affect the risk environment of fintech?* – **answered**. The research question answered positive – The new approach to digital product manufacturing affects the risk environment of fintech.

The crypto-assets-based products include both blockchain-based and crypto asset-based offerings. These products introduce new and innovative possibilities to the market. Businesses within smart cities have the potential to boost their profits by providing clients with necessary innovative goods and services (Still *et al.*, 2019). This approach opens new opportunities for businesses to stay competitive within smart cities.

The emergence of ICOs changes funding for blockchain-based businesses, which use ICO to introduce new goods based on crypto assets, market them, and then reinvest the revenue from sales to develop related programs and products. Therefore, the need for transparent accounting procedures is greatly important.

There is an obligatory requirement for financial institutions in the EU to adopt IFRS for financial reporting. (Cualain & Tawiah, 2023) This regulatory framework ensures uniformity and consistency in financial reporting practices, making it easier for investors, stakeholders, and regulatory authorities to assess the financial performance of fintech. The mandatory use of IFRS in the EU for fintech accounting emphasises the region's commitment to transparency, investor confidence, and increasing fintech industry. The IFRS standards can be also used to determine the costs (Pope & McLeay, 2011; Pole, 2018; Smith, 2019; IFRS Committee, 2021).

ICO process comprises the issuance and distribution of crypto assets, therefore, it is not directly linked to the issuer's capital raising, and equating ICO to IPO in terms of capital raising is inaccurate. In IPO, a private company transitions are publicly owned, and investors become shareholders. However, IFRS-based evaluations of ICO reveal no legal obligation for issuers to be accountable to crypto asset purchasers. Thus, the ICO process can classified as manufacturing of crypto assets (Cernisevs & Popova, 2023).

3.2 Sharing the financial services in the EU economy

The global trend of urbanisation led to the emergence of the smart city concept, where cities are designed to be open, user-centric, and innovative in using ICT infrastructure to enhance the standard of living and resource management for residents (Ninčević Pašalić *et al.*, 2021), contributing to improved quality of life, economic progress, circular economy implementation, and more efficient governance processes (Popova & Popovs, 2022).

One aspect of the smart economy is the sharing economy. While extensively discussed in scientific literature, the application of sharing economy principles to fintech companies and their financial operations remains relatively unexplored. The Thesis considers the possibility of implementing sharing services in fintech companies to achieve smart city KPIs and analyse the associated financial costs.

Rome was chosen as a case study. To assess the development of Rome as a smart city, the information provided by the municipal authorities of Rome was analysed. It was analysed in accordance with plan of developing smart areas in Rome (Municipality of Rome, 2021), which includes 81 projects across 11 areas, considering 119 city indicators and 120 smart KPIs to monitor progress initiatives, and critical areas. The chosen KPIs allow estimating the level of digitisation and innovative technologies development and the potential implementation of crypto-assets-based products. Then the indicators evaluated for the possibility of integrating crypto-assets-based products into Rome municipal strategy.

The model of economic growth for Rome aims to achieve several objectives:

1. Facilitate the interactions between the public and private sectors.
2. Encourage businesses to become more competitive, leading to increased employment numbers, improved productivity, efficiency, and human capital.
3. Promote the exchange and transfer of knowledge.

The identified specific KPIs permit to estimate the effectiveness of implementing the smart city concept. Table A11.1 in Annex 11 illustrates the potential use of crypto-assets-based products as a means to achieve the following KPIs of smart city development:

- Places used for coworking - the services of the coworking spaces may be paid for by the crypto-assets-based products (like cryptocurrency), or controlled by issuing and circulating access tokens
- Online services for starting a business or commercial activities - Smart Users may use crypto-assets-based products for verify the identity of the applicant, for the payments for the service, for submitting the document via the blockchain.
- Number of requests submitted online - Smart Users may use crypto-assets-based products for verify the identity of the applicant, for the payments for the service, for submitting the document via the blockchain.
- Presence of the Economic Development Plan for at least 3 years - not directly connected to the crypto-assets-based products and services
- Number of knowledge-sharing events (conferences, meetings, etc.) - may be available per presenting the crypto-assets-based ticket.
- Presence of the city brand on the platforms of e-commerce - The cryptocurrency issue with the city brand joins B2B and B2C payment.
- Number of participants who support the city's brand - not directly connected to the crypto-assets-based products and services
- Smart city products/service sales volumes - Own blockchain-based payment platforms B2C and B2B, tax payments via the city payment platform, concentration of utilities and services within the same platform.
- Presence of the server clusters for the economic development - Server cluster managing companies may use crypto-assets-based keys to control these accesses, accept crypto-assets payments (including within the smart city's own payment platform).
- Number of initiatives for the development of SMEs - Network for the crowdfunding, easy way of the inter-payments, supporting SMEs with the standard payment acceptance solution (B2C and B2B) based on the blockchain

Therefore, digital products are interconnected with implementation of smart city KPIs. These digital products involve open banking. (O'Leary *et al.*, 2021) identified the key elements of business processes required to evaluate financial institutions' readiness for implementing Open Banking (Figure 3.1).

Digital Infrastructure	**Human Components**	
	□	Need for competition/negative sentiment toward established banks
	□	Customer Expectations
	□	Smartphone/Mobile Banking Penetration
	□	Unbanked individuals
	Technological Components	
	□	API Standards
	□	Internet Infrastructure
	□	Culture of Technology/Innovation
	□	Services SLA (Service Level Agreement)
Digital Assets	**Account information services**	
	□	Iban account number(s)
	□	Each Iban account balance in each account currency
	Payment initiation services	
	□	List of the payments type
	□	Each Payment type parameters
	□	Request for payment initiation
	Customer authentication services	
	□	WEB authentication
	□	SDK authentication
	Payment instrument issuer Services	
	□	List of the payment instruments
	□	Request if enough funds to make a payment.
	Third-Party Provider management system	
	□	Third-Party providers Sandbox
	□	Third-Party identifications certificate management
	□	Customer's consent management in relation to each Third-Party provider
	Additional services (optional) outside of the PSD2	

Figure 3.**1 Elements of Financial institution readiness for open Banking**

(Popova and Cernisevs, 2023)

The payments within the financial operations in smart city are based on special licensing types and special protocols. Account Information Service (AIS) is the license type for AISROE providers, which allows access to the information of payment accounts; Payment Initiation Service (PIS), which allows to initiate payments from the customer's accounts. The key elements for evaluating the readiness for open banking implementation were identified:

- License of local regulators for providing AIS or PIS.
- Existing procedure to obtain customer consent for accessing their accounts and financial instruments.
- Proper cybersecurity management.

- Following the capital adequacy requirements in compliance with the legislative acts.

It is also very important to determine the financial cost of integrating the sharing economy into the financial sector of a smart city. There were analysed the costs associated with financial services for both financial institutions and smart cities. In the case of smart cities, the costs for AIS or PIS are considered as fixed, with no variable costs.

For financial institutions, the structure of shared financial service-related fixed costs is similar to that of smart cities. However, a key difference lies SLAs. The SLA relies on metrics that calculate the availability percentage of the financial institution's ICT system. To achieve high availability, institutions invest in business continuity processes, often involving twin ICT systems with different infrastructures. It increases reliability, but also incurs additional expenses for infrastructure maintenance. Fixed costs for shared financial services are presented in the following way:

$$FC_{fi} = f(SLA; AC; HC_{fi}) \quad (1)$$

where SLA costs involve no downtime server infrastructure management, AC are the costs of operations of the administrative staff in terms of 24 × 7, and HC_{fi} are the hosting costs of the financial institution, consisting of domain payments and server hosting costs

The variable costs of financial institutions are determined by the formula:

$$VC_{fi} = OTP*Q \quad (2)$$

where OTP is the cost to deliver to the customer one time password, and Q is the quantity of the transactions.

OTP in its turn is determined by the following function:

$$OTP = \beta(Ch_1; Ch_2; Ch_n) \quad (3)$$

where Ch_n represents any channel of password delivery

As a result, the variable costs of financial institutions are presented as follows:

$$VC_{fi} = Q * \beta(Ch_1; Ch_2; Ch_n) \quad (4)$$

The study determines the operating leverage for the financial institutions:

$$OL_{fi} = \frac{(TP_{fi} - VC_{fi}) * Q}{(TP_{fi} - VC_{fi}) * Q - FC_{fi}} \quad (5)$$

where OL_{fi} is the operating leverage for the financial institution, TP_{fi} is the price of one transaction, which the financial institution customer pays to process the payment

Manufacturing of the financial products, such as investment instruments, insurance policies, and loans, always involves the inherent risks related to market fluctuations, creditworthiness, and regulatory compliance. The creation of derivative products can amplify systemic risks, potentially leading to market downturns and financial crises.

Inadequate risk management practices can also result in mispricing, suboptimal investment decisions, and excessive exposure to risk. Marketing and selling financial products without adequate transparency may result in financial fraud. To mitigate these risks and ensure stability, integrity, and fair outcomes for all stakeholders it is necessary to implement risk management, strong regulatory supervision, and effective consumer protection measures

Research question of the Thesis – *Does sharing economy creates additional compliance and regulatory risks for fintech company?* – **answered.** Yes, the sharing economy creates additional compliance and regulatory risks for fintech company.

3.3 KPIs and Risk indicators

Operating in the contemporary market requires not only following the regulatory acts but also establishing good risk management, and it is especially important for fintech, which is comparably new business model and needs special attention to security and safety.

Groups of risks faced by financial institutions

- Credit risk. This risk arises when borrowers fail to repay their loans or meet other obligations. Inadequate credit policies and ineffective monitoring systems increase the likelihood of default, which can result in substantial losses for the institution.
- Market risk. It refers to potential losses arising from changes in market conditions such as interest rates, foreign exchange rates, and commodity prices.
- Operational risks. They arise from internal processes within an organisation rather than external factors. They include issues like fraud or system failures that disrupt regular operations leading to reputational damage or financial loss.
- Liquidity risks. Illiquid assets make meeting the short-term obligations challenging to during times of stress. A lack of liquidity may cause panicked investors to seek redemptions, resulting in fire sales, pushing down asset values, creating panic among customers.

To remain competitive, financial institutions need to manage these risks effectively (Nguyen *et al.*, 2019; Abid *et al.*, 2021; Fantazzini & Calabrese, 2021; Rastogi *et al.*, 2022; Cernisevs *et al.*, 2023). The regulatory efforts aim to prevent the financial crises by ensuring that banks have adequate capital buffers and risk management processes. By complying with

these regulations, financial institutions can better protect themselves against market volatility and unexpected shocks.

KPIs and Risks for fintech

KPIs are essential tools for monitoring and measuring the performance of financial institutions. However, there is a lack of KPI selection methodologies specific to fintech. One reason for it is the rapid pace of technological change in the industry. Fintechs are constantly introducing new products and services that require new KPIs to be developed to measure their performance. This makes it challenging to develop standardised KPI selection methodologies that are relevant to all fintech.

Another reason is the diverse range of fintech operating in the market. Fintech operate in various segments of the financial industry, including payments, lending, insurance, and investment management. Each segment has its unique set of KPIs that are relevant to the specific fintech. The traditional KPIs lack of clarity and transparency (see Annex 1). Often, these KPIs heavily prioritise financial performance over other essential aspects such as risk management, control, and crucial cultural and behavioural factors. This imbalance also exists within internal control functions and for chief risk officers. Supervisors identify weaknesses in traditional KPIs concerning their alignment with risk appetite, the processes and controls related to variable remuneration, and the application of malus and clawback clauses in response to excessive risk-taking or misconduct (see Annex 1). These facts demonstrate the need for improvement in traditional KPIs.

Moreover, fintech often operate with different business models compared to traditional financial institutions, which makes it difficult to apply traditional KPIs. For instance, traditional KPIs like Net Interest Margin and Return on Equity may not be suitable for fintech that operate on a fee-based revenue model. Therefore, a different set of KPIs may be required to measure the performance of fintech accurately. However, the scholars who addressed the risks as fintech metrics do not provide a KPI selection methodology and do not explicitly establish a correlation between risk and KPIs.

The ECB, in its Supervision Newsletter dated 15 February 2023 (see Annex 1), emphasised the problematic issue of KPIs within the financial industry. They noted that KPIs are not always transparent and clear, and in many cases, they focus on financial performance, neglecting critical aspects such as risk, control, and key cultural and behavioural factors. Recognizing the need for improvement in this area, the ECB emphasises the importance of supervisory attention to enhance KPIs' effectiveness in risk management

For fintech, a risk-based strategy effectiveness depends on a comprehensive understanding of the risks they face. Within this Thesis risk is considered as inherent risk - the

risk that must be acknowledged before implementing any mitigation measures, such as processes, policies, controls, and other precautionary steps. A thorough analysis of risks manifestation was done; it considered two key elements: vulnerabilities, which represent weaknesses that could appear, and threats, which are external forces that could use these vulnerabilities.

The comprehensive analysis of risks included two stages: preliminary and principal. The preliminary research allowed identifying the components and indicators of risk model. It was done via the interview with risk officers of financial companies operating within the EU. The main stage was constructing the statistical models for determining the relations between defined risk groups and KPIs.

Determining risk categories and their relations with KPIs

The preliminary stage included the Delphi method, which is widely used in social spheres, such as public policy, health, and education (Beiderbeck *et al.*, 2021). It is used to receive opinions of panel of experts. The process is iterative and usually involves multiple rounds of questionnaires.

Then following steps were used within the Delphi survey:

- Selection of Experts;
- Round 1 Questionnaire: Develop a questionnaire or survey to be sent to the panel of experts. The author prepared the questioner with the 217 threats and 87 Vulnerabilities within the phase of the preliminary research and requests panel of experts analyse these risk elements as binding for their type of the business;
- Analysis of Round 1 Responses;
- Round 2 Questionnaire: Develop a second questionnaire based on the responses from the first round. As the result the final list of threats and vulnerabilities divided per 11 types of the risk were developed (217*11 +87*11 = 2387 +957 = 3344 elements); they were evaluated per 2 parameters – impact and likelihood. Totally 3344 * 2 *5 = 33 440 data elements were evaluated;
- Analysis of Round 2 Responses;
- Subsequent Rounds: Continue this process of refining questions and collecting responses until a consensus is reached, or until diminishing returns are observed in terms of convergence of opinion. This might require several rounds;
- Final Report: Once a sufficient level of consensus is reached, or it is determined that additional rounds will not yield further convergence, the findings are compiled into a final report.

The selection criteria included the following issues: company must be registered in the EU, must be regulated or supervised by financial authorities, must have a risk management, must be payment business. In accordance with the above-mentioned criteria, 5 companies were selected:

- •Credit Institution in Latvia
- Virtual Asset Management company in Finland
- Virtual Asst Management company in Estonia
- fintech company in Latvia
- Electronic Money Institution in Malta

Each identified risk represented a threat or a series of threats that could use the company's existing vulnerabilities. The data for the model's elements and indicators were collected through semi-structured interviews conducted in 2017 and 2022 with the five selected companies.

Before conducting the interviews for the Delphi survey, there were identified the potential risk indicators that would be applicable to the risk-based model. Considering that risk can vary across different financial institution types, they were divided into 11 groups. The criteria for threats and vulnerabilities impact and likelihood assessment were developed.

The semi-structured interviews with representatives from the selected companies regarding their risk management practices, vulnerabilities, and experiences with potential threats provided qualitative data that formed the basis for the risk assessment model. During the interviews, the data on various risk indicators, the way how each company perceived risk, identified vulnerabilities, and assessed the potential impact or likelihood of different risk events were collected. The semi-structured interviews were conducted in time periods – between 2017 and 2022. This allowed comprehension of trends or changes in risk perceptions over time.

With data gathered from the interviews, the author developed a risk model that included the identified risk indicators. This model formed the basis for evaluating risk in fintech and guided decision-making processes.

The preliminary stage also included determination of fintech as business, considering the global and regional economic aspect and the economic policy of the EU and their influence on the fintech, defining the role of ECB as fintech regulator, identification of pricing factors affecting financial products.

The combination of academic research, regulatory guidance, and expert consultations, along with the thoughtful grouping of risks, creates a basis for the risk-based model.

The following groups of risks are analysed within this model:

Governance Risks - The risk that the company's rules, processes, and mechanisms, function improperly. Governance risks relate to the directors' decisions. Governance risks are associated with the ability of company to comply with the relevant framework of laws (Schmid *et al*, 2011; Asante *et al.*, 2014; Elderson, 2022).

Operational Risks - The risk that the company experiences a loss due to inadequate or failed internal processes, people, systems or external events (Cole *et al.*, 2001; Wang *et al.*, 2018; Cristea, 2021; Kaddumi & Al-Kilani, 2022).

Human Resources Risks - The risks which human resources pose on the company's operations (Ibrahim & Melhem, 2016; Boon *et al.*, 2019; Stahl *et al.*, 2020).

Health and Safety Risks - The risk of the company being exposed to a health and safety hazard which may result in harm, injury, death or illness of an employee in a specific workplace (Silva & Navarro, 2012; Lai *et al.*, 2020; Mustard & Yanar, 2023).

Financial Risks - The risk of losing money on an investment or business project (Syed & Bawazir, 2021; Zhang, 2022).

Cyber Risks - This risk includes hardware and software failures, spam, viruses, malicious attacks, and other ICT matters (Scarlat *et al.*, 2011; Khan & Malaika, 2021; Varga *et al.*, 2021).

Capital Adequacy Risks refer to the risks associated with the firm's capital position, focusing on the sufficiency of capital to support existing and future business activities, as well as the accessibility of additional capital if required. (Dangl & Lehar, 2004; Décamps *et al.*, 2004; Petersen & Mukuddem-Petersen, 2005; Bosch *et al.*, 2008; Fouche *et al.*, 2008; Baker & Wurgler, 2015; Giudici, 2018; Nguyen *et al.*, 2019; Jain *et al.*, 2023; Pontryagin, 1963)

Environmental/External Risks - Risks arising from economic events which are out of the control of the corporate structure (Hummel *et al.*, 2021; Torinelli & Silva Júnior, 2021; Tao *et al.*, 2022).

Law and Regulation Risks - The risk that the firm suffers financial, reputational or litigation damage through failure to monitor, control and eliminate or substantially reduce regulatory compliance risk (Laeven & Levine, 2009; Darolles, 2016; Mursalov, 2021; Rastogi *et al.*, 2022).

Strategic Risks - The risk of loss from poorly addressed strategic goals, failed execution of policies and processes, and inability to respond to macroeconomic and industry dynamics (Delkhosh & Mousavi, 2016; Dvorský *et al.*, 2020; Kryvych & Goncharenko, 2020; Kunz & Heitz, 2021).

Financial Crime Risks - The risks that arise from the failure to prevent financial crime, money laundering and market abuse (Europarlament, 2018; Al-Suwaidi & Nobanee, 2020; Faccia *et al.*, 2020).

The list of threats and vulnerabilities was developed (see Annex 9). For each risk type, every identified threat and vulnerability was carefully classified to determine its relevance and association with that specific risk. This process aimed to define whether each threat and vulnerability was directly related to the particular risk under consideration or not.

The following criteria for assessing the impacts of the threats and vulnerabilities by the participating companies were developed (Tables 3.2, 3.3 and 3.4):

Table 3.2

Criteria for estimating impact of threats and vulnerabilities in internal processes

Risk group	Very High	High	Medium	Low	Very Low
Governance	More than 50 % of decisions are not delivered for final execution, which is a critical failure. Making decisions too slowly results in crucial failures that make it impossible to carry out essential tasks. The impact threatens the initiative or organization's continued existence.	A less than 50 % failure rate occurs when choices are not delivered for final execution. Failure to make choices results in the breakdown of crucial processes, which lowers performance. The initiative, activity, or organization's survival is in jeopardy.	Decisions are not provided in time for the last execution. Delays in making decisions have an effect on the company and lead to poorer performance, including missed goals. Although there is no threat to an organization's existence, there may be a thorough evaluation.	Decisions are not provided in time for the last execution. Delays in making decisions have an effect on the company and lead to poorer performance, including missed goals. Although there is no threat to an organization's existence, there may be a thorough evaluation.	Minor failures of the internal procedure's execution.
Operational	A widespread or protracted halt to activities - Inability to promote services effectively -Dangerous market share loss threat	To handle operational issues, significant internal and/or external resources must be committed. - Significant and/or ongoing business disruptions	Implementing increased internal and/or external resources is necessary to handle operational challenges. -More extensive or widespread organisational inefficiency (s)	Aggravation of the resources that must be dedicated to resolve practical issues - Minor inefficiencies in functioning	Modest resources need to be committed to internal operational issue -Insignificant operational inefficiency
Financial	> €990,000	€330,000.01–€990,000	€160,000.01–€330,000	€30,000.01–€160,000	< €30,000
Human Resources	Protracted unavailability of critical skills/personal	Unavailability of critical skills of personal.	Unavailability of core skills affecting services.	Minor impact to capability	Minor skill impact
Cyber risk	Destruction or	Extensive Damage	Damage or loss of	Minor damage or	Minor damage or

	complete loss of > 50 % of assets. Critical failure(s) preventing core activities from being performed. The impact threatens survival of the project or organization itself.	or loss of < 50 % of assets. Breakdown of key activities leading to reduction of performance. Survival of the project/activity/organization is threated.	< 20 % of assets. Impact on organization resulting in reduced performance such as targets are not met. Organizations existence is not threatened, but could be subject to significant review.	loss of < 5 % of assets. Some impact on business areas in terms of delays, system quality but able to de dealt with at operational level.	vandalism of assets. Minimal impact on non-core business operations. The impact can be dealt with by routine operations
Capital Adequacy	>50 % of the capital	30 %–50 % of the capital	15%–30% of the capital	5%–15% of the capital	< than 5% of the capital
Financial Crime	Extreme consequences	High consequences	Medium consequences	Low consequences	Minor consequences

Source: Generated by the author (Cernisevs *et al.*, 2023)

Table 3.3

Criteria for evaluating threats and vulnerabilities for compliance-related processes

Risk group	Very High	High	Medium	Low	Very Low
Governance	A critical failure occurs when more than 50 % of choices are not delivered for final execution. Slow decision-making leads to critical errors that render it impossible to complete crucial duties. The effect jeopardises the initiative's or organization's viability.	When choices are not provided for final execution, there is a failure rate of less than 50%. Making poor decisions causes vital processes to break down, which lowers performance. The continuation of the project, endeavour, or company is in danger.	The last execution is delayed due to a lack of choices. Delays in decision-making affect the business and result in poorer performance, including missed objectives. An organization's existence is not in danger, but it could still be thoroughly evaluated.	For the most recent execution, decisions were not given in time. Delays in decision-making affect the business and have a negative impact on performance, including missed objectives. An organization's survival is not in danger, but it could still be thoroughly evaluated.	Execution errors in the internal process.
Financial	>€990,000	€330,000.01-€990,000	€160,000.01-€330,000	€30,000.01-€160,000	<30,000
Health and Safety	Death or major injuries. Toxic Envier Damage > = 1’000’000 EUR Damage	Extensive injuries. High Envier Damage < = 1’000’000 EUR Damage	External medical. Medium Envier Damage < = 100’000 EUR Damage	Some First Aid required. Low Envier Damage. < = 10’000 EUR Damage	Even First Aid was not required. Damage <1’000 EUR
Capital Adequacy	>50% of the capital	30%–50% of the capital	15%–30% of the capital	5%–15% of the capital	< than 5% of the capital
Environmental/External	-Occurrence prevents achievement of specific objectives	- Event has a major impact on strategic objectives and/or financial plan of the	-Event has a moderate impact on strategic objectives and/or financial	-Event has a minor impact on strategic objectives and/or financial plan	-Event has limited local damage with no wider

	and financial plan - Sustained, serious loss in market share, company brand value and/or public confidence - Significant attrition in employee retention/attraction	Company -Serious decline in market share, Company brand value, and/or public confidence - Noticeable attrition in employee retention/attraction	plan -Market share, Company brand value and/or public confidence will be affected in the short term -Some attrition in employee retention/attraction	-There is a potential impact on market share, Company brand value and/or public confidence -Consequences can be absorbed under normal operating conditions -Potential attrition in employee retention/attraction	impact likely to be no impact on financial plan - No material impact on market share, Company brand value and/or public confidence - Limited-to-no attrition in employee retention/attraction
Legal/ Compliance	- Cessation of operations by a regulatory body - Court decree	- Operations under surveillance by an external regulatory body - Court case	- Significant legal penalties together with having operations under surveillance internally	- Low penalties	- Minor penalties
Strategic Risks	-Reverses progress on one or more of the Company's strategic goal or threatens strategic plan failure	- Stop progress on more than one strategic goal	-Stops progress on one Company strategic goal	-Slow progress on more than one Company strategic goal	-Slow progress on one Company strategic goal

Source: generated by the author

The following criteria to estimate the probability of threats and vulnerabilities were used:

Table 3.4

Criteria for assessing likelihood of threats and vulnerabilities

Very High	High	Medium	Low	Very low
Event is expected to occur in most circumstances 90%-100%	Event will probably occur in most circumstances 60 %–90 %	Event is as likely to occur as not occur 35 %–60 %	Event could occur at some point in time 10 %–35 %	Event may only occur in exceptional circumstances 0 %–10 %

Source: Generated by the author (Cernisevs *et al.*, 2023)

Model Development

In accordance with (Abid *et al.*, 2021 Cernisevs *et al.*, 2023), the risk is calculated as follows:

$$IR = Im * L \tag{6}$$

where

IR – inherent risk

Im – the impact of the risk

L – the likelihood of the risk

The author calculated the probability and impact of the inherent risk by determining the average likelihood and impact associated with each combination of threats and vulnerabilities contributing to the specific risk. This comprehensive approach enabled the author to arrive at a holistic assessment of the inherent risk, considering all relevant factors such as threats, vulnerabilities, impact, and likelihood. In cases where the same risk generated multiple threats and vulnerabilities, the final threat and vulnerability values were computed as the average of all the relevant factors, resulting in a comprehensive and accurate evaluation of the overall risk landscape (Cernisevs *et al.*, 2023).

$$Im = \frac{\sum_{i=1}^{n} (Ti_i + \frac{(Vi_1 + Vi_2 + \cdots + Vi_m)}{m})}{n * 2} \tag{7}$$

where

Im – the Impact of the risk

Tii -Threat impact per each of the Threats within the risk group

Vi – Vulnerabilities impact

m – number of vulnerabilities per risk group

n – number of threats per risk group

$$L = \frac{\sum_{i=1}^{n} \left(Tl_i + \frac{(Vl_1 + Vl_2 + \cdots + Vl_m)}{m}\right)}{n * 2} \quad (8)$$

where

L – the Likelihood of the risk

Tli –Threat likelihood per each of the Threats within the risk group

Vl – Vulnerabilities likelihood

m – number of vulnerabilities per risk group

n – number of threats per risk group

The scales for impact and likelihood and risk value interpretation were developed (see Annex 10, Tables A10.1 and A10.2).

KPIs and their relationship with risks

The absence of a clear relationship between KPIs and risks poses a significant challenge within the financial management. If KPIs lack a direct alignment with the inherent risks faced by the companies, it becomes difficult to assess and manage potential threats effectively.

The ECB concerns about the current state of KPIs in fintech governance, emphasising the need for a transparent and risk-related methodology in their selection (Kerstin af Jochnick, 2020; Elderson, 2022).

Financial management should be closely tied to both financial risk and capital adequacy risk. By developing KPIs that are specifically tailored to assess and address these risks, fintech can improve risk governance. Comprehensive and risk-related KPIs enable better decision-making, effective resource allocation, and improved risk management, contributing to the stability and success of fintech operations.

Research question of the Thesis – *Do traditional KPIs cover the requirements of the contemporary fintech?* – **answered**. Traditional KPIs without proper relationship to risk of the fintech do not cover the requirements of the contemporary fintech

3.4 Internal processes KPIs of the EU fintech based on KRIs

The ECB emphasises the necessity to consider risks in the process of developing KPIs for financial institutions (see Annex 1). Various risks associated with digital financial products, including cybersecurity hazards, operational risks, and compliance challenges, are examined in detail this study. However, to construct the system of KPIs on risk indicators, it is necessary to first of all determine, what type of financial institutions can use what kinds of KPIs based on KRIs. The hypotheses, formulated in this Thesis, reflect this situation:

1. The European financial institutions can set the Key Performance Indicators on the basis of the Key Risk Indicators for the financial management.

2. The same set of KPIs is suitable for the financial management of European financial institutions of different types.

To confirm these hypotheses, two models that assess the relationship between various types of risks for financial institution and KPIs were developed. The first model focuses on evaluating the relationships between internal operational risks within a financial institution and the corresponding financial management KPIs.

The analysis of multiple statistical relationships was done with employment of structural equation modelling: partial least squares structural equation modelling (PLS-SEM) (Chin *et al.*, 2020; Dash & Paul, 2021; Hair *et al.*, 2021a).

The choice of PLS-SEM method is based on its suitability for exploratory and confirmatory research and absence of requirements to the size of data samples and to data normal distribution (Popova & Popovs, 2022; Popova & Zagulova, 2022). It is suitable for a practical causal-predictive analysis (Khalilzadeh *et al.*, 2020; Hair et al., 2021b), allowing explaining the variance in the constructs, identifying the direct and indirect effects, as well as mediating and moderating factors (Mateos-Aparicio, 2011, Ringle et al., 2020, Dash & Paul, 2021). The KPIs were considered in relation to financial and capital adequacy risks. Consequently, other risk groups were determined based on their potential impact. Considering that these risk groups comprise both internal and external processes, it was decided to represent internal processes through the following risk groups chosen for the modelling:

- Governance Risk
- ICT Risk
- Operational Risk
- Financial Crime Risk
- Human Resources Risk

There were developed the hypotheses for this model. The first set of hypotheses (H1–H5) refers to financial risk:

- H1: Governance risk directly affects company KPIs.
- H2: ICT risk directly affects company KPIs.
- H3: Operational risk directly affects company KPIs.
- H4: Financial crime risk directly affects company KPIs.
- H5: Human resource risk directly affects company KPIs.
- The second set of hypotheses (H6–H10) refers to capital adequacy risk:
- H6: Governance risk directly affects company KPIs.
- H7: ICT risk directly affects company KPIs.

- H8: Operational risk directly affects company KPIs.
- H9: Financial crime risk directly affects company KPIs.
- H10: Human resource risk directly affects company KPIs.

The preliminary work included the analysis of threats and vulnerabilities in the payments industry based on the list of risks, determined by experts in the industry. The companies were divided on the basis of their control of capital adequacy into three groups: banks (credit institutions), financial institutions (electronic money institutions or payment institutions), and enterprises under the second payment directive and cryptocurrency trading companies. Despite differences in risk types and control strategies, all companies aimed to achieve capital adequacy; therefore, it is possible to assume that businesses of different types face the similar risk management tasks using standardised assessment criteria.

The following types of companies are included in the research based on their control of capital adequacy:

Banks (Credit Institutions) – They maintain government funds as guarantees for customer money, ensuring reimbursement in case of bankruptcy, making liquidity of bank funds highly important for capital adequacy.

Financial Institutions (Electronic Money Institutions or Payment Institutions) – These entities are obligated to safeguard customer funds and reimburse them from segregated accounts in the event of bankruptcy.

Enterprises under the second payment directive and cryptocurrency trading companies – Although not legally required to separate customer funds, they are still subject to capital adequacy risks.

Despite variations in risk types and control strategies, the objective of achieving capital adequacy remains the same for companies of different type. Therefore, the author assumed similar risk management tasks across business types using the same assessment criteria.

The list of threats and vulnerabilities applicable to all companies was used to evaluate corporate risks with consistent criteria for impact and likelihood (see Annex 9, Section A). the estimations scaled from 1 to 5 were done for likelihood and impact of these threats and vulnerabilities. On the basis of these estimations the average risk associated with each respondent for each risk group were calculated[1].

The obtained results served as the data source for PLS-SEM analysis, implemented in SmartPLS software.

[1] The methodology of risk assessment is described in Chapter 3.1 pp. 87-90 of this Thesis.

PLS-SEM model construction

The conducted PLS-SEM analysis in SmartPLS software included the following stages:

1. Outer model estimation: This stage focused on verifying the validity of the constructs in the model on the basis of relationships between the latent variables (constructs) and the indicators, forming them. The indicators loadings of the identified constructs are checked and the model's reliability and validity assessed. To ensure the accuracy of the data, any loading with a critical ratio below 0.6 was considered inadequate and removed from the dataset. However, in this study, all loadings had a design confidence higher than 0.6, indicating their reliability and suitability for inclusion in the model loadings. The number of iterations required for SmartPLS to complete the assessment was also determined during this stage.
2. Inner (Structural) Model Evaluation: In this stage, the relationships between the dependent and independent variables are assessed. The used specific values such as impact magnitude (f^2), standardised path coefficients (β), and the coefficient of determination (R^2) allow estimating the strength of these relationships.
3. Overall model evaluation: To ensure that the model fits the data accurately, a comprehensive evaluation of the entire model is performed. Then, the model is assessed for relation to the tested hypotheses.

Table 3.5 presents the referenced data for models' evaluation. This table contains the results of specific literature analysis.

Table 3.5

Recommendation for PLS-SEM evaluation

Assessment	Description	Criteria
Construct validity (Outer model)		
Number of iterations	Sum of the outer weights' changes between two iterations (Ringle *et al.*, 2020)	5–10
	Maximum number of iterations (Memon *et al.*, 2021)	300
Item reliability	Indicators loadings (IL) (Nunnally, 1978; Widaman, 2012; Kock, 2015; Hair *et al.*, 2019)	>0.70 (highly satisfactory)
		>0.50 <0.70 (acceptable)
		>0.40 <0.50 (week)
Convergent validity (The study variables represent the latent constructs intended for measurement, as demonstrated by convergent validity.)	Design reliability, a gauge of the scale components' internal coherence (Nunnally, 1978; Wong, 2019)	>0.80 (Peter, 1979) (satisfactory)
		>0.70 <0.80 (acceptable)
		>0.60 <0.70 (A acceptable range in exploratory study is 0.60 to 0.70)
	The average variance extracted (AVE)	>0.5 (Bagozzi & Yi, 1988)
		AVE >0.5 and CR <0.6 (Fornell & Larcker, 1981)
Discriminant validity	Fornell & Larcker (F&L), in SmartPLS – Divergent validity heterotrait: monotrait ratios (HTMT)(Henseler *et al.*, 2015; Hair *et al.*, 2017)	Confidence intervals shouldn't contain a value of 1; values lower than 0.85 for conceptually different constructs and below 0.90 for similar constructs
Structural model (Inner model)		
Coefficient of determination	The preferred number is a greater one (Chin, 1998; Ringle *et al.*, 2020) – R^2	0.67 (substantial)
		0.33 (average)
		0.19 (weak)
Standardised path coefficients	Identify the importance and the confidence intervals – (β)	from −1 to +1.
Effect size	The strength of the connection between two variables in a population is measured by the effect size. – f^2	0.35 (strong effects)
		0.15 (moderate)
		0.02 (weak)
Variance inflation factor	An indicator of the degree of multicollinearity (VIF)	VIF < 3.3 (Petter *et al*., 2007; Hair *et al.*, 2010; Hair *et al.*, 2011)
Final model evaluation		
Fit Measures	Standardised Root Mean Square Residual (SRMR) – The disparity between the observed correlation and the model-implied correlation matrix is known as the SRMR. As a result, it enables evaluation of the (model) fit criterion using the average magnitude of the discrepancies between observed and anticipated correlations. (Henseler *et al.*, 2015)	< 0.08

Source: generated by the author based on research (Cernisevs *et al.*, 2023)

Outer Model Evaluation

The model is created using SmartPLS software; the latent variables are formed in accordance with the hypotheses set for this model. In the exploratory study, indicators of latent variables with loadings greater than 0.60 were initially selected, as this threshold is considered appropriate. All latent variable values exceeding 0.60 were included in the model (Annex 9, Section A).

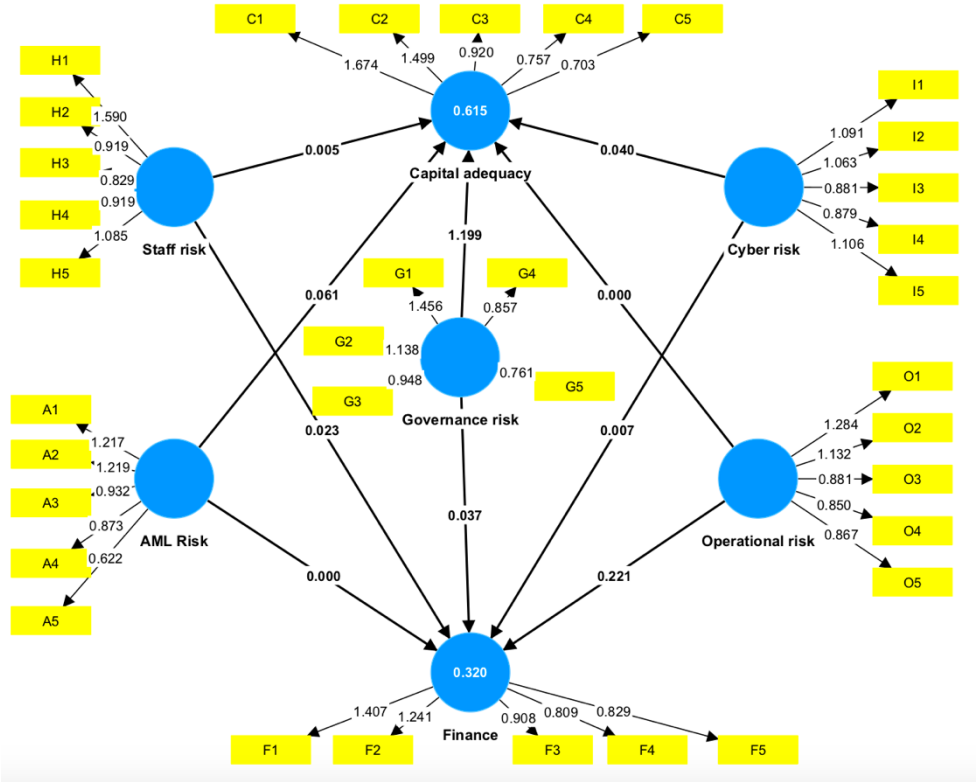

Figure 3.2 O**perational risks model for internal processes**
Source: generated by the author based on PLS-SEM in SmartPLS 4.0 (Cernisevs *et al.*, 2023)

All loading weights for each variable were found to be greater than 0.6, thus they were all considered. The outer model's construct validity metrics, such as composite reliability (CR) and average variance extracted (AVE), were within the required bounds (see Table 3.5 and Table 3.6). Each construct demonstrated high dependability and internal consistency. The composite reliability was > 0.984, and the average variance extracted was >0.942, indicating that the selected variables accurately represent the latent constructs.

Table 3.6

Values of constructs validity for internal processes model

Constructs	CR	AVE	Composite reliability (rho_a)
Cyber Risk	0.995	0.981	1.005
Operational Risk	0.976	0.912	0.995
Financial Risk	0.970	0.894	0.980
Financial Crime Risk	0.989	0.954	1.073
Human resource Risk	0.992	0.968	1.004
Governance Risk	0.983	0.935	0.994
Capital adequacy Risk	0.986	0.947	0.988

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Discriminant validity identifies differences between the constructs within the model; its assessment is important indicator of the model quality. Three widely used techniques for this assessment in PLS SEM are the Fornell–Larcker criterion, cross-loadings and the Heterotrait–Monotrait ratio of correlations (HTMT) (Hair *et al.*, 2017).

The Fornell-Larcker criterion is commonly employed, but it has been considered weaker (Hair *et al.*, 2014; Dijkstra & Henseler, 2015), more error-prone, and less effective in certain situations. A more rigorous approach is the HTMT method (Henseler *et al.*, 2015), which is recommended by some researchers (Hair *et al.*, 2014) over the Fornell-Larcker technique due to its enhanced sensitivity in detecting discriminant validity. In this model all criteria for discriminant validity estimation demonstrated the high quality of model due to proper discriminant validity (see Table 3.7 and Table 3.8).

Table 3.7

Fornell-Larcker criterion values for internal processes model

	AML	Capital adequacy	Cyber	Finance	Governance	Operational	Staff
AML	0.977	–					
Capital Adequacy	0.253	0.973	–				
Cyber	−0.657	−0.264	0.991	–			
Finance	0.255	0.490	−0.121	0.945	–		
Governance	0.127	0.755	−0.344	0.304	0.967	–	
Operational	0.492	0.334	−0.258	0.526	0.311	0.955	–
Staff	−0.311	−0.110	0.171	−0.128	−0.020	−0.004	0.984

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Table 3.8

HTMT values for internal processes model

	AML	Capital adequacy	Cyber	Finance	Governance	Operational	Staff
AML	–						
Capital Adequacy	0.215	–					
Cyber	0.659	0.261	–				
Finance	0.232	0.483	0.138	–			
Governance	0.127	0.756	0.343	0.291	–		
Operational	0.490	0.315	0.247	0.529	0.299	–	
Staff	0.325	0.108	0.168	0.127	0.053	0.046	–

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Another important measure for model quality is analysis of multicollinearity. The variance inflation factor (VIF) serves as an indicator of multicollinearity. VIF values should ideally not exceed 3.3 (Petter *et al.*, 2007; Hair *et al.*, 2010; Hair *et al.*, 2011).

The model demonstrates high quality (see Table 3.9), the indicators are lower than admissible, demonstrating absence of multiple correlations in the model.

Table 3.9

Variance inflation factor (VIF) values for internal processes model

	Capital Adequacy	Finance
AML	–	–
Capital Adequacy	2.161	2.161
Cyber	–	–
Finance	2.499	2.499
Governance	2.685	2.685
Operational	2.265	2.265
Staff	1.497	1.497

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Evaluation of the inner (structural) model. Verifying the hypotheses

The inner model evaluates the relationships between constructs using three key metrics: the coefficient of determination (R2), standardised path coefficients (β), and impact size (f2). The study was terminated after completing seven iterations, which is within the permitted limits (Hair *et al.*, 2011). Initially, the model's framework, as shown in Figure 3.2, was analysed.

Of particular interest were the R^2 values for the constructs "Capital Adequacy Risk" and "Financial Risk," as they are the target variables of the model. The results indicated that approximately 61.5% of the other types of risks significantly impact the Capital Adequacy Risk,

while 32.0% of the other types of risk significantly influence the Financial Risk. These R^2 values are relatively high, suggesting that the research successfully identified the key factors influencing financial and capital adequacy for fintech and potentially for businesses of similar size and infrastructure. Table 3.10 presents the direct impact of independent variables on Capital Adequacy and Financial Risks indicators as dependent variables. The tested relationships correspond to 10 hypotheses set for this model

Table 3.10

Direct effects for internal processes model

Risk group	β	f^2
AML Risk -> Capital adequacy	0.150	0.061
AML Risk -> Finance	0.016	0.000
Cyber risk -> Capital adequacy	0.119	0.039
Cyber risk -> Finance	0.072	0.006
Governance risk -> Capital adequacy	0.742	1.202
Governance risk -> Finance	0.218	0.044
Operational risk -> Capital adequacy	0.013	0.000
Operational risk -> Finance	0.447	0.044
Staff risk -> Capital adequacy	-0.062	0.005
Staff risk -> Finance	-0.200	0.023

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Only five of ten tested hypotheses were confirmed, indicating that there are specific relationships between risks and other factors. Notably, Governance risk was found to have the most significant overall impact on capital adequacy risk (β = 0.742), while Cyber risk had the smallest overall impact (β = 0.119) (Table 3.11).

Table 3.11

Result of hypotheses testing for internal processes model

	Hypotheses	Result of Checking
H1	AML Risk -> Capital adequacy	***Confirmed***
H2	AML Risk -> Finance	Not Confirmed
H3	Cyber risk -> Capital adequacy	***Confirmed***
H4	Cyber risk -> Finance	Not Confirmed
H5	Governance risk -> Capital adequacy	***Confirmed***
H6	Governance risk -> Finance	***Confirmed***
H7	Operational risk -> Capital adequacy	Not Confirmed
H8	Operational risk -> Finance	***Confirmed***
H9	Staff risk -> Capital adequacy	Not Confirmed
H10	Staff risk -> Finance	Not Confirmed

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

For the overall model assessment, a PLS-SEM study requires a comprehensive evaluation. In this case, the SRMR resulted in 0.089, slightly higher than the necessary value

of 0.080. However, this difference is not significant, and the findings of this research remain valuable and informative.

Interpretation of the model' results

The analysis of KRIs and their relationship with KPIs permit development of approach to the selection KPIs for financial institution, based on risk parameters.

The model focused on risks representing internal processes of the company, such as governance risk, ICT risk, operational risk, financial crime risk, and human resources risk, and their impact on finance and capital adequacy. The correlation of these risks to financial and capital adequacy risk was verified, confirming a connection between financial KPIs and capital adequacy risk. All considered risks, except staff risk, correlated with the financial and/or capital adequacy risk. Approximately 61.5% of the other risk categories affecting capital adequacy risk and 32.0% affecting financial risk were explained by latent variables in the model. The primary factors influencing different risk types impacting financial and capital adequacy risk were identified.

These findings allow creating the manual or automated KPI selection and evaluation models for fintech or other businesses with similar levels of digitalisation. Staff risk does not show a definitive correlation with financial or capital adequacy risk; however, it is important for the model development, though it is excluded from the final model.

Research question – *Do Key Risk Indicators (KRI) of the fintech determine KPI related to financial management?* – **answered**. The current assessment confirms that risk indicators of the fintech have relationship with its KPIs. This fact proves that KRIs determine fintech's KPIs.

3.5 Fintech compliance with regional EU legislation: KPIs and KRIs

Compliance is a highly important factor for the financial market, requiring following the legal and regulatory rules, policies, and laws to prevent data protection issues and to have effective decision-making and risk-prevention strategies (Esmaeilian *et al.*, 2016; Paritala *et al.*, 2017; Mayer *et al.*, 2021; Cernisevs *et al.*, 2022; Cernisevs *et al.*, 2023; Cernisevs *et al.*, 2023; Popova & Cernisevs, 2023).

Human resource management in compliance also receives additional attention due to the technological progress and changing laws. Health and safety are integral parts of a company's strategy. Sustainable event planning reduces environmental impact. Strategic planning integrates compliance into a financial institution's forecasting and considers necessary compliance resources (Boon *et al.*, 2019; Jatobá *et al.*, 2019; Garengo *et al.*, 2022).

The digital transformation of the economy requires adequate and specific KPIs related to compliance for each business. A multidisciplinary approach is used to identify how

managerial, financial, and technological aspects affect compliance risks in the digital space. The model of relationships of compliance risk and KPIs is the continuation of the developing the approach towards KPIs selection on the basis of KRIs.

This part of analysis as well as the previous one is implemented in SmartPLS software. The analysis is done in accordance to the methodology presented above.

The latent variables are constructed on the basis KRIs and their relation with compliance KPIs. The analysis included such risk groups as governance risk, health and safety risk, environmental/external risk, legal/compliance risk, and strategic risk.

To examine the direct impact of each risk group on company compliance-related KPIs, the set of hypotheses was formulated. These hypotheses refer to the ability of specific risks to influence the company's compliance-related objectives. The first group of hypotheses (H1–H5) relate to capital adequacy risks, and the second group of hypotheses (H6–H10) refer to financial risks.

- H1: Governance risk has a direct impact on company compliance-related KPI.
- H2: Health and safety risk has a direct impact on company compliance-related KPI.
- H3: Environmental/external risk has a direct impact on company compliance-related KPI.
- H4: Legal/ Compliance Risk has a direct impact on company compliance-related KPI
- H5: Strategic Risk has a direct impact on company compliance-related KPI.
- H6: Governance risk has a direct impact on company compliance-related KPI.
- H7: Health and safety risk has a direct impact on company compliance-related KPI.
- H8: Environmental/external risk has a direct impact on company compliance-related KPI
- H9: Legal/ compliance risk has a direct impact on company compliance-related KPI.
- H10: Strategic risk has a direct impact on company compliance-related KPI.

Based on this set of hypotheses, the model is constructed in SmartPLS software. The employment of method of PLS-SEM analysis, as well as the methodology of its application are shown in Section 3.5.

The estimation of the model is done in three stages:

- assessment of the outer model,
- assessment of the inner model,
- estimation of the entire model and interpretation of the obtained results.

Outer Model Evaluation

The outer model analyses the constructs from the point of view of indicators, included in each variable. This type of study is exploratory, and for exploratory study indicators of latent variables with loadings >0.60 are initially selected, as this boundary value is considered

suitable. The outer model's construct validity metrics, including composite reliability (CR) and average variance extracted (AVE), all meet the required thresholds (see Tables 3.5 and 3.12). Each construct showed high levels of dependability and internal consistency. The average variance extracted is > 1.007, and the composite reliability is > 0.992, indicating that the variables accurately represented the latent constructs intended for measurement.

Table 3.12

Values of constructs validity for compliance-related processes model

Constructs	CR	AVE	Composite reliability (rho_a)
Environmental/External Risk	0.988	0.956	1.007
Health and Safety Risk	0.992	0.968	0.993
Financial Risk	0.970	0.894	0.981
Legal/ Compliance Risk	0.964	0.871	1.005
Strategic Risk	0.989	0.958	0.994
Governance Risk	0.983	0.935	0.994
Capital adequacy Risk	0.986	0.947	0.988

Source: generated by the author based on SmartPls 4.0(Cernisevs, Popova and Cernisevs, 2023)

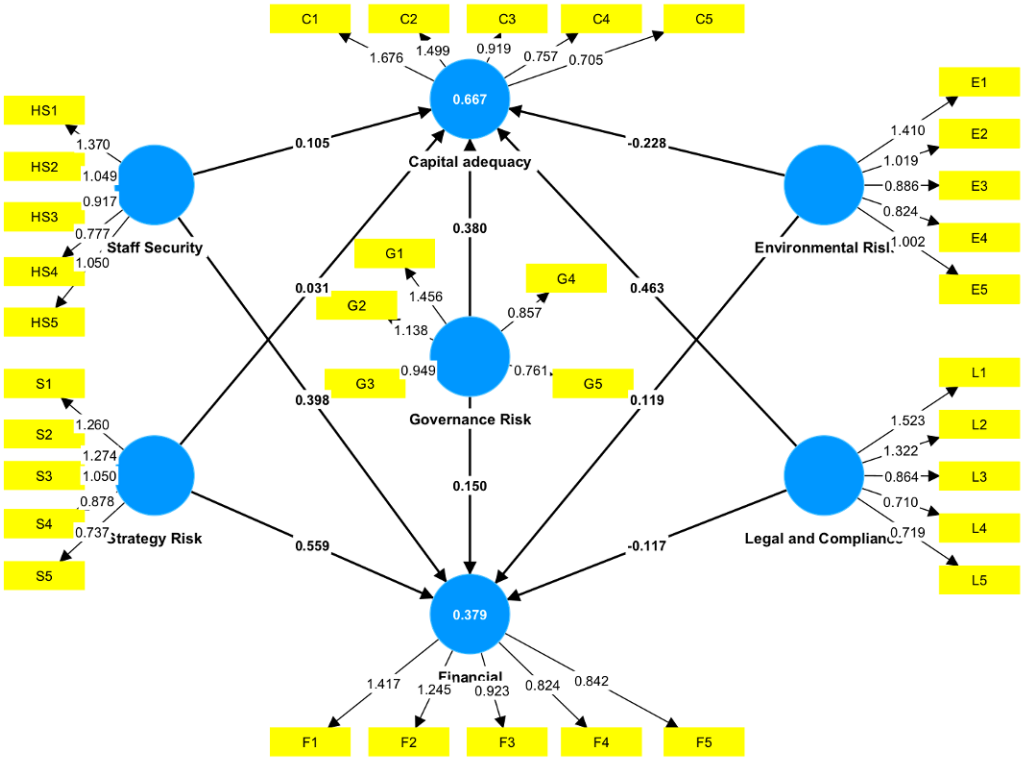

Figure 3.3 **Compliance-related risks model**

Source: generated by the author based on PLS-SEM in SmartPLS 4.0 (Cernisevs *et al.*, 2023)

Discriminant validity identifies differences between the constructs within the model; its assessment is important indicator of the model quality. To assess the discriminant validity in the outer model estimation, three widely used methods were employed: the Fornell-Larcker measure, cross-loadings and the Heterotrait-Monotrait ratio of correlations (HTMT). While the

Fornell-Larcker criterion is commonly used, it has been considered weaker and less effective, with some potential for error. To address this, the HTMT approach, known for its stricter benchmark, was also utilised (Hair *et al.*, 2014).

The results of these methods, as shown in Table 3.13 for the Fornell-Larcker criterion and Table 3.14 for HTMT, fully meet the diagnostic validity requirements (Hair *et al.*, 2014; Dijkstra & Henseler, 2015). Each indicator has the highest loads in the corresponding construct it was intended to measure, ensuring discriminant validity. Additionally, all latent factors satisfied the HTMT criterion, confirming the absence of any diagnostic validity issues. Therefore, the quality of inner model is high.

Table 3.13

Fornell-Larcker criterion values for compliance-related processes model

	Capital Adequacy	**Environmental/External Risk**	**Financial Risk**	**Governance Risk**	**Legal/ Compliance Risk**	**Health and Safety Risk**	**Strategic Risk**
Capital Adequacy	0.973	–					
Environmental/External Risk	−0.283	0.978	–				
Financial Risk	0.518	0.022	0.944	–			
Governance Risk	0.755	−0.273	0.328	0.967	–		
Legal/ Compliance Risk	0.714	-0.054	0.164	0.677	0.933	–	
Health and Safety Risk	−0.342	0.611	0.136	−0.277	−0.412	0.984	–
Strategic Risk	0.477	−0.313	0.532	0.543	0.411	−0.284	0.979

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Table 3.14

HTMT values for compliance-related processes model

	Capital Adequacy	**Environmental/External Risk**	**Financial Risk**	**Governance Risk**	**Legal/ Compliance Risk**	**Health and Safety Risk**	**Strategic Risk**
Capital Adequacy	–						
Environmental/External Risk	0.279	–					
Financial Risk	0.483	0.055	–				
Governance Risk	0.756	0.269	0.291	–			
Legal/ Compliance Risk	0.699	0.097	0.199	0.671	–		
Health and Safety Risk	0.346	0.607	0.160	0.278	0.414	–	
Strategic Risk	0.475	0.310	0.520	0.551	0.411	0.286	–

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

The cross-loading results confirm the excellent discriminant validity of the factors.

The variance inflation factor (VIF) in regression analysis assesses the level of multicollinearity, which occurs when there is a correlation between multiple independent variables in a multiple regression model. Typically, VIF values should not exceed 3.3 to avoid significant multicollinearity issues (Petter *et al.*, 2007; Hair *et al.*, 2010; Hair *et al.*, 2011). In this model, the highest VIF value observed was 2.685, indicating no significant concern regarding multicollinearity (Table 3.15).

Table 3.15

Variance inflation factor (VIF) values for compliance-related processes model

	Capital Adequacy	Finance
Capital Adequacy	–	–
Environmental/External Risk	2.161	2.161
Financial Risk	–	–
Governance Risk	2.499	2.499
Legal/ Compliance Risk	2.685	2.685
Health and Safety Risk	2.265	2.265
Strategic Risk	1.497	1.497

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Evaluation of the inner (structural) model. Testing the hypotheses

The inner model's effect size (f^2), standardised path coefficients (β), and coefficient of determination (R^2) are used to estimate the connections between the constructs. The number of iterations is seven out of the ten allowed (Hair *et al.*, 2017; Chin *et al.*, 2020).

The constructed model is presented in Figure 3.3. The latent variables of the model demonstrated that approximately 66.7 % of the other types of risk impact the "capital adequacy risk," while 36.9 % of the other types of risk impact the "financial risk." These relatively high R^2 values indicate the author accurately identified key factors influencing the target variables of the model, namely "Capital Adequacy Risk" and "Financial Risk."

The direct effects of the model are shown in Table 3.16

Table 3.16

Direct effects for compliance-related processes model

Risk group	β	f^2
Environmental Risk - > Capital adequacy	−0.185	0.048
Environmental Risk - > Financial	0.074	0.004
Governance Risk - > Capital adequacy	0.401	0.194
Governance Risk - > Financial	0.150	0.015
Legal and Compliance - > Capital adequacy	0.449	0.226
Legal and Compliance - > Financial	−0.058	0.002
Staff Security - > Capital adequacy	0.079	0.008
Staff Security - > Financial	0.272	0.053
Strategy Risk - > Capital adequacy	0.040	0.003
Strategy Risk - > Financial	0.574	0.357

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

Regarding the precise relationship between risks and other factors, only five out of ten hypotheses were confirmed. The study revealed that environmental risk has the least overall effect (β = 0.574), and strategic risk has the most significant impact on financial risk (β = 0.074).

Results of hypotheses testing are presented in Table 3.17

Table 3.17

Result of Hypotheses testing for compliance-related processes model

	Hypotheses	Result of Checking
H1	Governance Risk -> Financial	Not Confirmed
H2	Health and Safety Risk -> Financial	***Confirmed***
H3	Environmental Risk -> Financial	Not Confirmed
H4	Legal and Compliance -> Financial	Not Confirmed
H5	Strategy Risk -> Financial	***Confirmed***
H6	Governance Risk -> Capital adequacy	***Confirmed***
H7	Health and Safety Risk -> Capital adequacy	Not Confirmed
H8	Environmental Risk -> Capital adequacy	***Confirmed***
H9	Legal and Compliance -> Capital adequacy	***Confirmed***
H10	Strategy Risk -> Capital adequacy	Not Confirmed

Source: generated by the author based on SmartPls 4.0 (Cernisevs *et al.*, 2023)

For the overall model assessment, a PLS-SEM study requires a comprehensive evaluation. In this case, the SRMR resulted in 0.091, slightly higher than the necessary value of 0.080. However, this difference is not significant, and the findings of this research remain valuable and informative.

Interpretation of the model' results

This study demonstrates a clear connection between KPIs and KRIs the compliance area. While KPIs measure business performance, KRIs identify potential risks.

The research reveals correlations between each risk factor in the model and financial and/or capital adequacy risks. Compliance-related risks account for 66.7% of capital adequacy risks and 36.9% of financial risks.

The first presented model (Figure 3.2) demonstrated that internal operational risks affect capital adequacy risks by 61.5% and financial risks by 32%.

The models demonstrate that both groups of risks – internal (Figure 3.2) and external (Figure 3.3) have significant relationships with KPIs. In case with external risks even the latent variable "staff risks", which does no not affect finance and capital adequacy risk within the internal processes, has significant impact in model with external processes. The aspect of human resource management concerning employee's health and safety standards influences the capital adequacy and financial risk. Compliance with legal requirements for employee working conditions influences company KPIs

The presented PLS-SEM analysis has certain limitations:

- The study is based on data of five different types of fintech operating in the EU. They differ in size, the degree of digitalisation, customer service strategies, regions of activity. The fintech working under other conditions (regional, legislative, and so on) might demonstrate different results.
- The study analysed the certain set of risks. Analysis of other risks might have different results.
- The study employs PLS-SEM analysis. Application of different statistical tolls might influence the results.

Therefore, to eliminate the possible doubts, each company working under specific conditions, can apply this approach to KPIs selection and use the specific components of analysis suitable for the situation.

Hypothesis 1 *The European financial institutions can set the Key Performance Indicators on the basis of the Key Risk Indicators for the financial management* - **CONFIRMED**

Hypothesis 2 *The same set of KPIs is suitable for the financial management of European financial institutions of different types* - **CONFIRMED**

Conclusions

On the basis of the study results the following conclusions were done:

1. The systematic literature review demonstrated that the topic of KPIs formation for financial institutions is not covered sufficiently in the scientific publications. The issues of cybersecurity and liquidity referring to risks are discussed, but they do not focus on selecting KPIs based on these risks. The Thesis proves that the traditional KPIs for measuring financial success, for example, ROE, can be used for fintech, but they do not cover the needs of fintech. The research offers the way of choosing the risk indicators suitable for the financial institution on the basis of the Delphi survey results. The selected risk indicators become the basis for developing the KPIs. The offered statistical model allows checking the relevance of the chosen risks for this institution.
2. The author developed the detailed classification of types of fintech and segmentation of the digital products in accordance with the type of fintech, which can be used by the financial institutions, producing the digital products. The analysis of fintech licensing can support the producers of digital products and decrease the compliance-related risks.
3. The author has developed the taxonomy of digital products. This allows connecting the production of various digital products and facilitating the activities of financial institutions.
4. The author provided a legal classification for electronic money and crypto assets, as well as a life-cycle classification based on the EU regulations, important for issuing these assets. A token classification algorithm was also developed.
5. The author suggests the pricing strategies for the digital products. These strategies are based on the EU regulatory acts and Fama's theory. The risks inherent in the price formation methods were identified and analysed.
6. The factors of regional dimension which affect the fintech operations were identified. They can be considered by the practitioners in their work. It is shown that the traditional resource theories are not applicable for the operations with digital products. Information and telecommunication development are the key factors for the digital economy.
7. The implementation of the EU regional policy at the EU member states level create different conditions for functioning of the financial institutions and can impact their functioning not only via regional policy, but also via legislative acts and national regulation. Therefore, the financial institution can choose the location within the EU, where the conditions are especially favourable for the operations of the exact financial institution.
8. The author analyses the requirements of the ECB to the financial institutions to select the KPIs on the basis of risk indicators and offers the ways how they can adopt these requirements for the operations of fintech in the EU.

9. The Thesis demonstrates the life-cycle and stages of producing of the digital assets in the EU, which determine their associated risks. It is simultaneously proven that digital assets production should be reflected in inventories but not in capital section in financial reporting, which contradicts the numerous scientific publications but supported by the approach of IFRS. This fact changes not only accounting practices of the EU financial institutions but also allows them to change the financial governance including risk management.
10. The author proves that fintech is one of the most important factors of smart city development. The Thesis demonstrates that smart city authorities can actively use fintech for providing the financial services with the division of costs on the basis of offered costs function; it is proven that smart city administration can efficiently use the operations of fintech for the city development.
11. The distribution of costs between financial institutions and smart city administration allows implementation of shared financial services in smart city. The developed costs functions can facilitate introduction of financial products in smart city. However, these operations also produce specific compliance and regulatory risks, which were identified.
12. The survey of experts in risk management of financial institutions using Delphi method allowed identifying the specific risk indicators for financial institutions relating financial stability and capital adequacy risks in internal and compliance-related processes. The criteria for their assessment were developed. The identified risks evaluated in accordance with the developed criteria and were included in the data sets, used for constructing the statistical models. The identified risks were used as latent variables in the developed statistical models.
13. Two statistical models were developed with application of PLS-SEM method for internal and compliance-related processes. The models examined the relationship between KPIs and KRIs in the fintech industry. The significant dependence between the majority of internal operational risks and financial/capital adequacy risk were determined. All of the analysed risks except staff risk show the relationships with financial results; however, staff risk, as well as other risks, is significant for compliance-related processes.
14. The quality of the developed models was estimated in accordance with the world-accepted methodology for estimating SEM. The quality of models is high. As a result, the Hypotheses of the Thesis are supported. Hypothesis 1 was confirmed through internal models' analysis, showing the links between financial metrics and risk categories. The development of accurate and relevant KPIs on the basis of KRIs improves financial governance of financial institutions and financial stability across Europe. Hypothesis 2 was confirmed by the analysis of outer models' indicators, where the indicator loadings for latent variables show

minimal variation, despite representing different types of financial institutions. The proximity in values suggests that these different institutions may employ similar KPIs for evaluating performance.

15. The recommendations for the financial institutions, regulatory bodies at the EU level (European Commission, the ECB and European supervisors) and at national level (National/Central banks and national supervisors) were developed. The recommendations relate only to the function of supervision of financial institutions. This function is implemented by all the above-mentioned bodies, and the recommendations were developed to all of them as supervisors.

Recommendations

On the basis of provided study the following recommendations fintech and for regulatory and supervising authorities were formulated.

For the financial management of financial institutions operating in the EU

1. *Implement a Dual Indicator System*. Financial institutions should adopt a dual indicator system that incorporates both Key Risk Indicators (KRIs) and Key Performance Indicators (KPIs) to ensure a comprehensive performance measurement that aligns with company objectives and complies with all legal regulations.
2. *Adopt the Statistical KPI Selection Models*. Utilize the tailored statistical models to analyze KPIs and risk factor correlations, allowing for precise determination of crucial relationships for each financial institution based on its unique operations, regional presence, goals, and risk profiles.
3. *Prioritize High-Risk Indicators*. Establish a process for identifying high-risk indicators relevant to the business and prioritize these as KPIs. These risk-based KPIs should be equally important to traditional performance metrics in strategic decision-making.
4. *Regularly Update KPIs*. Schedule consistent evaluations of KPIs relevance to adapt to evolving conditions within the digital finance sector, ensuring that metrics remain aligned with current business and regulatory landscapes.
5. *Enhance Risk Prediction Processes*. When assessing potential risks, include considerations of average risk probabilities prevalent in the wider market, not solely based on the institution's past negative experiences, to form a more comprehensive risk assessment.
6. *Optimize KPI Reporting Mechanisms*. Develop an in-depth reporting framework for communicating KPIs and risk factors to all stakeholders, such as investors, board members, regulatory bodies, and employees, enhancing transparency and accountability.
7. *Expand Training and Knowledge Sharing*. Offer dedicated training for management and employees to deepen their understanding of the interplay between KPIs and KRIs, fostering a culture of informed risk management and performance assessment.
8. *Conduct Regular Benchmarking*. Perform regular benchmarking against industry standards to pinpoint areas of improvement, stay abreast of market developments, and proactively adjust strategic directions.
9. *Invest in KPI Tracking Technology*. Allocate resources to advanced technological systems that enable sophisticated tracking, analysis, and reporting of KPIs, thereby elevating decision-making processes and strategic planning capabilities.

10. *Systematize Feedback Loops for KPI and KRI Analysis*. Establish a structured feedback system that periodically reviews the dynamics between the company's KRIs and KPIs, facilitating continuous improvement and strategic refinement.

For the EU financial regulators and lawmakers (ECB, the European Commission and the European Supervisors)

1. *Publish Integrated KPI and KRI Guidelines*. Issue comprehensive guidelines that detail the incorporation of Key Performance Indicators (KPIs) with Key Risk Indicators (KRIs), ensuring that both are given equal importance in the performance assessments of fintech entities.
2. *Mandate KPI and KRI Disclosure*. Amend financial reporting regulations to mandate the disclosure of both KPIs and KRIs, offering a clearer understanding of the risk profile and performance metrics of fintech companies.
3. *Develop Standardized Risk-Performance Metrics*. Initiate the creation of a standardized set of risk-performance metrics, drawing on the results of recent studies to ensure industry-wide applicability and comparability.
4. *Encourage Risk-Based Performance Measurement*. Promote policies that incentivize fintech firms to develop financial KPIs that reflect their specific operational risks, encouraging more tailored risk management practices.
5. *Support Cross-Sector KPI and KRI Model Development*. Foster collaboration across fintech firms, traditional financial institutions, academia, and regulatory bodies to tailor KPI and KRI models to each financial entity's needs.
6. *Advocate for RegTech Adoption*. Encourage the implementation of Regulatory Technology (RegTech) to enhance the accuracy and efficiency of KPI and KRI management, tracking, and reporting, thereby improving regulatory oversight.
7. *Institute Periodic Industry Reviews*. Schedule regular industry assessments to ensure KPIs remain aligned with the evolving risk landscape of the fintech sector.
8. *Monitor KPI and KRI Evolution*. Continuously monitor fintech industry KPI and KRI changes to adjust regulatory requirements accordingly, maintaining their effectiveness and relevance.
9. *Create Adaptive Regulatory Frameworks*. Establish dynamic regulatory frameworks capable of quick adaptation to changes in fintech, ensuring KPIs and KRIs are updated in response to emerging risks.
10. *Offer KPI and KRI Integration Training*. Develop training programs for fintech professionals on creating and implementing an integrated approach to selecting and utilizing

KPIs and KRIs. This could involve specific modules or certifications, potentially in collaboration with European financial educational institutions.

In implementing these recommendations, policymakers should consider revising key legislative documents such as the Markets in Financial Instruments Directive (MiFID II), the Capital Requirements Regulation (CRR), and the Payment Services Directive (PSD2), to incorporate the necessary provisions for KPI and KRI integration and reporting. Additionally, white papers and best practices manuals could be developed to guide the industry in these new standards.

For the national financial regulators (National (Central) Banks and National Supervisors)

1. *Institutionalize Risk-Based Performance Metrics*. National (Central) Banks and National Supervisors should promote the integration of KRIs into the performance metrics (KPIs) for domestic financial institutions. This could involve drafting and adopting new regulations or amendments to existing financial oversight frameworks that require financial institutions to adopt KPIs that reflect their risk exposure.
2. *Develop National KPI Training Programs*. Organize and facilitate training programs tailored to the national context for financial institutions, focusing on the adoption of an integrated risk-based approach to KPI selection. This training could be made a part of mandatory continuing professional development for finance professionals and could involve the creation of detailed instructional materials, online courses, or workshops.
3. *Harmonize Implementation Strategies*. Establish a uniform set of implementation strategies for risk-based performance metrics that align with those recommended by EU-level regulators. This would require the creation or update of national regulatory guidelines, potentially including a national version of the EU's guidelines. These guidelines would ensure consistency in the application of the integrated KPI and KRI approach across all member states.

To facilitate these recommendations, it would be prudent for national authorities to review and revise national financial oversight acts and guidelines. They might consider producing a national handbook or circular that translates EU-level recommendations into the specific legal and regulatory context of their country. Additionally, they should ensure that these national documents are in harmony with EU directives like the Fourth Anti-Money Laundering Directive or the Digital Finance Strategy for the EU, thereby ensuring a cohesive regulatory environment across both national and European landscapes.

For the Smart City's administration

1. AIS and PIS Integration for Smart Economies:

1.1. Smart cities should actively pursue the integration of Account Information Services (AIS) and Payment Initiation Services (PIS) into their financial frameworks. This should include creating secure digital infrastructure to support these services, which will improve payment efficiencies for residents and businesses.

1.2. Develop a strategic plan of the smart city, outlining the steps for integration, such as partnering with fintech firms, ensuring data protection, and setting clear benchmarks for success.

1.3. Conduct pilot programs in select districts or sectors to measure the impact of AIS and PIS on the local economy and mobility, adjusting the approach as necessary before a wider rollout.

2. Strategic KPI Assessment for Shared Financial Services:

2.1.Establish a task force to conduct a comprehensive analysis of how shared financial services can enhance the performance of the city's economy and mobility sectors.

2.2. Update existing Smart City KPI frameworks to include metrics that specifically measure the impact of shared financial services. These metrics should assess improvements in transaction times, cost savings for the city administration and users, and user satisfaction levels.

2.3.Document best practices and lessons learned from other smart cities that have successfully implemented shared financial services, and adapt these insights to the local context.

3. Engaging entities under PSD2:

1.1.Smart cities should create a policy framework that encourages collaboration with entities under PSD2 directive to broaden the financial service offerings within the city.

1.2.Initiate a regulatory sandbox that allows entities to test innovative financial solutions in a controlled environment, ensuring these services meet regulatory standards and address the needs of the city.

1.3.Set up a Smart City fintech hub that serves as an incubator for entities collaborations, offering support and resources for the development of tailored AIS and PIS solutions for residents and businesses.

To implement these recommendations, Smart Cities governance should develop the detailed guidelines and action plans that outline the phased integration of AIS and PIS, identify clear objectives and milestones for shared financial services, and create a supportive

environment for entities. These documents should align with the broader strategic goals of the smart city and include collaboration frameworks, data privacy and security protocols, and an evaluation mechanism to track progress and impact.

Publications and reports on topics of Doctoral Thesis

Publications

1. Cernisevs, O. (2021). Analysis of the factors influencing the formation of the transaction price in the blockchain. Financial and credit systems: prospects for development, 3(3), 36–47. https://doi.org/10.26565/2786-4995-2021-3-04 [**COPERNICUS**]
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Reports and theses at international congresses and conferences

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5. Cernisevs, O., Zemcova A., Sannikova L., Danileiko D. 2022. Globalization and cross-industrial risks framework. *XII International Scientific Conference "Time of challenges and opportunities: challenges, solutions, perspectives"* 13-14 May 2022, Riga, Latvia: Baltic International Academy.
6. Cernisevs, O. 2022. Initial Coin Offering assessment analysing accounting approach in EEA *Round Table Program On the theme of: "European Union for Smart and Sustainable Growth. European Union for Georgia" Dedicated to the 90th anniversary of the University,* 11 July 2022, Tbilisi, Georgia: Sokhumi State University
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10. Cernisevs, O. 2023. Industry 4.0 and fintech Financial Governance Actualities *VIII International Scientific-Practical Conference* October 19–20, 2023, Edmonton, Canada

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Annexes

Annex 1

ECB SUPERVISION NEWSLETTER

15 February 2023

Risk culture is a set of norms, attitudes and behaviours related to awareness, management and controls of risks in a bank. It shapes managements and employees' day-to-day decisions and has an impact on the risks they take.

Weaknesses in risk culture may signal problems in the future, such as financial losses or misconduct. Conversely, a bank's strong financial position could be misleading if there is an underlying problem with culture and conduct. Therefore, even in periods of solid financial health, strong risk culture can be essential in preventing future losses which could damage the reputation of a bank.

This is why supervisors thoroughly examine this risk area based on the European Banking Authority's guidelines on governance. It is each bank's responsibility to define and shape its own risk culture. In turn, it is the supervisor's role to assess the dimensions of this risk culture.

Tone from the top & communication

- Composition of management bodies
- Functioning of management bodies
- Inclusion of risk and compliance perspectives throughout the bank (e.g. code of ethics)
- Speak-up culture, including whistleblowing mechanism

Incentives	**Accountability & ownership of risk**
• Incentives schemes (including renumeration and promotion) • Consequence management to sanction misconduct behaviours	• Effectiveness of the three lines defence • Risk-based decisions, in line with risk appetite framework • Strength and stature of risk management and internal control functions • Escalation in case key risk metrices are breached • Oversight appropriate to group's structural complexity (e.g. over entitles and business lines)

It is challenging to observe and measure risk culture because it comprises many qualitative elements. However, supervisors have specific tools to examine underlying and more salient factors which may contribute to risk culture. These tools include interviews with board members and business line representatives, sitting in on board meetings, fit and proper assessments, examining documentation like policies, minutes or reports and on-site inspections.

While there are many components of risk culture, this article focusses on three key dimensions: the tone from the top, incentive policies, and risk accountability and ownership.

The observations and sound practices identified here are based on extensive supervisory reviews over the past few years, including bank-specific deep-dives and horizontal analyses.

One of the main duties of banks' management bodies is to establish an appropriate "tone from the top", as this plays a crucial role in holding individuals accountable for prudent risk-taking. To set the right tone, the management body needs to collectively possess the relevant skills and expertise, be of good repute, consider diverse viewpoints in discussions and be able to constructively challenge senior management.

Evidence shows that banks need to improve the capacity to challenge board members on the decisions they make in areas related to risk culture. A limited challenging capacity may also hinder follow-up on findings flagged by control functions and supervisors. Moreover, several banks' management bodies do not explicitly oversee culture or effectively cascade culture and ethical standards to all levels throughout the bank. However, some banks have developed good practices to strengthen the effectiveness of oversight. One such example is firms that have established a rigorous framework for monitoring internal culture and conduct, including full transparency through a dashboard. This allows monitoring of how risk culture is embedded within the bank through indicators to gauge how the code of conduct is implemented across the organisation.

Remuneration schemes are another key dimension of risk culture. These are often based on key performance indicators (KPIs) that determine variable remuneration and should ensure behaviours are properly aligned with prudent risk-taking. However, KPIs are not always clear and transparent. In many instances they rely excessively on financial performance as compared with risk, control and key cultural and behavioural aspects. Surprisingly, this also holds true for employees in internal control functions and even for chief risk officers. Supervisors have also observed weaknesses in KPIs' alignment with risk appetite, in processes and controls around variable remuneration and in the application of malus and clawback clauses in case of excessive risk taking or misconduct. There is generally room for improvement in this area, which calls for supervisory attention.

A third dimension of sound governance and risk culture is risk accountability and ownership. Some banks do not clearly allocate roles and responsibilities for risk and control-related tasks. Others have risk management and compliance functions, which do not sufficiently challenge business lines or are at times overruled by them. These functions may also have insufficient resources, stature, and practical impact which therefore calls into question their standing within the organisation.

A well-developed risk appetite framework, supported by effective processes deployed across the bank is the cornerstone of a sound risk culture, because it ensures that the risks taken are within a set of acceptable boundaries.

That is why ECB Banking Supervision will continue to assess banks' progress in improving risk culture through peer benchmarking, sharing good practices and ongoing industry dialogue, with appropriate supervisory escalation where key weaknesses are identified. Additionally, as part of the supervisory priorities for 2023-25, a targeted analysis will assess the tone from the top as well as the quality of banks' nomination processes and will feed into the Supervisory Review and Evaluation Process (SREP).

Evaluation of the study by the Czech Association of Payment Institutions

Asociace poskytovatelů platebních služeb České Republiky, z.s.

23.08.2023
№: 23-08-01

To,
Mr. Olegs Cernisevs
Doctoral Student,
Baltic International Academy
Riga, Latvia

Subject: Appreciation and Recommendation of Your Research Presentation on KPI-based Financial Management System

Dear Mr. Cernisevs,

On behalf of the Czech Payment Companies' Association, I wish to extend our heartfelt gratitude for your insightful presentation on the 5th of June 2023. Your detailed research results concerning the KPI-based financial management system and its relation to Key Risk Indicators (KRI) were both illuminating and timely. The methodology for the KRI evaluation that you showcased was particularly captivating and resonated well with our association's ethos of staying at the forefront of innovative financial practices.

The dialogue that ensued post your presentation, involving the intricate mechanics of selecting KPIs based on KRIs, offered our members a fresh perspective. It sparked a much-needed discussion on enhancing our current systems and methodologies, making us reconsider the structural alignment of our practices.

Considering the relevance and potential impact of your research, the Czech Payment Companies' Association is pleased to inform you that we will be wholeheartedly recommending your proposed approach for practical use to our member companies. We believe that by adopting your methodology, our member companies can pave the way for more transparent, efficient, and risk-aware financial management within the Czech Republic's payment landscape.

Your dedication to this research and the manner in which you presented complex concepts with clarity is commendable. We are confident that your approach, if adopted widely, will bring substantial benefits to our industry.

We look forward to possible future collaborations and wish you continued success in your academic and professional endeavors.

Thank you once again for sharing your expertise and vision with us.

Warm regards,

Sergej Jurlov / President

Revoluční 762/13, Staré Město, 110 00 Praha 1
+420 775555502
Info@aspps.cz

LATVIJAS BANKA
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Riga; **FOR THE DATE, SEE THE TIMESTAMP OF THE DOCUMENT SIGNATURE**
Our ref.: 22-08.1.1/2023/14141

To whom it may concern

It is to certify that Mr Olegs Cernisevs submitted his doctoral thesis "NEW APPROACH FOR FINTECH FINANCIAL MANAGEMENT IN THE EUROPEAN ECONOMIC AREA" to the Latvijas Banka with the purpose of obtaining an expert opinion regarding his thesis.

The submitted thesis offers a high-quality and versatile analysis of the current challenges in the fintech sector within the European economic area. The narrative of the thesis is logical and allows to follow the development path of the "Fintech" sector from economic and technological aspects.

A special focus shall be dedicated to the 2nd chapter of the thesis where the author analyses the nature of a "digital financial product" and the market of the "digital financial products". The raised question of an appropriate selection of the KPIs for the evaluation of a fintech project is highly relevant in today's reality and deserves special attention.

The practical analysis of the key risk indicators in the 3rd chapter of the thesis and the subsequent conclusions (i.e., "the sharing economy creates additional compliance and regulatory risks for fintech company") may serve as a knowledge basis for policy making and oversight institutions like Latvijas Banka in order to increase the efficiency of a risk-based approach to supervision.

The implementation of financial management practices for fintech companies based on key risk indicators represents an innovative and sophisticated approach to financial management in today's "digital economy". The aforementioned approach has a practical application, and we are keen to see further adoption of such techniques by local fintech companies as this will support an integrity and sustainable development of the local fintech sector.

Yours sincerely,

THIS DOCUMENT HAS BEEN DIGITALLY SIGNED WITH A SECURE DIGITAL SIGNATURE CONTAINING A TIMESTAMP

Evija Dundure
Head of Insurance and Pension Supervision Department

PAPAYA

Olegs Cernisevs
Via delle fornaci 139,
Roma (RM), 00165
Italia

November 15, 2023

Dear Mr. Cernisevs,

On behalf of Papaya Ltd, a renowned Maltese Electronic Money Institution, I am writing to extend our deepest gratitude and commendation for your invaluable contribution to developing our company's risk framework. Your expertise and innovative approach have significantly enhanced our risk management strategies and processes. We are delighted to inform you that the risk framework you developed has been thoroughly reviewed and unanimously approved by our Board of Directors. It is a testament to the robustness, relevance, and efficiency of the framework you crafted. Following this approval, we have seamlessly integrated the framework into all operational processes of Papaya Ltd, ensuring a comprehensive and effective risk management system throughout our organization.

Moreover, your pioneering approach to selecting Key Performance Indicators (KPIs) based on the specific risks facing Papaya Ltd has revolutionized our financial governance. This methodology has enabled us to monitor our performance more accurately and significantly enhanced our ability to anticipate and mitigate potential risks proactively. Your work has laid a solid foundation for our continuous growth and stability in the dynamic electronic money sector. Your collaboration with us under the company's risk framework elements has been instrumental in achieving these milestones. The insights and expertise you brought to this project have been invaluable, and the impact of your contributions will be felt for many years to come.

We look forward to possibly collaborating with you again in the future and wish you all the best in your doctoral studies and subsequent endeavors. Please do not hesitate to contact us should you need any further information or wish to discuss potential opportunities for collaboration. Once again, thank you for your outstanding contribution to Papaya Ltd. Your dedication and hard work have been crucial to our ongoing success and development.

Warm regards,

Igor Tsybolyuk
CEO
Papaya Ltd

Annex 5

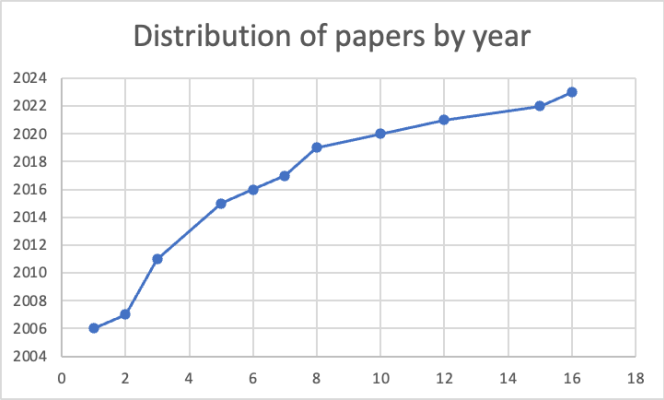

Figure A5.1 **Publications by years**
Source: generated by the author

Table A5.1

Analysis of articles on the topic

Title	Positive factors to inclusion	Negative factors to inclusion	Review
Gaviyau, W., & Sibindi, A. B. (2023). Customer Due Diligence in the FinTech Era: A Bibliometric Analysis. Risks, 11(1), 11.	The article defines the financial crime as the risk	This article type is a bibliographical review and therefore, the financial crime risk is not properly assessed.	Based on the anti-money laundering, crime, and financial crime subject, the authors show the heat map of the keyphrases or keywords commonly used. These keywords show the relevance and growth over the period from 2012 to 2021. This information reveals the impact and how the subject area is evolving. This study examined the current developments in customer due diligence during the FinTech era including the approach to its measurement. Based on the findings, the integration of CDD with FinTech is still an emerging area that requires interdisciplinary collaborations. Due to digital innovations, the financial sector remains vulnerable, which can result in financial instability and failure to protect consumers.
de Lima Lemos, R. A., Silva, T. C., & Tabak, B. M. (2022). Propension to customer churn in a financial institution: A machine learning approach. Neural Computing and Applications, 34(14), 11751-11768.	The article discusses the customer churn from the financial institution, which define some aspects of the strategic risk	This article type is a bibliographical review and therefore, the strategic risk does not properly assess.	According to the World Retail Banking Report 2019, 66.8% of current banking customers have already used or intend to use a bank account from a neo-Bank in the next three years. This paper investigates the behavior of a representative dataset of 500,000 clients of a Brazilian financial institution, aiming to generate a churn predictive model of account holders through machine learning, capable of identifying the variables with a more significant predictive potential of a client's propensity to churn. In addition, the authors leverage the availability of a large number of attributes in the dataset not only to obtain accurate predictions of customer churn but also to understand which attributes have the highest predictive power when determining the likelihood of a potential churn. This analysis can provide insightful information on customer behavior that may be used to develop policies to mitigate customer churn.

Table A5.1 continued

Kaur, A., & Verma, R. (2022). Financial Literacy and Financial Inclusion: A Systematic Literature Review. ECS Transactions, 107(1), 9893.	The article defines the metrics of financial literacy and financial inclusion as the part of the governance risk.	The assessment is not comprehensive and discuss only two metrics.	The significance of financial literacy has skyrocketed over the past two decades, as financial services have become the fastest-growing sector and the engine of economic growth. To achieve inclusive economic growth, the government and institutions have begun focusing on financial literacy and financial inclusion, resulting in an abundance of research on the topic. This paper aims to examine all facets of financial literacy and its development alongside financial inclusion. The study was conducted using a keyword search and a comprehensive cluster analysis of seventy research papers. The primary conclusion of this analysis is that financial literacy efforts and studies must be conducted alongside an evaluation of the impact of financial inclusion. To conduct a complete analysis, it is necessary to examine both of these metrics together. The study can serve as a resource for researchers and policymakers conducting additional research and evaluating current efforts.
Li, Y. (2022). Security and Risk Analysis of Financial Industry Based on the Internet of Things. Wireless Communications and Mobile Computing, 2022.	The article defines the metrics of ICT, which describes the major risks of cybersecurity	The article limits their topic only to the internet of things.	Yizhi Li reported on security and risk analysis of financial industry based on the Internet of things. The same generation of high-end technology, the target in the bank's security system, and wilful, against the wind crime, customer information stolen, and the loss of funds, reduce the credibility of the bank. Based on the Internet of things environment, and conduct research and analysis on asset management, monitoring, and measuring risks. Attackers access IoT devices through the Internet, which can make the IoT vulnerable to malicious attacks from external sites. The current IoT positioning and algorithm models have a long time extension period, and the accuracy needs to be enhanced. Main purpose of this article is to study the interpretation of the analysis of financial safety and risk under the Internet. There were 39 parameter indicators included in the study.
Kruger, C., Schutte, W. D., & Verster, T. (2021). Using model performance to assess the representativeness of data for model development and calibration in financial institutions. Risks, 9(11), 204.	The article is comprehensive research of the capital adequacy metrics.	The metrics, mentioned within the article does not addressed as risk.	The aim of this paper is to develop a methodology to measure representativeness when using external data in regulatory models. Our aim is to assess the data representativeness of both model development and model calibration
Al-Busaidi, K. A., & Al-Muharrami, S. (2021). Beyond profitability: ICT investments and financial institutions performance measures in developing economies. Journal of Enterprise Information Management, 34(3), 900-921.	The article defines the metrics of ICT, which describes the major risks of cybersecurity	The metrics, mentioned within the article does not addressed as risk.	The results of the longitudinal study provided substantial evidence of the effect of ICT investment on financial performance indicators; the value of ICT is substantially positive. In addition, the results indicated that there is an acceptable consensus among business and ICT managers that ICT is linked to non-financial performance indicators; ICT value is linked to customer indicators, internal process indicators, learning and growth indicators, and sector indicators.
Gandica, Y., Béreau, S., & Gnabo, J. Y. (2020). A multilevel analysis of financial institutions' systemic exposure from local and system-wide information. *Scientif ic reports*, *10*(1), 17657.	The authors try to define metrics for the particular company and this approach is cause of inclusion this article into the research result.	The metrics, mentioned within the article does not addressed as risk.	The authors reports the results for the regular metrics. The rows in report the names along with the signs of the coefficient of the variables that appear significant in one of the four columns. Higher vulnerability corresponds to smaller cumulative returns and larger maximum drawdown.

Table A5.1 continued

Khan, S., Sivaraman, E., & Honnavalli, P. B. (2020). Performance evaluation of advanced machine learning algorithms for network intrusion detection system. In *Proceedings of International Conference on IoT Inclusive Life (ICIIL 2019), NITTTR* Chandigarh, India (pp. 51-59). Springer Singapore.	The article defines the metrics of ICT, which describes the major risks of cybersecurity	The metrics, mentioned within the article does not addressed as risk.	In the past decade, the Internet has experienced tremendous growth, while malicious attacks on government, corporate, and financial institutions have increased. Intrusion Detection Systems (IDSs) have been developed and adopted by many institutions to monitor intrusion and other malicious activity in response to these attacks. Low detection accuracy, False Negatives (FN), and False Positives (FP) continue to be challenges for these IDSs. (FP). To address these issues, Machine Learning (ML) techniques are employed, which increase the accuracy of intrusion detection and significantly reduce the false negative and false positive rates. On the UNSW-NB15 dataset, we evaluated five algorithms, namely Decision Tree (D-tree), Random Forest (RF), Gradient Boosting (GB), AdaBoost (AB), and Gaussian Nave Bayes (GNB). Based on the following metrics: detection accuracy, F1 score, and false positive rate, we discovered that Random Forest is the best classifier.
Wassie, S. B., Kusakari, H., & Sumimoto, M. (2019). Performance of microfinance institutions in Ethiopia: Integrating financial and social metrics. *Social Sciences*, *8*(4), 117.2019	The article is comprehensive research of the capital adequacy metrics.	The metrics, mentioned within the article does not addressed as risk.	More explicitly, given the increasing focus of MFIs on commercialization, is there a "mission drift" or re-orientation from their original mission of serving the poor in pursuit of commercial viability. Prior studies have analysed the factors affecting the social and financial performance of MFIs and social performance of MFIs. In the context of this paper, the success of a firm is measured by its effort to attain its organizational goal-in this case, using social and financial metrics.
Henry, J. & Janamp, L. (2017). Network analysis and systemic FX settlement risk. *Statistics & Risk Modeling*	This article defines metrics, in relation to the correspondence bank assessment and liquidity management.	The metrics, mentioned within the article does not addressed as risk.	Consideration is given to a proposal to apply network analysis to a foreign exchange (FX) settlement system. Specifically, network centrality metrics are employed to evaluate the payments of financial institutions that clear through CLS Bank. (CLS). Network centrality metrics provide a method for analysing settlement member connectivity, determining the evolution of their payments over time, and measuring network topology variability. Although the continuous link settlement (CLS) network structure can be approximated with a power law degree distribution on many trade days, this is not always true. A network community detection algorithm is applied to the FX settlement network to investigate community relationships and identify classification patterns in FX trading net payments. SinkRank is used to construct a classification of the most systemic settlement risk-critical financial institutions trading on the FX system and to determine how the metric is affected by network connectivity. Since network metrics do not completely explain the settlement process's dynamics, the CLS settlement system is simulated to measure the contagion of unsettled trades and their spread among network members. Also investigated is the effect of settlement failure and contagion on settlement members.
Fall, M., & Viviani, J. L. (2016). A new multi-factor risk model to evaluate funding liquidity risk of banks. *The European Journal of Finance*, *22*(11), 985-1003.	This article defines metrics, in relation to liquidity management.	The metrics, mentioned within the article does not address as risk.	This paper examines the funding liquidity risk of banks. We present a new statistical multi-factor risk model that generates three new funding liquidity risk metrics based on the probability distribution analysis of the liquidity gap. This allows us to distinguish some stylised facts regarding the evolution of liquidity risk and its relationship to bank size. Our primary objective is to develop the Basel III-proposed monitoring instrument for "the contractual maturity mismatch."

Table A5.1 continued

León, C., Machado, C., & Murcia, A. (2016). Assessing systemic importance with a fuzzy logic inference system. *Intelligent Systems in Accounting, Finance and Management*, *23*(1-2), 121-153.	Three metrics were selected for the financial institutions.	The metrics, mentioned within the article does not address as risk.	Three metrics are designed to evaluate the size, connectedness, and non-substitutability of Colombian financial institutions as the primary determinants of systemic importance: (i) centrality as net borrower in the money market network; (ii) centrality as payments originator in the large-value payment system network; and (iii) asset value of core financial services. An aggregated systemic importance index is calculated using a fuzzy logic inference system and expert knowledge. For comparison purposes, we calculate a benchmark index using principal component analysis. The similarities between the two indexes suggest that the aggregation of expert knowledge is consistent with that based on a strictly quantitative standard approach. Specific non-negligible distinctions are consistent with the nonlinear characteristics of an approach designed to simulate human reasoning. Both indices are complementary and provide a comprehensive relative assessment of each financial institution's systemic significance in the case of Colombia, where the choice of metrics is based on the macroprudential perspective of financial stability.
Chacko, G., Das, S., & Fan, R. (2016). An index-based measure of liquidity. Journal of Banking & Finance, 68, 162-178.	This article defines metrics, in relation to liquidity management.	The metrics, mentioned within the article does not address as risk.	The liquidity shocks of 2008-2009 revealed that the majority of financial institutions' measures of liquidity risk were grossly inadequate. Errors like extraneous risk factors and hedging error are introduced during the construction of long-short portfolios using liquidity proxies. Using exchange-traded funds (ETFs), we devise a new measure for liquidity risk that attempts to minimise this error. We develop a theoretically supported measure that is long ETFs and short the underlying components of that ETF, i.e., long and short the same set of underlying securities with the same weights. Liquidity differences between the ETF and its fundamental components cause pricing disparities between long and short positions. In order to validate our new liquidity metric, the authors construct theoretically supported liquidity risk factors for a number of markets and conduct a number of validation experiments. The authors illiquidity measure is strongly related to other illiquidity measures, explains bond index returns, and reveals a systematic illiquidity component across fixed-income markets, as shown by the results.
Fayman, A., & He, L. T. (2011). Prepayment risk and bank performance. The Journal of Risk Finance, 12(1), 26-40.	This article defines metrics for financial institution in relation to risks.		According to the findings of this study, prepayment risk may have a substantial effect on the return on loans, return on equity, and real estate loans to total loans ratios of various commercial banks. Prior to and subsequent to the passage of the Financial Institutions Reform and Recovery Act, the magnitude and direction of the effects differ. The findings indicate that the addition of a prepayment risk variable to regression models can enhance their ability to explain bank performance metrics.
Shahbaz Khan, S. & Azeem, M. (2007). Performance indicators and evaluation framework. *The International Journal of Interdisciplinary Social Sciences: Annual Review*	This article defines metrics for financial institution in relation to some risks.	The metrics, mentioned within the article does not have comprehensive relations to risk systems.	This study investigates comprehensive institutional performance metrics. Using a qualitative paradigm and a literature review methodology, the study investigated the utility of performance indicators in decision-making. Each of the four categories of metrics and performance indicators—inputs, outputs, outcomes, and process—should be included in an analysis of performance. Inputs indicators are easily quantifiable, process indicators include the means to deliver the program, outputs indicators concentrate on the quantity of outcomes, and outcomes indicators emphasise the quality of the programme's benefits. On performance indicators, a proposed conceptual framework and a set of guiding principles are highlighted. The following conclusions are reached: first, the performance measures must reflect the institution's Vision and Mission; second, measurement and evaluation are necessary for effective planning and enable us to determine how we are performing in relation to our goals; and third, performance indicators are of limited use for institution-specific policy development.
May, T. (2006). Criteria for performance excellence. *Materials Performance*	This article defines metrics for the governance of the financial institutions	The metrics, mentioned within the article does not address as risk.	Several characteristics of an effective organisational leader are discussed. In his book Leaders, Warren Bennis identifies four characteristics of outstanding leadership. The four characteristics are vision, which involves imagining a plausible future and devising strategies to achieve it, communication, trust, and dedication. Leadership is an equilibrium of character, values, integrity, respect for others, bravery, and the ability to share success. Excellence in leadership encompasses both organisational leadership and social responsibility.

Source: generated by the author

Annex 6

List of EU Directives

The European Union employs multiple directives to regulate transactions involving crypto assets:

- Directive 2009/110/EC of the European Parliament and of the Council of 16 September 2009 on the ratification, implementation, and prudential oversight of electronic money institutions, amending Directives 2005/60/EC and 2006/48/EC, and repealing Directive 2000/46 /EU.
- 24 September 2020 publication of Legislative Proposals for Crypto Assets: Capturing Opportunities and Mitigating Risks.
- Proposed REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on digital operational sustainability for the financial sector and amending Regulations (EC) no. 1060/2009, (EC) no. 648/2012, (EU) no. 600/2014 and (EU) no. 909/2014COM/2020/595
- Directive (EU) 2018/843 of the European Parliament and of the Council of 30 May 2018 amending Directive (EU) 2015/849 on the prevention of the use of the financial system for the purposes of money laundering or terrorist financing, as well as Directives 2009/138/EU and 2013/36/EU.

Annex 7

Table A7.1

Comparison of regulation in Germany and Estonia

	Germany	**Estonia**
Entrepreneurial character	• The brokerage firm • Bank	• Limited Liability Company
Minimum Capital	150 000 EUR	150 000 EUR
AML law application	Yes	Yes
MIFID II	Yes	No
Management suitability	Yes	Yes
Internal audit requirements	Yes	Yes
B Possibility of service passporting	Yes	Yes
ICT Protection	ISO 27001 certification	Self-assessed measures
Payment services based on cryptocurrency	Yes	Yes
Risk management system	Yes	Yes
Establish a business online	No	Yes
Electronic signatures on documents	Yes	Yes
Manage the business online from any location in the globe.	No	Yes
Online corporate tax filing	No	Yes

Source: created by the author

IDR report on Italy, authorised on February 26, 2020

This report identifies the following as the most significant issues and challenges facing the Italian economy (European Commission, 2020a):

"Key to lowering Italy's public debt ratio and reversing macroeconomic imbalances are the weak macro-outlook and the difficulty of sustainability, productivity development, and potential growth. The implementation of ambitious structural reforms and prudent fiscal policies, along with targeted investments, will support Italy's digital transformation and ecological transformation, thereby driving sustainable economic growth. Renewed reform must assure sound public finances, more efficient public administration and justice, a more efficient education system and labour market, a more hospitable business climate, and more resilient banking institutions.

Despite a gradual recovery on the labour market, Italy's economic activity remains weak. After a 0.8% increase in real GDP in 2018, GDP grew by 0.2% in 2019 and is projected to increase by 0.3% and 0.6% in 2020 and 2021. As real disposable income remains below pre-crisis levels and savings, domestic demand remains feeble. rose. However, the 2019 introduction of a new minimum income scheme and significant interest rate reductions are anticipated to boost household expenditure. Despite evidence of recovery in 2019, public investment remains below levels seen prior to the crisis. Slow productivity growth continues to impede the economic recovery of Italy. There are still a number of downside hazards, particularly in the context of international trade and domestic stability. Despite the fact that the employment rate remains well below the EU average, particularly among women and young people, it has continued to rise in 2019, supported by permanent employment contracts, particularly in the North. The unemployment rate decreased from 10.3% in the third quarter of 2018 to 9.8% in the third quarter of 2019. However, there is still a significant disparity in employment levels across the nation's regions."

Table A8.1

Italy's in-depth results contrasted to EU projections

Europe 2020	National goals	Results	Effect to fintech
75% of the 20-to-64 population should be employed.	The target employment rate is set at 67-69%.	The employment rate increased to 63.6% in the third quarter of 2019, which is still well below the national target and the EU average of 73.6%.	Overall, the decrease in the employment rate can introduce both challenges and opportunities for the fintech industry. Fintech companies need to closely monitor economic trends and adapt their strategies to navigate through these changes successfully. This may involve adjusting product offerings, managing credit risk, exploring new market segments, and staying abreast of evolving regulatory and economic conditions.
3 percent of the EU's GDP should be invested in R&D.	The Country should invest 1.53 percent of its GDP in research and development.	In recent years, Italy has made limited progress and is not on course to reach its goal. In 2018, research and development expenditures represented 1.39 percent of GDP.	Increased investment in research can stimulate innovation, enhance competitiveness, and foster sustainable growth in the fintech industry, contributing to overall economic development and financial inclusion.
The 20/20/20 climate/energy targets must be attained, including an increase of up to 30 percent in emission reductions if conditions are favourable.	The national goal for GHG emissions: -13% below 2005 levels by 2020. (in sectors not included in the EU Emissions Trading Scheme)	Italy is on track to achieve its 2020 target for greenhouse gas emissions. According to 2019 projections, Italy will reduce its emissions by 20% by 2020, exceeding the target by seven percentage points. Compared to the intermediate goal of 12%, emissions were reduced by 18% in 2018, according to preliminary data. (i.e., with a margin of 6 percentage points).	By aligning with sustainability initiatives and developing innovative green solutions, fintech companies can contribute to the broader efforts to address climate change while also tapping into emerging markets and meeting evolving consumer demands.
Less than 10% of students should drop out prior to graduation.	Less than 16% of students should drop out prior to graduation.	In 2018, the school attrition rate was 14.5%, which was below Italy's 2020 European goal but above the EU average of 10.6%.	Overall, while the school attrition rate may not have a direct impact on the day-to-day operations of fintech companies, it can influence the availability of skilled talent, innovation, financial inclusion efforts, and consumer behavior.
At least forty percent of the newer generation must possess a college degree.	Twenty-six to twenty-seven percent of the 30- to 34-year-old population should be college-educated, according to the goal.	In 2018, the proportion of 30 to 34-year-olds with tertiary education was 26.9%, which was in accordance with the national goal but second highest in the EU (EU average: 39%).	Overall, the fact that the country has a lower proportion of 30 to 34-year-olds with tertiary education compared to the EU average can have implications for the availability of talent, innovation, financial literacy, policy decisions, and global competitiveness in the fintech sector.
No more than 20 million people should be at risk of poverty.	Absolute reduction target for the number of individuals at risk of destitution or social exclusion: -2.2 million (2010 baseline: 15.1 million).	With more than 1,300,000 more individuals at risk of poverty or social exclusion (AROPE) than in 2008, Italy failed to meet this objective. AROPE decreased from 28.9% in 2017 to 27.3% in 2018. Nonetheless, it remains significantly higher than the pre-crisis level (25.5% in 2008) and the EU average (21.9%).	Overall, the high AROPE percentage in Italy compared to the pre-crisis level and the EU average indicates the presence of significant economic challenges in the country. Fintech companies operating in Italy need to be mindful of these socio-economic factors and develop strategies that address the financial needs of vulnerable populations while contributing to broader social and economic development goals.

Source: created by the author

IDR report on France, authorised on February 26, 2020

This report identifies the following as the most significant issues and challenges facing the Italian economy (European Commission, 2020a):

"France has continued its reform efforts, but additional action is required to enhance its economic performance of France. Persistent structural issues include high public debt and high unemployment. In addition, France's productivity is declining, necessitating continued investment in skills, rapid progress on the recent reform of vocational education and training, and measures to better the business environment. Concurrently, spending restraint will be necessary to place the debt on a sustainable downward trajectory. It is anticipated that the pension system will be reformed by the end of 2020.

In the foreseeable future, economic growth is anticipated to remain close to its potential despite slowing in 2019. The growth of the gross domestic product (GDP) has decreased since its zenith in 2017 and reached 1.2% in 2019. In 2020 and 2021, it is anticipated to remain close to its prospective growth rates of 1.1% and 1.2%, respectively. In France, domestic demand will be resilient in 2020 and 2021, following a brief decline at the end of 2019. The increase in purchasing power recorded since the end of 2018 as a consequence of lower unemployment and inflation, higher wages, and stimulative fiscal measures will benefit consumer spending. As a result of favourable financing conditions, it is anticipated that investment growth will decelerate from current high levels but remain generally robust. Consistent with domestic demand, import growth will accelerate. In contrast, the deteriorating international environment is anticipated to exert pressure on exporters compared to 2017 and 2018.

The labour market is strengthening, but unemployment remains elevated, particularly among vulnerable groups. Despite the economic downturn since the beginning of 2018, the unemployment rate continued to fall and reached 8.4% in the fourth quarter of 2019. Additionally, the circumstance of the youth has improved. However, low-skilled individuals and immigrants struggle to integrate into the labour market. Ongoing reforms are improving their employment prospects. In certain industries, there is a skills gap and mismatch issue." The text is cited from the France. Report prepared in accordance with Article 126(3) of the Treaty on the Functioning of the European Union (European Commission, 2020a)

Table A8.2

France in-depth results contrasted to EU projections

Europe 2020	National goals	Results	Effect to fintech
75% of the 20-to-64 population should be employed.	75% of the population aged 20 to 64 should be employed.	In 2018, the employment rate for employees aged 20 to 64 increased from 70.6% to 71.3%. It stabilised in the third quarter of 2019, with the metropolitan France employment rate reaching 71.7%. Despite sustained private sector job creation, however, the 75% target remains elusive at this time.	Overall, the employment rate is a crucial economic indicator that can influence various aspects of the fintech industry in France. As the employment rate evolves, fintech companies need to remain attentive to its impact on customer behavior, market conditions, hiring strategies, and regulatory developments to effectively navigate the changing landscape.
3 percent of the EU's GDP should be invested in R&D.	Investing 1.53 % of the country's GDP in research and development is necessary.	The intensity of investment in research and development in 2018 increased by 2.20% compared to 2.02% in 2007 and by 2.19% in 2017, which is less than in 2016, when it was 2.24 (EU average 2.11%). The intensity of public investment in research and development has remained stable over the past two years at 0.73% in 2018 and 0.73% in 2017, but with a decrease from 0.78% recorded in 2016 (EU average 0, 69%). The intensity of business investment in research and development has increased since 2007, where it was 1.28%, and has remained fairly stable since 2012, from 2016 (1.43%), 2017 (1.42%) and 1. 44% in 2018 (EU average 1.41%).)	fintech companies operating in a country with higher R&D investment may have access to advanced technologies and research partnerships, giving them a competitive edge in the global market. On the other hand, fintech firms in countries with lower R&D investment might face challenges in keeping pace with technological advancements and gaining a strong foothold in the industry.
The 20/20/20 climate/energy objectives must be met, including an increase in emission reductions of up to 30 percent if conditions are favourable.	National GHG emissions target: -14% in 2020 compared to 2005 (in sectors not included in the EU Emissions Trading Scheme)	Between 2005 and 2020, non-ETS emissions will decrease by 13% based on the most recent national projections and existing measures. Thus, it is anticipated that the -14% target will be missed by a single percentage point.	The fact that emissions reduction targets are expected to be narrowly missed can have significant implications for the fintech industry. It may influence the regulatory environment, investor preferences, risk assessment, financing decisions, innovation opportunities, and a country's international reputation.
Less than 10% of students should drop out prior to graduation.	The rate of early education dropouts should be less than 9.5%.	France's early education dropout rate remained stable at 8.9% in 2018 compared to 8.9% in 2017, remaining below the 2020 European target. Even though the early school dropout rate is lower than the EU average, substantial regional disparities persist. Too many young people continue to drop out of school with only a high school diploma, particularly in remote regions where job prospects have not improved significantly relative to metropolitan France.	the stable but concerning early education dropout rate in France, particularly with regional disparities, can have implications for the fintech industry in terms of workforce skills, regional access to services, social and economic inclusion, opportunities in educational technology, impact on entrepreneurship, government initiatives, CSR efforts, and consumer behavior. By recognizing these factors, fintech companies can proactively address challenges and leverage opportunities to contribute positively to educational and economic development in the regions they operate.

Table A8.2 continued

At least forty percent of the newer generation must possess a college degree.	50 percent of the 17-to-33-year-old population must attain a postsecondary education.	In 2018, the tertiary completion rate for the 30-34 age group in France was 46.2%, up from 44.4% in 2017. This exceeds the EU goal of 40 percent for tertiary education. Academically, women (51.2%) consistently outperform males (41.0%).	The higher tertiary completion rate and the academic performance of women in France can positively influence the fintech industry by providing access to a skilled workforce, fostering innovation and research, promoting gender diversity, encouraging entrepreneurship, expanding the customer base, fostering collaboration with academic institutions, and facilitating regulatory compliance. Fintech companies can leverage these advantages to stay competitive, drive innovation, and meet the evolving needs of customers in the dynamic digital financial services landscape.
No more than 20 million people should be at risk of poverty.	Reduce the number of individuals at risk of destitution or social exclusion - 1.9 million in cumulative terms since 2007.	Cumulatively, the number of individuals at risk of poverty or social exclusion has decreased by 106,000 since 2008, a reversal of previous gains.	the reduction in the number of individuals at risk of poverty or social exclusion can influence the fintech industry in various ways, such as by expanding market potential, influencing consumer behavior, shaping risk assessment strategies, promoting social impact investments, fostering collaboration opportunities, and impacting regulatory considerations. Fintech companies should be aware of these changes in the socio-economic landscape and adapt their strategies to effectively address the evolving needs and demands of a changing customer base.

Source: created by the author

Section A

The research data is available as appendix to the article Cernisevs, O., Popova, Y., Cernisevs, D. (2023a). Risk-Based Approach for Selecting Company Key Performance Indicators in an Example of Financial Services. In Informatics (Vol. 10, No. 2, 54). MDPI. https://doi.org/10.3390/informatics10020054

Section B

The research data is available as appendix to the article Cernisevs, O., Popova, Y., Cernisevs, D. (2023b). Business KPIs Based on Compliance Risk Estimation. Journal of Tourism and Services, 14(27), 222-248. https://doi.org/10.29036/jots.v14i27.636

Annex 10

Table A10.1

The use weights of components

Numeric Value	Letter abbreviation	Title
1	**VL**	**Very low/irrelevant**
2	**L**	**Low**
3	**M**	**Medium**
4	**H**	**High**
5	**VH**	**Very High**

Source: Generated by the author (Olegs Cernisevs, Yelena Popova and Dmitrijs Cernisevs, 2023)

Table A10.2

Inherent risk value interpretation

Letter abbreviation	Title	Numeric Value
VL	Very low/irrelevant	from 0 to 5
L	Low	from 5.01 – 10
M	Medium	10.01 to 15
H	High	15.01 to 20
VH	Very High	20.01 to 25

Source: Generated by the author (Olegs Cernisevs, Yelena Popova

Annex 11

Table A11.1

Rome smart city KPIs

KPI NAME	KPI DESCRIPTION	CRYPTO-BASED PRODUCTS
Places used for coworking	The number of coworking spaces. Coworking is sometimes referred to as the "new form of work" and is an example of the collaborative and sharing economy. (Durante and Turvani, 2018)	The coworking spaces management has two aspects, which crypto assets products may manage: Considering that space or objects (meeting rooms, working places) are usually limited, it may be controlled by issuing and circulating access tokens (utility tokens) or based on them. The services of the coworking spaces may be paid for by the crypto-assets-based products (like cryptocurrency)
Multiple online services or streamlined procedures for starting a business or engaging in commercial activities	The number of businesses registered online.	Services related to starting a business or engaging in commercial activity from the perspective of the processes, may be divided into three parts: Conducting the service itself. Smart Users may use crypto-assets-based products for the payments of the service. Identification of the applicant. Smart Users may use crypto-assets-based products to verify the identity of the applicant. Submitting to the applicant publicly verified extracts. Applicants may submit such kind of document via the blockchain.
Number of requests submitted online	Business models digitalization	Conducting the service itself. Smart Users may use crypto-assets-based products for the payments of the service. Identification of the applicant. Smart Users may use crypto-assets-based products to verify the identity of the applicant. Submitting to the applicant publicly verified extracts. An applicant may submit such kind of document via the blockchain.
Presence of the Economic Development Plan for at least 3 years	Smart City KPI is not directly connected to the crypto-assets-based products and services	
Number of Knowledge Sharing events (conferences, meetings, etc.)	The number of conferences and events organised in the city.	The tickets for such events may be sold as a crypto-assets-based product. Payments for these events may be made by cryptocurrency (Tupa and Steiner, 2019)If they have limited access, the proceeding of the conferences may be available per presenting the crypto-assets-based ticket.
Presence of the city brand on the platforms of e-commerce	The Rome city brand within the payment platforms, payment products or development of its payment platform for Smart city Users	Development of own payment planform, based on the blockchain technology The cryptocurrency issue with the city brand joins B2B and B2C payment across the smart city.
Number of participants who support the city's brand	The presence of the city brand in the image or marketing campaign of the products or services represented by the business forms the city's economy.	
Smart city products/service sales volumes	Number of transactions and sales volumes generated by the businesses presented within the smart city	Own blockchain-based payment platform B2C and B2B will increase intra smart city payments volumes Tax payments (like F24 (national tax payment system)) via the same smart city payment platform will increase intra smart city payments volumes City utilities and services concentrated within the same platform will increase intra smart city payments volumes
Presence of the server clusters for the economic development (at the level of the city and districts)	Server clusters for the digital economy are manufacturing, management and distribution infrastructure. Their existence, availability and location determine the sustainability and success of the smart city.	Server clusters are, in some way, coworking manufacturing infrastructure. Taking into account that contemporary servers may be segregated into areas, with the allowance to access for separate groups of users – One server cluster may be used by different smart Users or producers of the smart city: Server cluster managing companies may use crypto-assets-based keys to control these accesses Server cluster managing companies may accept crypto-assets payments (including within the smart city's own payment platform) for the services offered by the Server cluster entities.

Table A11.1 continued

Number of initiatives for the development of SMEs (Small and Medium Enterprises)	Achieve a high number of SME initiatives is not the goal by itself. The main target is to achieve an increased number of effective and working initiatives, which will help develop small and medium enterprises.	Smart city may widely use crypto assets and blockchain for such initiatives like: Network for the crowdfunding Easy way of the inter-payments Supporting SMEs with the standard payment acceptance solution (B2C and B2B) based on the blockchain

Source: Generated by the author (Cernisevs & Popova, 2023)