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THE AI PARADOX IN CENTRAL BANKING: NEW POWERS, NEW VULNERABILITIES

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Abstract

The integration of artificial intelligence into central banking disrupts the traditional bank-regulator relationship, creating asymmetries that private institutions exploit. This paper examines how AI-driven market surveillance and predictive risk modelling erode private banks' informational advantages, compelling them into a Schumpeterian race for survival in which innovation becomes imperative. Using a qualitative analysis of regulatory developments and financial market adaptations, this study argues that enhanced central bank AI capabilities paradoxically accelerate the emergence of opaque financial segments designed to evade oversight. The findings indicate that this shift transforms regulatory dynamics, positioning central banks as real-time market participants while private institutions develop increasingly sophisticated methods of regulatory evasion. This evolution generates systemic risks that existing regulatory frameworks struggle to address, necessitating adaptive oversight mechanisms. The study concludes that the imperative progressively drives financial innovation to maintain opacity in response to algorithmic supervision, underscoring the need for regulatory models that balance AI's benefits with emerging vulnerabilities.

Keywords: *regulatory evasion, ai-resistant markets, algorithmic supervision, financial innovation and opacity, information asymmetry*

I. INTRODUCTION

The interplay between social and institutional evolution alongside technological advancement presents one of the most fascinating paradoxes of the 21st century. Jacques Monod's observation that "a curious aspect of the theory of evolution is that everybody thinks he understands it" mirrors a similar phenomenon in humanity's relationship with technology. [1] Just as it is said that man assumes mastery over evolutionary concepts while often misunderstanding their nuances, there is a penchant for easily embracing technological innovations with a confidence that sometimes borders on

[1] Jacques Monod, "Chance and Necessity," *Nobel Prize Lecture*, (1965), https://www.nobelprize.org/uploads/2018/06/monod-lecture.pdf?utm.

hubris. Neil Postman's warning becomes particularly relevant here, as he said, "technology always has unforeseen consequences, and it is not always clear, at the beginning, who or what will win, and who or what will lose."[2] This is similar to what Tom Standage notes, that "Many of our technology-related problems arise because of the unforeseen consequences when apparently benign technologies are employed on a massive scale".[3]

This discourse sets the stage for this research on the convergence of artificial intelligence (AI) and central banking activities, representing one of the most significant transformations in monetary policy since the advent of electronic trading. Central banks, as custodians of financial stability and economic welfare, are increasingly engaging with AI systems to process vast amounts of economic data, forecast market trends, and even help shape monetary policy decisions. However, like evolutionary systems, which often produce unexpected outcomes through complex interactions, this integration carries both profound potential and considerable risks that we may not fully comprehend.

AI systems processing economic data operate within similarly complex networks of financial markets, human behaviour, and global economic conditions. The confidence with which some central banks are deploying these technologies mirrors the very same overconfidence Monod observed in people's perceived understanding of evolution. This pattern has become increasingly concerning given the fundamental role central banks play in global economic stability.

This paper advances the thesis that AI's integration into central banking operations represents not merely a technological upgrade but a fundamental transformation of financial governance and market dynamics. While AI offers unprecedented capabilities for market surveillance, risk assessment, and policy implementation, it simultaneously creates new vulnerabilities and potentially destabilising dynamics in the financial system. This dynamic creates a paradox where increased regulatory capability might inadvertently spark nefarious financial innovation in areas specifically designed to evade algorithmic supervision, leading to new forms of financial instability and systemic vulnerabilities that are fundamentally different from historical patterns. Through this analysis, the paper aims to contribute to both theoretical understanding and practical policymaking in the rapidly evolving landscape of central banking.

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[2] Neil Postman, *"Informing Ourselves to Death,"* 1990, https://web.williams.edu/HistSci/curriculum/101/informing.html.

[3] Tom Standage, *A Brief History of Motion: From the Wheel to the Car, to What Comes Next*, 8. 25-30 (London: Bloomsbury Publishing, 2021).

While AI integration in central banking appears inevitable and potentially beneficial, its implementation requires careful consideration of systemic implications and unintended consequences. This paper examines how the same technology that can enhance algorithmic oversight this same technology may also provide cover to unethical behaviour, creating new forms of systemic risk. By analysing the parallels between evolutionary complexity and technological innovation in monetary policy, this article develops a standard for thoughtful AI adoption that deploys enhanced supervisory capabilities in the face of emerging challenges in regulatory dynamics and financial stability.

II. THEORETICAL FOUNDATION

II.A. Schumpeterian Innovation Dynamics

This paper grounds its arguments in various theories, primarily Schumpeterian Innovation Dynamics as a foundational theoretical framework for understanding technological transformation in financial markets. The concept of creative destruction, first articulated by Joseph Schumpeter, provides a powerful framework for understanding AI's transformative impact on financial markets and central banking.[4] Schumpeter's vision of economic progress as evolutionary, where new technologies and business models systematically displace established structures, manifests in financial markets through waves of innovation that simultaneously create opportunities while rendering existing practices and institutions obsolete.

Viewed through this theoretical lens, financial innovation represents more than mere technological advancement; it embodies a fundamental force that reshapes market structures and redefines the relationship between financial institutions and their stakeholders. The emergence of AI in this domain exemplifies Schumpeter's "perennial gale of creative destruction". AI-driven systems revolutionise everything from risk assessment to market-making, forcing traditional financial institutions to adapt or face obsolescence, while simultaneously disrupting processes and fundamentally altering the nature of financial intermediation and established market paradigms.[5]

The innovation-regulation dialectic in financial markets adds another layer of complexity to this Schumpeterian dynamic. As AI systems introduce novel approaches to financial operations, they create a tension between innovation's creative forces and regulators' mandate to maintain system stability. This relationship is not simply antagonistic. Rather, it represents a sophisticated

[4] Joseph A. Schumpeter, *Capitalism, Socialism and Democracy* (New York: Harper & Brothers, 1942): 82–85

[5] Ajay Agrawal et al., "Economic Policy for Artificial Intelligence," *Innovation Policy and the Economy* 19 (2019): 139-159.

interplay where regulatory frameworks must evolve alongside technological capabilities. The challenge lies in fostering innovation while preventing the destructive aspects of creative disruption from undermining financial system stability, a balance that Schumpeter himself might have recognised as crucial for sustainable economic progress.

AI's disruptive role in finance goes beyond efficiency, marking a leap in technology through advanced analytics and autonomous decision-making, aligning with Schumpeter's view that true innovation reorganises economic systems. AI is reshaping fundamental operations, from price discovery and risk management to liquidity provision, forcing participants to adapt to new competitive dynamics. By challenging traditional assumptions about market efficiency and financial intermediation, this technological transformation extends beyond operational changes to restructure markets themselves, replacing established paradigms with more efficient systems.

II.B. Competition and Innovation.

Through Schumpeter's lens, innovation in modern financial markets has evolved from a driver of growth to an essential survival mechanism. Financial institutions now face an existential imperative to innovate, not merely to maintain competitive advantage but to ensure their continued relevance in an increasingly digitised financial ecosystem.[6] Darwinian pressures have transformed financial competition from a focus on service quality and pricing to one centred on technological capabilities and algorithmic sophistication.[7] Yet this evolution reveals a fascinating paradox. While technological advancement theoretically lowers barriers to entry, the capital-intensive nature of sophisticated financial technology creates new forms of market concentration. The emergence of dominant technological platforms in finance mirrors evolutionary biology's concept of adaptive radiation, where rapid diversification occurs in response to new environmental opportunities.[8] Unlike biological evolution's gradual pace, however, this technological evolution proceeds at an unprecedented pace, creating winner-take-most dynamics that fundamentally alter competitive landscapes and ultimately undermine the natural selection mechanism of competitive markets.[9]

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[6] Francesca Arnaboldi and Bruno Rossignoli, "Financial Innovation in Banking," in *Bank Risk, Governance and Regulation*, ed. Elena Beccalli and Federica Poli (Palgrave Macmillan, 2015), 127– 162.

[7] Gianpaolo Abatecola et al., "Darwinism, Organizational Evolution and Survival: Key Challenges for Future Research," *Journal of Management and Governance* 20, no. 1 (2016): 1–17, https://doi.org/10.1007/s10997-015-9310-8.

[8] Marco Dell'Erba, *Technology in Financial Markets: Complex Change and Disruption* (Oxford: Oxford University Press, 2024): 115

[9] Henry Birdseye Weil, "Competitive Dynamics — Winning in Technology Markets," *MIT Sloan School of Management Working Paper* 6957-23, 2023.

The rush to develop trading and service sophistication to capture new markets has accelerated the accumulation of risk in specific sectors, creating systemic vulnerabilities that dramatically manifested in the 2007-2009 financial crisis.[10] Innovation as a survival mechanism in financial markets has proven to be a double-edged sword. As institutions compete through financial engineering, novel services, and technological advancement, they naturally gravitate toward similar profitable market segments, creating dangerous concentrations of risk.[11] This herding behaviour, driven by the imperative to survive in an increasingly competitive landscape, leads to the formation of asset bubbles and systemic risks. Consequently, rather than producing more robust institutions, this consolidation creates entities so large and interconnected that their failures threaten the entire financial system.

The structural evolution resulting from this process presents a fundamental contradiction. While competition theoretically should eliminate weaker institutions, the emergence of "too big to fail" financial institutions has created a class of institutions effectively immune to market discipline.[12] Central bank intervention during the financial crisis, providing selective bailouts to systemically important institutions, represented a profound departure from free market principles. This intervention, while necessary for system stability, effectively suspended the Darwinian mechanisms that supposedly drive market efficiency and innovation. By bailing out these reckless entities, central banks effectively created a two-tier market structure, one for systemically important institutions that are too big to fail, and another for smaller institutions subject to genuine market discipline.[13] Technological disruption patterns in this context reveal another layer of complexity. The same technological capabilities that drive institutional growth and market concentration also create new vulnerabilities.[14] The interconnectedness enabled by advanced trading systems and algorithmic decision-making means that disruptions can propagate through the financial

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[10] Mohamad El Hajj and Jamil Hammoud, "Unveiling the Influence of Artificial Intelligence and Machine Learning on Financial Markets: A Comprehensive Analysis of AI Applications in Trading, Risk Management, and Financial Operations," *Journal of Risk and Financial Management* 16, no. 1 (2023): 434, https://doi.org/10.3390/jrfm16100434.

[11] Arnaboldi and Rossignoli, "Financial Innovation in Banking," 129.

[12] George G. Kaufman, "Too Big to Fail in Banking: What Remains?" *The Quarterly Review of Economics and Finance* 42, no. 3 (2002): 423 – 436.

[13] Luca Leanza et al., "Bail-in vs Bail-out: Bank Resolution and Liability Structure" (working paper, Finance Department, University of Milan, 2019), accessed January 17, 2025, https://finance.unibocconi.eu/sites/default/files/files/media/attachments/LeanzaSbuelzTarelli_BailInVSBailOut20190603083157.pdf.

[14] Financial Stability Board, "The Financial Stability Implications of Artificial Intelligence," November 14, 2024, https://www.fsb.org/2024/11/fsb-assesses-the-financial-stability-implications-of-artificial-intelligence/.

system at unprecedented speed.[15] Yet the very institutions that should be most vulnerable to these disruptions, the largest and most interconnected banks, are paradoxically protected by their systemic importance. The transformation of central banks' role in this environment represents a tacit acknowledgement of the limits of pure market competition in financial services.

This creates a feedback loop, allowing these top-tier protected institutions to take greater innovation and market expansion risks, further solidifying their dominance. The evolution of financial markets under these conditions suggests that traditional concepts of competition no longer fully capture modern dynamics. Innovation remains vital, but the pressures have shifted from pure products and services to an interplay among technological capabilities, regulatory frameworks, and systemic importance.

II.C. Information Asymmetry Evolution

While technological competition reshapes market dynamics, a parallel transformation occurs in information asymmetry, traditionally a cornerstone of banking power. The evolution of information asymmetry in financial markets heralds a fundamental transformation in central bank-private bank relationships.[16] The traditional banking model, built upon information advantages derived from privileged access to client data and transaction histories, is giving way to a system where algorithmic capabilities determine competitive advantage. This shift represents more than technological advancement; it suggests a fundamental restructuring of financial intermediation, challenging banks' historical dominance in assessing creditworthiness and managing client relationships.[17] Private banks leveraged this asymmetry to maintain their dominant position in financial intermediation, effectively controlling both the flow and interpretation of financial information.[18] This information asymmetry not only enabled banks to extract significant economic rents but also created

[15] Alessio Azzutti et al., "Machine Learning, Market Manipulation, and Collusion on Capital Markets: Why the 'Black Box' Matters," *University of Pennsylvania Journal of International Law* 43, no. 1 (2022): 1–84.

[16] Vikas Kumar Jaiswal, "Information Asymmetry in Financial Markets: Causes, Consequences, and Mitigation Strategies," *International Journal of Current Research*, 2023, accessed January 17, 2025, https://journalcra.com/article/information-asymmetry-financial-markets-causes-consequences-and-mitigation-strategies.

[17] Stephen G. Cecchetti, "The Future of Financial Intermediation and Regulation: An Overview," Current Issues in Economics and Finance, Federal Reserve Bank of New York, 1999; Robert C. Merton, "A Functional Perspective of Financial Intermediation," *Journal of Economic Perspectives* 7, no. 2 (1993): 89–110, https://doi.org/10.1257/jep.7.2.89.

[18] Adeniyi A. Alao, "Issues in Information Asymmetries and Financial Markets: A Review of Literature," *Journal of Financial Management 4*, no. 2 (2018): 45–60, accessed January 17, 2025, https://iiardjournals.org/get/JAFM/VOL.%204%20NO.%202%202018/ISSUES%20IN%20INFORMATION.pdf.

natural barriers to entry, leading to concentrated banking structures and ultimately the "too big to fail" phenomenon.[19]

Regulatory information gaps have emerged as a natural consequence of this system, with supervisory bodies often struggling to maintain comprehensive oversight of increasingly complex financial operations. The inadequacy of this information structure became starkly evident during the 2007-2009 financial crisis, when traditional periodic reporting and examinations failed to capture increasingly complex risk exposures.[20] Rather than being eliminated by market forces, information asymmetries have created profound distortions in pricing and resource allocation, particularly in opaque markets for complex financial instruments, distortions paradoxically reinforced by the very regulatory structures designed to prevent them. The regulatory architecture that has emerged around traditional banking was itself predicated on these information asymmetries, with supervisory frameworks designed to monitor institutions that possessed substantially more information than their clients or regulators. However, these traditional dynamics face unprecedented challenges as technological advancement democratises access to financial data and analytics. The information gaps that regulators historically struggled to bridge, particularly in understanding complex financial instruments and interconnected risk exposures, are being transformed by algorithmic surveillance capabilities and real-time monitoring systems.

As information advantages shift from relationship-based knowledge to algorithmic processing capability, the very basis of competition in banking undergoes a profound transformation, necessitating a reconceptualization of market efficiency that accounts for the new dynamics of information processing and distribution in an algorithmically driven financial system. This evolution of information asymmetry in financial markets heralds a fundamental transformation in central bank-private bank relationships, where the traditional banking model built upon relationship-driven information advantages pivots to a system where algorithmic capabilities determine competitive advantage. Such a shift represents more than mere technological advancement; it suggests a potential restructuring of the entire financial intermediation landscape.

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[19] Thorsten Beck et al., "Bank Concentration and Fragility: Impact and Mechanics," *National Bureau of Economic Research Working Paper* No. 11500 (2005), accessed January 17, 2025, https://www.nber.org/system/files/working_papers/w11500/w11500.pdf.

[20] Joel Spina, "Information Asymmetry and the Recent Financial Crisis," *SSRN*, October 20, 2019, accessed January 17, 2025, https://ssrn.com/abstract=3474479.

III. HISTORICAL EVOLUTION OF CENTRAL BANKING

The evolution of central banking institutions fundamentally reflects the dialectical relationship among state power, economic development, and the material conditions of society. The emergence of modern central banks, beginning with Sveriges Riksbank in 1668 and the Bank of England in 1694, coincided with the revolutionary establishment of capitalist modes of production and the consequent transformation of state functions.[21] This evolution was not merely institutional; it represented the state's growing imperative to exert control over increasingly complex financial and economic sectors as productive forces advanced and market relations expanded.

This unparalleled transformation of production necessitated new forms of monetary control and financial intermediation, especially in the formation of new state structures and their relationships. As industrial capitalism expanded, destroying feudal economic structures and creating new classes with distinct economic interests, central banks evolved from simple government banks into sophisticated instruments of State economic management, with the eventual monetary policy frameworks emerging directly from the material conditions of expanding capitalist production. The gold standard era (1870-1914) represented not merely a monetary arrangement but a specific phase of economic and financial development, where central banks' primary function was maintaining the stability of international trade and capital flows necessary for industrial expansion.[22]

While this era marked an early attempt at systematic monetary control through fixed exchange rates and gold convertibility, its subsequent breakdown during the interwar period laid bare inherent tensions between national economic sovereignty and international capital mobility.[23] This crisis forced central banks to adapt, leading to the emergence of traditional monetary policy frameworks focused on managing national currencies and maintaining price stability. Though initially straightforward, these frameworks evolved into increasingly complex systems as financial markets developed and economic understanding advanced.[24]

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[21] El Hajj and Hammoud, "Unveiling the Influence," 10; Forrest Capie et al., "The Origins of Central Banking: Lessons from History", in *The Future of Central Banking: The Tercentenary Symposium of the Bank of England,* Forrest Capie, Stanley Fischer, Charles Goodhart, and Norbert Schnadt (Cambridge University Press, 1994): 5.

[22] Michael D. Bordo and Hugh Rockoff, "The Gold Standard as a 'Good Housekeeping Seal of Approval,'" *Journal of Economic History* 56 (1996): 389.

[23] Maurice Obstfeld et al., "Monetary Sovereignty, Exchange Rates, and Capital Controls: The Trilemma in the Interwar Period," *IMF Staff Papers* 51, Special Issue (2004), accessed January 17, 2025, https://www.elibrary.imf.org/downloadpdf/view/journals/024/2004/005/article-A004-en.pdf.

[24] Arnaboldi and Rossignoli, "Financial Innovation in Banking" 6; Bank for International Settlements, "Monetary Policy Frameworks and Central Bank Market Operations," October 7, 2019, accessed January 17, 2025, https://www.bis.org/publ/mc_compendium.htm.

The concentration of central banking tools and functions intensified in response to recurring crises of capital accumulation. The Great Depression marked another pivotal moment, exposing the inadequacy of existing monetary frameworks to address the social and economic fallout of such a collapse, thereby catalysing the expansion of central bank functions beyond mere monetary management to encompass broader economic stabilisation objectives.[25] This expanded role was institutionalised through the Bretton Woods system (1944-1971), reflecting the state's growing involvement in economic management and the need to regulate international capital flows.[26] In the post-Bretton Woods era, this dialectical relationship further intensified as financial liberalisation and technological advancement enabled private institutions to penetrate new markets and create new financial instruments, compelling central banks to develop increasingly sophisticated tools for monetary control and financial supervision.[27] The 2008 global financial crisis exposed the contradictions inherent in this arrangement, leading to further expansion of central bank powers and the development of macroprudential policy frameworks as the crisis demonstrated that price stability alone was insufficient for ensuring financial stability.[28]

Consequently, the relationship between central banks and private financial institutions evolved through a continuous process of action and reaction. As private banks developed new financial instruments and entered new markets to escape regulatory constraints, central banks expanded their supervisory functions and regulatory frameworks. This dialectical relationship drove financial innovation while simultaneously necessitating more sophisticated forms of state oversight. The Basel Accords emerged as an international response to this dynamic, attempting to establish common standards for banking regulation while preserving space for financial innovation.[29]

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[25] David C. Wheelock, "Monetary Policy in the Great Depression: What the Fed Did, and Why," *Federal Reserve Bank of St. Louis Review*, March/April 1992, accessed January 17, 2025, https://fraser.stlouisfed.org/files/docs/meltzer/whemon92.pdf.

[26] Paul Stevens, "Bretton Woods: 1944–1971," *Foundation for Economic Education*, May 1, 1973, accessed January 17, 2025 https://fee.org/articles/bretton-woods-1944-1971/.

[27] Arnaboldi and Rossignoli, "Financial Innovation in Banking," 6; Benjamin Braun et al., "Financial Globalization as Positive Integration: Monetary Technocrats and the Eurodollar Market in the 1970s," *Review of International Political Economy* 28, no. 4 (2021): 794-819.

[28] Ben S. Bernanke, "The 2008 Financial Crisis: Causes and Consequences," *Brookings Institution*, September 1, 2024, accessed January 17, 2025. https://www.brookings.edu/articles/bernanke-on-the-causes-of-the-financial-crisis-questioning-how-we-measure-potential-economic-output-and-more-new-research-in-economics/.

[29] Panagiotis Delimatsis, "Financial Innovation and Prudential Regulation – The New Basel III Rules," *Journal of World Trade 46*, no. 6 (2012): 1309-1343; UNCTAD. "Revising Basel II: The Impact of the Financial Crisis and Implications for Developing Countries." *G-24 Discussion Paper Series*, June 2010. accessed January 17, 2025, https://unctad.org/system/files/official-document/gdsmdpg2420102_en.pdf.

This historical evolution follows a consistent pattern. As financial markets develop new mechanisms for profit and regulatory evasion, central banks respond by adapting their supervisory capabilities. The contemporary transformation of central banking reflects a fundamental shift in the relationship between state economic management and financial innovation, driven primarily by AI technologies. Now, as AI promises central banks unprecedented monitoring capabilities, this historical dialectic suggests private institutions will once again evolve, not through traditional financial innovation, but by, as this paper argues, developing markets specifically designed to resist algorithmic oversight. Understanding this pattern of innovation and regulatory response provides crucial context for analysing how AI might reshape the contemporary relationship between central banks and private financial institutions.

The Basel III framework, conceived in the aftermath of the 2008 crisis, epitomises this dynamic. By recalibrating capital adequacy standards and introducing liquidity metrics, Basel III sought to mitigate risks born of opaque financial instruments and interconnected shadow banking systems. Yet, much as these reforms addressed the symptoms of pre-2008 financialisation, they inadvertently set the stage for a new phase of innovation, one now accelerated by AI's transformative capabilities.[30] AI's integration into central banking mirrors this historical pattern but amplifies its stakes. Where Basel III responded to static risks embedded in balance sheets and derivatives, AI introduces dynamic risks rooted in algorithmic interdependence and real-time market evolution. The liquidity coverage ratios (LCR) and net stable funding ratios (NSFR) of Basel III, designed to ensure institutional resilience against liquidity shocks, now confront a landscape where AI-driven high-frequency trading and decentralised finance (DeFi) platforms compress risk propagation to near-instantaneous speeds. This shift demands a paradigmatic reimagining of regulatory tools, from rules-based capital buffers to adaptive frameworks capable of parsing AI's nonlinear risk trajectories.

Crucially, Basel III's macroprudential focus, emphasising systemic stability over individual institution compliance, offers a conceptual blueprint for AI governance. However, the qualitative nature of AI-driven risks (e.g., adversarial data manipulation, algorithmic herding) necessitates moving beyond Basel's quantitative metrics. Just as Basel III emerged from the ashes of the mortgage-backed securities crisis, AI regulation must anticipate vulnerabilities inherent in synthetic financial ecosystems, where opacity is not a byproduct but rather a design feature of AI-resistant instruments. This evolution underscores the Schumpeterian dialectic at the paper's core. Regulatory frameworks, like

[30] Jon Danielsson and Andreas Uthemann, "Artificial intelligence and financial crises," *arXiv preprint* (2024), http://arxiv.org/pdf/2407.17048.pdf.

markets, evolve through cycles of creative destruction. Basel III's emphasis on transparency and capital resilience was a reactive adaptation to past innovations; AI compels proactive innovation in oversight mechanisms.

Central banks must now institutionalise the lessons of Basel III, not by replicating its structures, but by reengineering its philosophical underpinnings for an era where financial stability hinges on algorithmic agility as much as capital adequacy. In doing so, they confront a defining challenge: harmonising the deliberate pace of regulatory evolution with the breakneck speed of AI-driven financial transformation. Consequently, the traditional model of central banks as overseers and private banks as intermediaries may give way to new forms of financial organisation and control that can barely be envisioned today. Just as the invention of double-entry bookkeeping transformed medieval banking, or how electronic trading revolutionised market operations,[31] AI technologies could catalyse equally profound changes in banking relationships and structures

IV. AI INTEGRATION IN CENTRAL BANKING: CURRENT MODELS AND EMERGING FRONTIERS

Central banks undeniably lie at the heart of any economy and are usually responsible for setting monetary policy, maintaining financial stability, and managing inflation. Their activities require a sensitive mix of expertise, judgment, and discretion, continually responding to economic imperatives.[32] Consequently, to ensure their activities are more timely, accurate, and effective, revolutionary technologies, there is encouragement to infuse AI into their structural frameworks. The various forms of AI adoption by central banks, however, reflect a cautious and measured approach to technological integration. Traditional machine learning algorithms, including Random Forests and Multi-Layer Perceptrons,[33] form the core of most central banks' AI capabilities,

[31] Frederic S. Mishkin, "Modern Central Banking," in *The Oxford Handbook of Banking*, 3rd ed., ed. Allen N. Berger, Philip Molyneux, and John O. S. Wilson (Oxford: Oxford Handbooks, 2019), accessed January 17, 2025, https://doi.org/10.1093/oxfordhb/9780198824633.013.19.

[32] Willem H. Buiter, "Central Banks: Powerful, Political and Unaccountable?" (Keynes Lecture in Economics, British Academy, London, September 18, 2014), https://www.thebritishacademy.ac.uk/publishing/journal-british- academy/2/central-banks-powerful-political-and-unaccountable/, July 25, 2023. accessed January 29, 2025.

[33] Alvaro Huertas-García et al., "A Comparative Study of Machine Learning Algorithms for Anomaly Detection in Industrial Environments: Performance and Environmental Impact," *Trends in Sustainable Computing and Machine Intelligence*, 2024, pp. 373-389. accessed January 29, 2025, https://link.springer.com/chapter/10.1007/978-981-99- 9436-6_26.

particularly applied to analytical tasks and risk assessment systems.[34] These implementations are primarily developed through robust in-house teams, though some institutions supplement their capabilities through carefully selected external partnerships.

While there is growing interest in Large Language Models (LLMs),[35] their adoption remains limited due to stringent data privacy requirements and regulatory considerations, with most central banks preferring proprietary solutions for sensitive applications rather than commercial Application Programming Interface (API) integrations.[36] Similarly, while central banks in larger economies are exploring advanced deep learning techniques such as Convolutional Neural Networks (CNNs)[37] and Recurrent Neural Networks (RNNs),[38] their implementation remains in early stages. The specific applications and implementations of these technologies in central banking functions is discussed in subsequent sections.

IV.A. Early Impact Assessment

As previously stated, integrating AI into central banking operations represents a critical juncture in the dialectical relationship between financial innovation and regulatory oversight. Current implementations, as catalogued by Ozili, reveal a strategic shift toward leveraging AI for enhanced IT capabilities, financial stability monitoring, and operational automation, functions that collectively redefine the material conditions of monetary governance.[39] Central banks now deploy machine learning algorithms to parse unstructured data streams, from news sentiment to transactional metadata, achieving granular insights into

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[34] European Central Bank. "Artificial Intelligence: A Central Bank's View," *European Central Bank*, July 4, 2024, accessed January 29, 2025, https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240704_1~e348c05894.en.html.

[35] Danielsson and Uthemann, "Artificial Intelligence and Financial Crises," 30; Ramanakar Danda, "Large Language Models: The Next Revolutionary Frontier in AI," *Forbes*, January 23, 2025, https://www.forbes.com/councils/forbestechcouncil/2025/01/23/large-concept-models-the-next-revolutionary-frontier-in-ai/.

[36] Leonardo Gambacorta et al., "CB-LMs: Language Models for Central Banking," *BIS Working Papers*, no. 1215 (October 2024), https://www.bis.org/publ/work1215.pdf. See also: International Monetary Fund. "Central Bank Digital Currency: Progress and Further Considerations." *IMF Policy Papers*, November 8, 2024, accessed January 29, 2025, https://www.imf.org/en/publications/policy-papers/issues/2024/11/08/Central-Bank-Digital-Currency- Progress-And-Further-Considerations-557194.

[37] Bank of England, "Machine Learning at Central Banks," *Bank of England*, September 1, 2017, accessed January 29, 2025, https://www.bankofengland.co.uk/working-paper/2017/machine-learning-at-central-banks.

[38] Zachary C. Lipton et al., "A Critical Review of Recurrent Neural Networks for Sequence Learning," *arXiv preprint* arXiv:1506.00019 (2015), https://arxiv.org/abs/1506.00019.

[39] Peterson K. Ozili, "Artificial Intelligence in Central Banking: Benefits and Risks of AI for Central Banks," in *Industrial Applications of Big Data, AI, and Blockchain* (2024), https://ssrn.com/abstract=4703524.

market dynamics that were previously obscured by the limitations of human cognition and legacy systems.[40]

The Bank for International Settlements (BIS) observed that such tools are increasingly institutionalised across four domains: macroeconomic analysis; payment system oversight; prudential supervision; and statistical compilation, reflecting a systemic recalibration of central banking's operational ontology. For instance, AI-powered nowcasting tools have been developed for inflation monitoring. The European Central Bank (ECB) utilises AI-driven web-scraping tools to collate price data from digital platforms, enabling near-instantaneous inflation nowcasting that bypasses traditional lagging indicators.[41] This capability not only enhances predictive accuracy but redefines the temporal boundaries of monetary policymaking, compressing decision cycles from quarters to days.

Consequently, these enhanced monitoring capabilities are transforming how central banks approach financial supervision. Survey results from the BIS indicate that 71% of central banks are already utilising generative AI, with another 26% planning implementation within two years.[42] These systems enable unprecedented granularity in market surveillance, allowing central banks to identify potential stability risks before they manifest as systemic problems. The ability to process and analyse vast amounts of real-time market data represents a sea change in the epoch regulator's supervisory capability.

Perhaps the most significant discourse surrounding AI integration is the fundamental alteration of the information dynamics between central banks and private financial institutions. Traditional information asymmetries are being eroded by central bank's enhanced analytical capabilities. The development of AI-generated synthetic data, as highlighted in Ozili's research, enables central banks to model and understand market behaviours with unprecedented precision.[43] This shift in informational power dynamics represents a fundamental challenge to traditional banking relationships, as the authorities of the central banks can extend beyond mere surveillance capabilities. The ECB's exploration of LLMs for data classification and analysis suggests a future where central banks can process and understand market information with unprecedented speed and accuracy. This capability threatens to disrupt the traditional role of

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[40] Sebastian Doerr, Leonardo Gambacorta, and Jose Maria Serena, "Big Data and Machine Learning in Central Banks," *BIS Working Papers*, no. 930 (March 2021), https://www.bis.org/publ/work930.pdf.

[41] European Central Bank, "Nowcasting Consumer Price Inflation Using High-Frequency Scanner Data: Evidence from Germany," *ECB Working Paper* Series, no. 2930 (2024), https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2930~05cff276eb.en.pdf.

[42] Bank for International Settlements. "Artificial Intelligence and the Economy: Implications for Central Banks," *Annual Economic Report*, June 25, 2024, https://www.bis.org/publ/arpdf/ar2024e3.htm.

[43] Ozili, "Artificial Intelligence in Central Banking," 39.

private banks as primary interpreters of market information, potentially forcing them to develop new strategies for maintaining their competitive advantages.

Where private institutions once derived a competitive advantage from privileged access to client data and opaque market practices, AI-enabled "panoramic supervision" can grant central banks unprecedented access to real-time financial information. Again, recall has to be made to the ECB's experimentation with web-scraping price data for inflation nowcasting, to exemplify this transformation, collapsing the temporal lag between economic activity and regulatory awareness. [44] Yet this epistemic shift remains incomplete. As the BIS warns, the reliance on AI-generated synthetic data introduces new vulnerabilities, overfitting to artificial datasets risks distorting risk assessments, while adversarial actors may weaponize algorithmic opacity through "data camouflage" tactics, such as injecting noise into transaction reports or exploiting biases in training corpora.[45]

Institutions like JPMorgan and Goldman Sachs now invest heavily in proprietary AI systems to maintain relevance, developing trading algorithms and risk models that operate at the margins of regulatory comprehension.[46] Concurrently, the organisational fabric of central banking undergoes strain. Recruitment priorities shift to data scientists and algorithmic auditors, while senior policymakers grapple with the hermeneutic challenge of interpreting AI-generated policy advice, a tension the ECB frames as "human-AI symbiosis".[47]

Looking ahead, the Centre for Economic Policy Research's analysis suggests that AI integration will require fundamental changes in central bank organisational structure and decision-making processes.[48] This evolution suggests a future where central banks are increasingly hybrid organisations, blending traditional economic expertise with sophisticated technological capabilities. However, it is crucial to note that while 55% of central banks are developing AI integration strategies, only 19% currently have concrete

[44] Doerr, Gambacorta, and Maria Serena, "Big Data and Machine Learning in Central Banks," 40. See also: Bank for International Settlements, "Artificial Intelligence and the Economy," 42.

[45] Bank for International Settlements, "Artificial Intelligence and the Economy," 42.

[46] Doerr, Gambacorta, and Maria Serena 40. See also: Goldman Sachs, "A New Generation of AI Tools and Models Is Emerging," December 21, 2023, https://www.goldmansachs.com/insights/articles/a-new-generation-of-ai-tools-and-models-is-emerging.

[47] Bank for International Settlements, "Artificial Intelligence and the Economy," 42.

[48] Jon Danielsson, Robert Macrae, and Andreas Uthemann, "Artificial Intelligence as a Central Banker," *CEPR VoxEU Column*, July 18, 2023, https://cepr.org/voxeu/columns/artificial-intelligence-central-banker. See also: Piero Cipollone. "Artificial Intelligence: A Central Bank's View," speech presented at the National Conference of Statistics on Official Statistics at the Time of Artificial Intelligence, Rome, July 4, 2024, https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240704_1~e348c05894.en.html.

implementation plans.[49] This gap between aspiration and execution sadly reflects another primary challenge to the future of financial regulation for the maintenance of operational reliability and public trust.

IV.B. The Displacement Effect of Private Banks

Having established how central banks are adopting AI technologies, this paper argues that the tremendous functionality of these technologies would not simply augment the functions of central banks but completely evolve them into more active, real-time participants in financial markets. This transformation, while potentially strengthening regulatory oversight and preventive mechanisms, could push private markets into extreme corners of financial engineering, creating new challenges for systemic stability. Central banks, now as both arbiters and actors in financial markets, would be required to navigate a landscape where their tools of control inadvertently fuel the very innovations they seek to constrain. This recursive dynamic, reminiscent of the shadow banking proliferation post-2008,[50] demands governance frameworks that acknowledge AI not as a neutral tool but as a contested terrain, a site where technological capability, market power, and regulatory authority converge in uneasy equilibrium.

This displacement effect would manifest as private financial institutions seeking to preserve their market power in response to the enhanced central bank capabilities, i.e., an evolutionary response, consistent with the historical trend stated earlier. Economic theory has long emphasised that perfectly competitive markets, which do not exist, especially in the banking world, generate greater social welfare than those characterised by market power.[51] In banking, this principle has historically driven liberalisation efforts since the mid-1980s, with policymakers actively working to reduce market concentration and enhance competition, which led to multiple market crashes (culminating in the 2009 crisis), and currently, policymakers are advocating again for the liberalisation

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[49] Iñaki Aldasoro, et al," Generative Artificial Intelligence and Cyber Security in Central Banking," *BIS Papers* No. 145, Bank for International Settlements, May 2024, https://www.bis.org/publ/bppdf/bispap145.pdf. See also: Bank for International Settlements. "Governance of AI Adoption in Central Banks," *Consultative Group on Risk Management*, January 2025, https://www.bis.org/publ/othp90.pdf.

[50] Bank for International Settlements, "Artificial Intelligence and the Economy," 42.

[51] Joaquín Maudos and Juan Fernández de Guevara, "The cost of market power in banking: Social welfare loss vs. cost inefficiency," *Journal of Banking & Finance* 31, no. 7 (2007): 2103-2125; Timothy Besley, "Welfare Economics and Public Choice," *London School of Economics and Political Science*, April 2002, accessed January 30, 2025, https://www.lse.ac.uk/economics/Assets/Documents/personal-pages/tim-besley/miscelanea/welfare-economics- public-choice.pdf.

of the banking sector.[52] However, the integration of AI into central banking creates a new dynamic where private institutions, rather than competing within traditional parameters, are incentivised to develop market segments specifically designed to evade algorithmic oversight.

This work posits that the evolution of central banks' roles could represent a significant departure from conventional understanding of banking sector competition, as while traditional measures of competition like the Lerner index or Panzar and Rosse's test have focused on observable market behaviours,[53] the emergence of AI-resistant market segments introduces new forms of market power that these metrics may fail to capture. These AI-resistant segments represent not merely an evolution of existing markets but rather the creation of entirely new financial ecosystems designed to preserve information asymmetries and market power, with the most prevalent being Private Permissioned Blockchains (PPBs), which are networks operated by consortia of major financial institutions.[54] Unlike public blockchains, these networks could be designed specifically to maintain opacity while facilitating large-scale wealth transfers and concentration. These systems could enable the creation of sophisticated financial instruments that exist entirely within closed ecosystems, making them particularly challenging for central bank AI systems to monitor or analyse. The true innovation here lies not in the blockchain technology itself, but in the creation of closed financial ecosystems that operate with their own rules and transparency levels, intentionally creating "blind spots" in regulatory oversight.

Building on existing dark pool infrastructure, banks are also likely to develop next-generation dark trading networks that incorporate dynamic opacity features, which would adapt in real-time to evade pattern recognition by central bank AI systems, potentially using sophisticated order matching algorithms that deliberately introduce noise and irregularity into trading patterns.[55] The

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[52] Allen N. Berger et al., "Bank Concentration and Competition: An Evolution in the Making," *Journal of Money, Credit and Banking* 36, no. 3 (2004): 433–51; Bank of England. "Evolution of the UK Banking System," *Bank of England Quarterly Bulletin*, December 2010, https://www.bankofengland.co.uk/quarterly-bulletin/2010/q4/evolution-of-the-uk-banking-system.

[53] Jacob A. Bikker et al., "Assessing Competition with the Panzar-Rosse Model: The Role of Scale, Costs, and Equilibrium," *Tjalling C. Koopmans Research Institute Discussion Paper Series* 09-27, Utrecht School of Economics, Utrecht University, September 2009, https://www.uu.nl/sites/default/files/rebo_use_dp_2009_09-27.pdf. See also: Joaquín Maudos and Xavier Vives, "Competition Policy in Banking in the European Union," *IESE Business School*, January 2019, https://blog.iese.edu/xvives/files/2019/01/Maudos-Vives-January-2019-1.pdf.

[54] William Cong and Zhiguo He, "Blockchain Disruption and Smart Contracts," *The Review of Financial Studies* 32, no. 5 (2019): 1754-1797.

[55] Hans Degryse et al., "Two Shades of Opacity: Hidden Orders versus Dark Trading," *Journal of Financial Intermediation* 47 (2018), https://doi.org/10.1016/j.jfi.2021.100919.

key innovation would be the ability to maintain large-scale trading activities while generating data patterns that appear random or meaningless to external AI analysis. A particularly concerning development would be the evolution of synthetic prime brokerage arrangements that deliberately fragment risk exposure across multiple jurisdictions and entities.[56] These structures could use complex chains of derivatives and special-purpose vehicles to create financial exposure that appears benign when analysed individually by AI systems but represents significant systemic risk when viewed holistically. These structures could be engineered to exploit the limitations of AI in connecting seemingly disconnected financial relationships.

A fourth, and arguably more complex, development involves cross-border synthetic instruments that capitalise on discrepancies among jurisdictionally fragmented regulatory AI systems.[57] As already addressed, not all central banks can or will transition from the ideation to the implementation of AI standards to practical structures. Consequently, by design, these new instruments can masquerade as simple, low-risk transactions within individual regulatory frameworks while concealing interconnected risk exposures that materialise only when analysed holistically across borders. The complexity stems from their capacity to weaponize the inherent blind spots of AI surveillance tools constrained by current jurisdictional boundaries, which could create systemic risks that evade detection until they reach critical thresholds.

Facing Schumpeterian pressures, private banks must tackle a paradoxical imperative: to innovate against regulatory oversight while retaining systemic relevance. This manifests in herding behaviour toward "algorithmically dark" markets, where complexity and opacity concentrate risk. The 2007– 2009 crisis demonstrated how such homogenisation breeds systemic fragility, yet AI intensifies this dynamic by compressing innovation cycles. As central banks' AI tools grow more sophisticated, private institutions would, and daresay must, innovate faster to maintain profitability, a feedback loop that threatens to bifurcate financial systems into supervised and unsupervised tiers. Larger banks with resources to develop in-house AI systems will engineer financial products and trading strategies that outpace other public-sector models. This mirrors the dynamic observed during the rise of high-frequency trading, where private entities' technological sophistication outstripped regulatory comprehension.[58]

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[56] Gina-Gail S. Fletcher and Michelle M. Le, "The Future of AI Accountability in the Financial Markets," *Vanderbilt Journal of Entertainment & Technology Law* 24, no. 2 (Winter 2022): 289-346, https://scholarship.law.vanderbilt.edu/cgi/viewcontent.cgi?article=1571&context=jetlaw.

[57] Linde Scheers et al., "Synthetic Prime Brokerage: Innovation in Trading Services," *European Securities and Markets Authority*, January 31, 2025, https://www.esma.europa.eu/sites/default/files/library/ESMA50-164-6247-AI_in_securities_markets.pdf.

[58] Fletcher and Le, "Future of AI Accountability," 56.

The development of these AI-resistant market segments represents a fundamental challenge to the effectiveness of central bank supervision. Unlike traditional regulatory arbitrage, which exploits legal loopholes, these new market segments are specifically engineered to create technological blind spots in AI-based surveillance systems. The sophistication of these approaches lies not just in their technical complexity, but in their ability to harbour significant systemic risks, while appearing benign when analysed by current AI systems.

Private banks, already criticised for prioritising profit maximisation over societal benefit, as highlighted by Wang,[59] are poised to exploit these opaque market segments to bolster profitability, potentially inflating the cost of financial intermediation. Unlike conventional strategies that navigate established legal frameworks, this evolution of regulatory evasion would weaponize weaknesses in supervisory AI systems, using targeted financial engineering to manipulate technological limitations rather than merely circumventing legal constraints. This calculated adaptation risks establishing a new form of market power, not rooted in traditional monopolistic advantages but in the ability to function within domains designed to resist algorithmic scrutiny. As institutions migrate toward these increasingly obscure markets, they not only drive up intermediation costs but also generate systemic risks that evade detection, even within AI-enhanced regulatory frameworks, reinforcing the urgent need for more adaptive and resilient oversight mechanisms.

Moreover, this evolution challenges the traditional relationship between competition and financial stability. While economic theory suggests that increased competition in banking markets should lead to greater efficiency and social welfare, the displacement effect driven by AI adoption may instead result in a form of "competitive opacity" where banks compete not on price or service quality, but on their ability to develop increasingly complex and AI oversight-resistant financial instruments. This represents a fundamental shift from the historical pattern of banking sector evolution, where regulatory pressure typically has driven institutions toward greater transparency and standardisation.

The displacement effect thus represents not merely a technological challenge but a fundamental transformation in how market power is created and maintained in the banking sector. As private institutions develop increasingly sophisticated methods to evade AI-based supervision, they may establish new forms of market power that traditional regulatory frameworks

[59] Yimeng Wang et al., "Maximizing Profits in Commercial Banking: A Holistic Examination of Non-interest Income, Risk Management, and Digital Technologies," *Journal of Information Systems Engineering and Management* 9, no. 2 (2024): 26802, https://www.jisem-journal.com/download/maximizing-profits-in-commercial-banking-a-holistic-examination-of-non-interest-income-risk-14803.pdf.

and competition metrics are ill-equipped to address. This evolution threatens to undermine decades of progress toward more competitive and safe banking markets.

It is crucial to note that this paper does not argue that AI adoption by central banks will solely create new market structures or drive financial institutions toward obscure markets. Indeed, as Lapavitsas and Powell demonstrate, the financial system has already evolved into an 'autonomous sphere' for capital accumulation with its own independent logic, driven by the fundamental imperative of profit maximisation.[60] The existing pattern of financialisation, thoroughly documented by Tori and Onaran, shows how financial activities have already grown disproportionately compared to the real economy's financing requirements, with financial institutions increasingly oriented toward speculative activities rather than productive investment.[61] However, this paper contends that the widespread adoption of AI by central banks will fundamentally accelerate and transform these existing dynamics. The enhanced supervisory capabilities enabled by AI will not create itself push the financial industry toward financial innovation and market opacity. These tendencies are already deeply embedded in the DNA of modern banking, as evidenced by the historical pattern of excessive financialisation documented in EU studies. Rather, AI integration will alter the technological and informational landscape within which these tendencies operate, creating new imperatives for how private institutions pursue their profit-maximisation objectives. This technological transformation will reshape the relationship between central banks and private institutions not by creating new motivations, but by fundamentally changing how existing motivations manifest in an AI-enhanced regulatory environment. As Berger, Molyneux, and Wilson's research suggests, such structural changes in banking supervision can have profound effects on how banks interact with both the financial and real economies.[62]

V. SYSTEMIC RISKS AND VULNERABILITIES

AI's integration into central banking goes beyond enhancing existing systems; it redefines financial regulation by reshaping the relationship between central

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[60] Costas Lapavitsas and Jeff Powell, "Financialisation varied: A comparative analysis of advanced economies," *Cambridge Journal of Regions, Economy and Society*, November 2013, https://doi.org/10.1093/cjres/rst019.

[61] Daniele Tori and Özlem Onaran, "The Effects of Financialisation and Financial Development on Investment: Evidence from Firm-Level Data in Europe," *Greenwich Political Economy Research Centre*, May 2016, https://cpes.org.uk/wp-content/uploads/2016/06/Tori_and_Onaran_paper.pdf.

[62] Allen N Berger et al., eds. *The Oxford Handbook of Banking*, 3rd ed., Oxford University Press, 2019, https://academic.oup.com/edited-volume/34288.

banks and private institutions. While past adaptations, as noted by Bordo and Siklos, saw central banks adjusting policy tools in response to systemic risks,[63] AI shifts central banks from periodic regulators to continuous, data-driven market participants, fundamentally altering financial governance. This shift introduces systemic vulnerabilities that surpass traditional financial risks, embedding central banks more deeply in daily market operations. No longer operating at arm's length, as BIS research highlights, they now engage in real-time monitoring and intervention, transforming their oversight role into a direct and immediate regulatory presence.[64]

However, this enhanced capability paradoxically introduces new systemic risks. As central banks engage more actively in market operations through AI, financial institutions may adopt standardised risk models and trading strategies, leading to market homogenisation.[65] This uniformity can, again, create blind spots, where participants collectively overlook risks that fall outside regulatory AI-generated parameters. This can arise when financial institutions align their risk models and trading strategies with supervisory algorithms, reducing diversity in market behaviour. As AI oversight prioritises specific risk indicators, firms can standardise their approaches, reinforcing systemic fragility. When market shocks emerge outside AI-developed parameters, these institutions, operating under similar models, risk collectively misjudging or failing to respond, amplifying instability. The opacity of these arrangements, combined with their deliberate complexity, would make it exceptionally difficult for central banks to identify bubble formations until the risks become irreversible.

The transformation of the central bank-private bank relationship also introduces new operational dependencies that themselves become sources of systemic risk. As central banks rely more heavily on AI systems for market surveillance and intervention, the potential for technological failures or algorithmic errors gradually becomes a significant concern. These operational risks are fundamentally different from traditional financial risks, as they stem from the very tools meant to enhance system stability. The consideration of this issue becomes a question of the efficacy of the technology developed, i.e., by whom, for whom, and where.

This is a necessary conversation to be had as historical evidence underscores systemic vulnerabilities in public-sector technological implementation, with studies revealing failure rates of 35–98% across government IT projects due

[63] Michael D. Bordo, and Pierre L. Siklos, "Central Bank Credibility: An Historical and Quantitative Exploration", *National Bureau of Economic Research*, January 2015, https://www.nber.org/papers/w20824.

[64] Bank for International Settlements, "Artificial Intelligence and the Economy," 42.

[65] Claudia Álvarez Toca and Alexandre Tombini, "Governance of AI adoption in central banks," *Bank for International Settlements*, January 2025, https://www.bis.org/publ/othp90.pdf.

to mismanagement, scope misalignment, and unrealistic expectations.[66] These operational risks, rooted in the tools designed to enhance institutional efficacy, raise critical questions about the viability of central banks' AI initiatives unless outsourced to third-party developers. Such reliance, however, introduces yet another paradox: while external expertise may mitigate implementation failures, it erodes central bank independence by creating technological dependencies on private actors. The shift from sovereign policy execution to hybrid public-private governance models challenges traditional notions of autonomy, as central banks become structurally entwined with external AI providers.[67] This interdependence risks compromising crisis responsiveness, as algorithmic tools, proprietary and opaque, may constrain policymakers' agility during systemic shocks, effectively transferring operational sovereignty to corporate entities whose incentives are different from public stability mandates.

The emergence of these new systemic risks necessitates a fundamental reconsideration of how central banks approach their mandates for market and price stability. The traditional focus on monetary policy and regulatory frameworks must expand to encompass the management of technological risks and the oversight of AI-resistant market segments. Specifically, the interaction between these various risk factors creates a particularly dangerous form of systemic vulnerability. As financial activities migrate toward AI-evasive market segments, the potential for rapid, unexpected market disruptions increases significantly. The combination of deliberate opacity, complex interdependencies, and rapid evolution would make it exceptionally difficult for central banks to maintain comprehensive oversight of systemic risks, even with advanced AI capabilities.

Moreover, the very technologies that central banks deploy to enhance their supervisory capabilities may also inadvertently contribute to risk accumulation. This creates a paradoxical situation where enhanced regulatory capability increases system-wide vulnerability by encouraging the development of more complex and opaque financial structures. The systemic risks created by AI-resistant market segments, discussed earlier, manifest most acutely in detection challenges that extend beyond traditional supervisory concerns. This surveillance challenge is exacerbated by the unprecedented speed of adaptation in financial markets. The technological arms race between private institutions

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[66] Richard Heeks, *Implementing and Managing eGovernment: An International Text* (SAGE Publications, 2006), 52–54; The Standish Group, "HAZE," The Standish Group International, Inc., 2015, 2-3, https://www.standishgroup.com/sample_research_files/Haze4.pdf; and National Audit Office. "Delivering Major Projects in Government: A Briefing for the Committee of Public Accounts," January 6, 2016, https://www.nao.org.uk/briefings/delivering-major-projects-in-government-a-briefing-for-the-committee-of- public-accounts/.

[67] Toca and Tombini, "Governance of AI adoption in central banks," 65.

and regulatory AI systems creates a unique form of systemic risk: the faster central banks enhance their detection capabilities, the more rapidly private institutions can modify their evasion strategies. Unlike traditional regulatory cycles, where adaptation occurs over months or years, AI-driven evolution happens in near real-time, challenging fundamental assumptions about how regulatory systems can maintain oversight.

VI. CRITICAL ANALYSIS

The central thesis that AI surveillance will drive financial institutions toward new forms of opacity through a process of creative destruction warrants critical examination through its theoretical foundations. The argument that financial institutions will evolve in Darwinian fashion toward AI-resistant market segments assumes that opacity represents the optimal adaptation strategy. However, true evolutionary fitness in an AI-dominated regulatory environment might instead favour institutions that develop superior algorithmic capabilities, engaging in a race of technological sophistication rather than retreat into opacity.[68] Yet this counter-argument underestimates how information asymmetry, as previously established, remains fundamental to financial profitability. The Darwinian imperative for survival through profit maximisation suggests that preserving information advantages, rather than competing on algorithmic capability alone, remains the more viable evolutionary strategy. Precedent supports this view: when faced with increased regulatory scrutiny, financial institutions consistently innovate toward opacity rather than transparency, as evidenced by the evolution of off-balance-sheet vehicles and shadow banking structures.[69]

The application of Schumpeterian creative destruction to regulatory evasion might be challenged because true creative destruction involves the creation of genuinely new value, not merely the preservation of existing advantages.[70] However, this criticism misunderstands how financial innovation operates through the dialectical relationship between regulation and evasion, which has already been established. New financial structures created to evade

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[68] Kostis Chlouverakis, "How artificial intelligence is reshaping the financial services industry," *EY*, January 31, 2025, https://www.ey.com/en_gr/insights/financial-services/how-artificial-intelligence-is-reshaping-the-financial- services-industry.

[69] Tobias Adrian et al., "Shadow Banking: Financial Intermediation beyond Banks," (paper presented at the European Money and Finance Forum, 2018), https://suerf.org/wp-content/uploads/2024/01/s_f5cfbc876972bd0d031c8abc37344c28_6951_suerf.pdf.

[70] John Van Reenen, "Creative Destruction for Growth and Change," *LSE Review of Books* (blog), September 25, 2023, https://blogs.lse.ac.uk/lsereviewofbooks/2023/09/25/creative-destruction-for-growth-and-change/.

AI surveillance would not merely hide existing activities but would likely generate novel forms of financial intermediation and value creation, just as derivatives markets emerged from attempts to circumvent capital controls.

Flowing from the discussion above, another critique of the arguments of this paper might be premised on the interpretation of the regulatory dialectic as inevitably driving toward opacity, raising questions by pointing to historical periods where increased transparency emerged from technological advancement.[71] For example, electronic trading made equity markets more transparent in the 1990s.[72] It should be stated, however, that this apparent contradiction dissolves under closer examination: such transparency typically emerged only in markets where competitive forces had already eroded traditional information advantages. Simultaneously, financial institutions developed new, more opaque market segments elsewhere, as evidenced by the concurrent rise of over-the-counter derivatives markets.

The capacity for regulatory frameworks to evolve alongside technological advancements presents another critical consideration. Post-2008 reforms demonstrate regulators' ability to adapt to systemic risks, with the potential for AI itself to enable "adaptive regulations" through predictive risk modelling and automated supervisory updates.[73] Yet this optimistic view underestimates the inherent asymmetry in the speed of adaptation between private innovation and regulatory response, a challenge previously highlighted in our discussion of the innovation-regulation dialectic. While AI-driven financial instruments can be developed in months, regulatory frameworks like Basel III require years for global implementation.

Market forces favouring transparency present a compelling counterpoint to our thesis about opacity. Contemporary demands for ESG reporting and blockchain-based audits suggest market participants might prefer transparent systems to avoid regulatory scrutiny.[74] However, this perspective overlooks the fact that asymmetric information remains a fundamental driver of profit in

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[71] Burkart Holzner and Leslie Holzner, *Transparency in Global Change: The Vanguard of the Open Society* (University of Pittsburgh Press, 2010): 83-85.

[72] Hans R. Stoll, "Electronic Trading in Stock Markets," *Journal of Economic Perspectives* 20, no. 1 (Winter 2006): 153–174.

[73] Lori Snyder Bennear and Jonathan B. Wiener, "Adaptive Regulation: Instrument Choice for Policy Learning over Time," (Working Paper, Harvard Kennedy School, Mossavar-Rahmani Center for Business and Government, 2019), https://www.hks.harvard.edu/sites/default/files/centers/mrcbg/files/Regulation%20-%20adaptive%20reg%20-%20Bennear%20Wiener%20on%20Adaptive%20Reg%20Instrum%20Choice%202019%2002%2012%20clean.pdf.

[74] Fateha Shaheen et al., "Corporate Sustainability Audits: Enhancing Transparency and Accountability in Financial Reporting," *Environmental and Earth Sciences* 2024, no. 2 (2024): 15–24, https://salford-repository.worktribe.com/output/3614734/corporate-sustainability-audits-enhancing-transparency-and-accountability-in-financial-reporting.

finance, a point demonstrated in our earlier analysis of information advantages. As with synthetic CDOs before the 2008 crisis, market participants consistently tolerate opacity when it enhances returns.[75] The potential for public-private collaboration warrants additional consideration, particularly through initiatives like the BIS Innovation; however, as the historical analysis demonstrated, such collaboration remains constrained by fundamentally misaligned incentives between private banks' profit maximisation and central banks' stability mandate. This misalignment, evident in ongoing tensions over capital requirements and transparency measures, suggests the adversarial dynamic will persist in an AI-enhanced regulatory environment.

Legal and ethical frameworks, particularly emerging AI regulations in jurisdictions such as the EU, may appear to constrain the development of AI-resistant market segments. However, as demonstrated by the evolution of shadow banking structures before 2008, financial innovation consistently outpaces legal frameworks. Privacy-focused blockchain networks exemplify how opacity can be reframed as a form of consumer protection, exploiting legitimate concerns about surveillance to create regulatory blind spots. With the integration of AI, a critical challenge emerges in determining liability when AI systems make decisions that significantly impact entire economies. Unlike traditional policy decisions, where accountability chains are transparent, AI-driven decisions create complex questions of responsibility. When an AI system fails to detect market manipulation in an emerging financial instrument, who bears responsibility - the central bank, the AI developers, or the oversight committee?[76]

VII. POLICY RECOMMENDATIONS

To address these challenges, this work proposes a "Tiered Algorithmic Governance" (TAG) framework[77] for central banks adopting AI, designed to calibrate human oversight to the stakes and complexity of AI-driven decisions. Under a TAG framework, mission-critical choices, such as monetary policy adjustments or systemic risk interventions, would undergo multi-layered human review. At the same time, routine analytical tasks (e.g., data processing)

[75] Marcin Wojtowicz, "CDOs and the Financial Crisis: Credit Ratings and Fair Premia," *Journal of Banking & Finance* 39 (2014): 1-13.

[76] Alessio Azzutti, "Artificial Intelligence and Market Manipulation: Regulatory Challenges in EU Financial Markets" (PhD diss., Universität Hamburg, 2024), https://ediss.sub.uni- hamburg.de/bitstream/ediss/11340/2/A%20Azzutti%20(2024)%20AI%20and%20Market%20Manipulation.pdf.

[77] Karthik Ramanna, "Reconciling Automated Weapon Systems with Algorithmic Accountability: An International Proposal for AI Governance," *Harvard International Law Journal*, October 2023, https://journals.law.harvard.edu/ilj/2023/10/reconciling-automated-weapon-systems-with-algorithmic-accountability-an-international-proposal-for-ai-governance/.

could operate with minimal oversight. To operationalise this framework, central banks should concurrently establish "AI Ethics Committees" with representation extending beyond technocrats and economists to include ethicists, legal scholars, and public advocates. These committees would establish guardrails for AI deployment, ensuring that efficiency gains do not outweigh public interest imperatives, such as equity and systemic stability. These committees would serve not merely as oversight bodies but as adaptive interfaces between technological imperatives and public interest mandates, comprising representatives from central banks, private institutions, technology specialists, and civil society organisations. Their primary function would be to anticipate and respond to the dialectical tensions identified in our analysis, including conducting algorithmic impact assessments, developing transparency standards for "black box" systems, monitoring market structure evolution, and establishing ethical guidelines that balance innovation with stability, thereby addressing the innovation-regulation paradox discussed earlier.

The global nature of financial markets necessitates international coordination in AI governance. Fragmented approaches to AI oversight could exacerbate systemic risks, potentially accelerating the migration of economic activity toward opacity. AI Ethics Committees would therefore coordinate through established bodies such as the Financial Stability Board or Bank for International Settlements to develop common standards and response mechanisms, providing trans-border dimension that is particularly critical given the potential for regulatory arbitrage in an AI-enhanced financial landscape, a concern that directly relates to this work's central thesis that enhanced central bank capabilities may drive private institutions toward increasingly complex market segments beyond algorithmic supervision. By creating institutional mechanisms specifically designed to monitor and manage this dialectical relationship, we can better harness AI's capabilities while mitigating the systemic vulnerabilities identified throughout this analysis.

To holistically address these challenges, international coordination must prioritise the establishment of "AI Supervisory Colleges", modelled after existing frameworks for global banks, to harmonise cross-border responses and curb regulatory arbitrage. These colleges would act as hubs for sharing AI-related risk intelligence, benchmarking best practices, and codifying unified standards for AI deployment in financial oversight. Complementing this global effort, central banks should also implement a "Layered Disclosure Framework" (LDF)[78] to balance transparency and security by tiering technical disclosures:

[78] Urs Gasser and Virgilio A.F. Almeida, "A Layered Model for AI Governance," *IEEE Internet Computing 21*, no. 6 (November/December 2017): 58-62, https://dash.harvard.edu/bitstream/handle/1/34390353/w6gov-18- LATEX.pdf?sequence=1&isAllowed=y.

high-level summaries for public accountability, granular documentation for regulators, and encrypted data streams for peer institutions. This stratification prevents sensitive AI capabilities from being weaponised while maintaining democratic oversight. To further future-proof their regulatory frameworks, central banks must institutionalise "AI Stress Testing" protocols that simulate adversarial scenarios, including deliberate data manipulation or market shocks, to expose vulnerabilities in real time. These tests should mirror tactics that can be employed by private institutions seeking to exploit AI blind spots, ensuring supervision evolves proactively.

Most importantly, however, to effectively regulate the new markets that financial institutions would explore, this work proposes that exploring symbiotic AI charters is the most expedient approach. These charters propose a radical reimagining of regulatory oversight in algorithmic finance, where private institutions would embed modular regulatory API access points within their proprietary AI systems, enabling non-invasive, real-time audits by supervisory algorithms of the central banks. This framework can reconcile the tension between competitive secrecy and systemic transparency, offering a middle path between unchecked innovation and draconian oversight. These APIs would function as cryptographic "inspection portals", permitting regulators to verify compliance with stability metrics, such as liquidity thresholds or exposure limits, while shielding intellectual property. Crucially, the data flow is bidirectional: supervisory algorithms feed anonymised risk insights back to institutions, creating a feedback loop that aligns private optimisation strategies with public stability goals.

The operational mechanics draw inspiration from modular fintech architectures, where core functionalities remain shielded but critical interfaces adhere to open standards. For instance, a bank's AI-driven liquidity management system might expose API endpoints revealing real-time stress test results or counterparty exposure trends, while keeping proprietary trading algorithms encrypted. Regulators, equipped with their own AI auditors, can run compliance checks through these APIs, flagging anomalies without the need for reverse-engineering the underlying models. This approach directly addresses the AI paradox outlined in this paper. By institutionalising transparency at the interface level, it reduces incentives for private institutions to develop wholly opaque AI-resistant markets. Instead, firms retain competitive advantage through algorithmic sophistication within regulated parameters, while regulators gain granular oversight capabilities. The charters would be enforced through a compliance-innovation index,[79] where institutions earn regulatory flexibility

[79] Andrea Esposito et al., "Building Symbiotic AI: Reviewing the AI Act for a Human-Centred, Principle-Based Framework," *arXiv preprint* arXiv:2501.08046 (January 14, 2025), https://arxiv.org/abs/2501.08046.

(e.g., lighter capital requirements) by demonstrating API robustness and audit responsiveness.

In practice, symbiotic AI charters operationalise the Schumpeterian dialectic, transforming regulatory evasion into collaborative adaptation. Much as Basel III's supervisory review pillar harmonised risk reporting, these charters would standardise algorithmic accountability, not by constraining innovation, but by channelling it toward symbiotic ends. For central banks, this can represent an evolution from adversarial oversight to participatory governance, where supervision becomes a shared infrastructure rather than a compliance burden.

VIII. CONCLUDING REMARKS

The integration of AI into central banking crystallises a defining paradox of modern financial governance: the very tools designed to enhance stability risk amplify fragility by incentivising unprecedented forms of regulatory evasion. As central banks evolve into real-time market participants armed with algorithmic surveillance, private institutions respond not with compliance but with innovations that weaponize opacity, crafting AI-resistant instruments and synthetic ecosystems that defy conventional oversight. This dynamic transcends mere technological adaptation, heralding a structural transformation in how risks propagate and markets self-organise.

The implications are profound. Regulatory frameworks developed in response to past crises, such as Basel III capital buffers, prove inadequate in an era where risks emerge not from balance sheets but from adversarial algorithms and cross-border synthetic exposures. The lesson of history that regulation lags innovation becomes existential in the context of AI, where evasion tactics evolve at machine speed. Central banks must now reimagine their role, shifting from reactive overseers to proactive architects of adaptive systems that anticipate, rather than merely respond to, algorithmic disruption.

Future research must prioritise interdisciplinary synthesis, bridging AI ethics, behavioural economics, and complexity science to decode how institutions adapt to and exploit algorithmic oversight. Equally critical are global governance models capable of harmonising AI standards across jurisdictions while respecting sovereignty, akin to a "Bretton Woods for algorithmic finance". Finally, the integration of ethical AI demands urgent attention, requiring frameworks that embed societal values, such as equity and transparency, into supervisory algorithms, ensuring that human judgment remains central to systemic stability.

Ultimately, the path forward demands institutional agility, not by outpacing AI's paradox but by embedding adaptability into financial regulation. Success

hinges on redefining regulatory paradigms to embrace AI's dual nature, requiring central banks to master its technical frontiers while exercising strategic foresight to anticipate unintended consequences. This evolution, not mere technological adoption, will determine whether AI stabilises or accelerates financial crises, shaping the future of trust in a digitised economy. As AI reshapes oversight and evasion, governance must evolve at the speed of code or risk obsolescence in the age of machines.

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