

INTERNATIONAL MONETARY FUND

MONEY AND CAPITAL MARKETS AND
INFORMATION TECHNOLOGY DEPARTMENTS

Powering the Digital Economy

Opportunities and Risks of Artificial Intelligence in Finance

Prepared by El Bachir Boukherouaa and Ghiath Shabsigh
in collaboration with
Khaled AlAjmi, Jose Deodoro, Aquiles Farias, Ebru S. Iskender,
Alin T. Mirestean, and Rangachary Ravikumar

DP/2021/024

2021
OCTOBER



DEPARTMENTAL PAPER

INTERNATIONAL MONETARY FUND

MONEY AND CAPITAL MARKETS AND INFORMATION TECHNOLOGY DEPARTMENTS

DEPARTMENTAL PAPERS

Powering the Digital Economy

Opportunities and Risks of Artificial Intelligence in Finance

Prepared by El Bachir Boukherouaa and Ghiath Shabsigh

in collaboration with

Khaled AlAjmi, Jose Deodoro, Aquiles Farias, Ebru S. Iskender, Alin T. Mirestean, and
Rangachary Ravikumar

Copyright© 2021 International Monetary Fund

Powering the Digital Economy: Opportunities and Risks of Artificial Intelligence in Finance
DP/2021/024

Authors: El Bachir Boukherouaa and Ghiath Shabsigh
in collaboration with

Khaled AlAjmi, Jose Deodoro, Aquiles Farias, Ebru S. Iskender, Alin T. Mirestean, and Rangachary Ravikumar¹

Cataloging-in-Publication Data
IMF Library

Names: Boukherouaa, El Bachir. | Shabsigh, Ghiath. | AlAjmi, Khaled. | Deodoro, Jose. | Farias, Aquiles. | Iskender, Ebru S. | Mirestean, Alin. | Ravikumar, Rangachary. | International Monetary Fund, publisher.

Title: Powering the digital economy : opportunities and risks of artificial intelligence in finance / prepared by El Bachir Boukherouaa and Ghiath Shabsigh in collaboration with Khaled AlAjmi, Jose Deodoro, Aquiles Farias, Ebru S. Iskender, Alin T. Mirestean, and Rangachary Ravikumar.

Description: Washington, DC : International Monetary Fund, 2021. | 2021 September. | Departmental paper series. | Includes bibliographical references.

Identifiers: ISBN 9781589063952 (paper)

Subjects: LCSH: Artificial intelligence—Economic aspects. | Machine learning —Economic aspects. | Financial services industry—Technological innovations.

Classification: LCC HC79.I55 B68 2021

ISBN	978-1-59806-395-2 (Paper)
JEL Classification Numbers:	C40, C510, C550, E17, G21, G23, G280, O310, O330
Keywords:	Artificial Intelligence, Machine Learning, Financial Stability, Embedded Bias, Financial Regulation, Cybersecurity, Risk Management, Data Privacy
Author's E-Mail Address:	GShabsigh@imf.org; EBoukherouaa@imf.org; KAlAjmi@imf.org; JDeodoro@imf.org; AFarias@imf.org; ESonbullskender@imf.org; AMirestean@imf.org; RRavikumar@imf.org

The Departmental Paper Series presents research by IMF staff on issues of broad regional or cross-country interest. The views expressed in this paper are those of the author(s) and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

Publication orders may be placed online or through the mail:

International Monetary Fund, Publication Services

P.O. Box 92780, Washington, DC 20090, USA

T. +(1) 202.623.7430

publications@imf.org

IMFbookstore.org

elibrary.IMF.org

¹ We are grateful to Aditya Narain and other IMF colleagues for valuable comments, and to Javier Chang for production support.

Executive Summary

This paper discusses the impact of the rapid adoption of artificial intelligence (AI) and machine learning (ML) in the financial sector. It highlights the benefits these technologies bring in terms of financial deepening and efficiency, while raising concerns about its potential in widening the digital divide between advanced and developing economies. The paper advances the discussion on the impact of this technology by distilling and categorizing the unique risks that it could pose to the integrity and stability of the financial system, policy challenges, and potential regulatory approaches. The evolving nature of this technology and its application in finance means that the full extent of its strengths and weaknesses is yet to be fully understood. Given the risk of unexpected pitfalls, countries will need to strengthen prudential oversight.

AI and ML are technologies with the potential for enormous societal and economic impact, bringing new opportunities and benefits. Recent technological advances in computing and data storage power, big data, and the digital economy are facilitating rapid AI/ML deployment in a wide range of sectors, including finance. The COVID-19 crisis has accelerated the adoption of these systems due to the increased use of digital channels.

AI/ML systems are changing the financial sector landscape. Competitive pressures are fueling rapid adoption of AI/ML in the financial sector by facilitating gains in efficiency and cost savings, reshaping client interfaces, enhancing forecasting accuracy, and improving risk management and compliance. AI/ML systems also offer the potential to strengthen prudential oversight and to equip central banks with new tools to pursue their monetary and macroprudential mandates.

These advances, however, are creating new concerns arising from risks inherent in the technology and its application in the financial sector. Concerns include a number of issues, such as embedded bias in AI/ML systems, the opaqueness of their outcomes, and their robustness (particularly with respect to cyber threats and privacy). Furthermore, the technology is bringing new sources and transmission channels of systemic risks, including greater homogeneity in risk assessments and credit decisions and rising interconnectedness that could quickly amplify shocks.

AI/ML in finance should be broadly welcome, together with preparations to capture their benefits and mitigate potential risks to the financial system's integrity and safety. Preparations include strengthening the capacity and monitoring frameworks of oversight authorities, engaging stakeholders to identify possible risks and remedial regulatory actions, updating relevant legal and regulatory, and expanding consumer education. It is important that these actions are taken in the context of national AI strategies and involve all relevant public and private bodies.

Cooperation and knowledge sharing at the regional and international level is becoming increasingly important. This would allow for the coordination of actions to support the safe deployment of AI/ML systems and the sharing of experiences and knowledge. Cooperation will be particularly important to ensure that less-developed economies share the benefits.

Contents

Executive Summary	<u>1</u>
Acronyms and Abbreviations	<u>4</u>
1. Introduction	<u>5</u>
2. Artificial intelligence in the Financial Sector	<u>7</u>
A. Forecasting	<u>7</u>
B. Investment and Banking Services	<u>7</u>
C. Risk and Compliance Management	<u>9</u>
D. Prudential Supervision	<u>9</u>
E. Central Banking	<u>12</u>
3. Risks and Policy Considerations	<u>14</u>
A. Embedded Bias	<u>14</u>
B. Unboxing the “Black Box”: Explainability and Complexity	<u>15</u>
C. Cybersecurity	<u>16</u>
D. Data Privacy	<u>17</u>
E. Robustness	<u>17</u>
F. Impact on Financial Stability	<u>18</u>
4. Conclusion	<u>20</u>
Annexes	
Annex 1. How Machine Learning Algorithms Work	<u>21</u>
Annex 2. Artificial Intelligence in Finance—Risk Profile	<u>24</u>
Annex 3. National Artificial Intelligence Strategies	<u>25</u>
References	<u>28</u>
BOXES	
Box 1. Artificial Intelligence and Machine Learning Capabilities	<u>6</u>
Box 2. Artificial Intelligence in Investment Management—Sample Use Cases	<u>8</u>
Box 3. Artificial Intelligence in Credit Underwriting	<u>8</u>
Box 4. Artificial Intelligence in Regulatory Compliance—Sample Use Cases	<u>10</u>
Box 5. Artificial Intelligence in Supervision—Sample Applications	<u>11</u>
Box 6. Artificial Intelligence in Central Banking—Sample Applications	<u>13</u>
Box 7. Explaining the “Black Box”	<u>16</u>
FIGURES	
Figure 1. Top Five Technologies Employed in Regulatory Technology Offerings	<u>9</u>
Figure 2. Technologies Used in Supervisory Technology Tools	<u>10</u>
Annex Figure 1.1. Machine Learning Paradigms	<u>22</u>

Annex Figure 1.2. Example of an Input Attack.....	23
Annex Figure 3.1. National Artificial Intelligence Strategy Landscape.....	25
Annex Figure 3.2. Key Features of National Artificial Intelligence Strategies	26

Acronyms and Abbreviations

AI	Artificial Intelligence
AML/CFT	Anti-Money Laundering/Combating the Financing of Terrorism
Fintech	Financial Technology
ML	Machine Learning
NLO	Natural Language Processing
OECD	Organisation for Economic Co-operation and Development
Regtech	Regulatory Technology
Suptech	Supervisory Technology