

## Aspects of Technological Innovation in Financial Markets

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### Abstract

*Financial markets have been significantly affected in recent decades by the effects of globalization, new regulations, the development of the Internet and of the communications system (including the reduction of operating costs) or new forms of trade. In this article we aim to clarify the main concepts used in the field of technological innovation in financial markets, but also to present the links between them. The factors that influence the technological development in finance are presented, as well as the influences that we can observe in the financial system, followed then by the market reaction materialized through mergers and acquisitions. The expansion of Fintech and the involvement of large technology companies in finance bring advantages and disadvantages, create opportunities, but at the same time raise many questions about future developments. If there are specific supervisory systems and regulations for the financial system, there is a regulatory gap in the technology sector.*

**Key words:** innovation on financial markets, technological development, Fintech

**J.E.L. classification:** O33, G15

### 1. Introduction

Innovation is one of the most common terms in business, the press and scientific literature, but what exactly it means can sometimes be unclear. Innovation can be explained by words, descriptions, using criteria or following reactions. It can be analysed as a whole, or it can be specific to a certain industry, group, or it can be seen from an artistic or social point of view.

In recent decades, financial markets have undergone significant changes influenced by the effects of globalization, regulation, the development of the Internet and the communications system (including the reduction of operating costs) or new forms of trade.

Influences have penetrated unevenly in different types of markets or in certain regions and countries, due to the existence of a varying level of development and regulation or cultural factors and resistance to change.

As the results of the latest surveys on the financial market show (e.g. in Germany, the Centre for Financial Studies survey), artificial intelligence is expected to be a major topic for the financial industry in the future, given that the financial sector is already strongly influenced by it, new technologies having the potential to strongly transform financial processes. The need to step up research in this area is thus clear, given that change is occurring very quickly and the impact on markets and the population is significant.

A first stage of research is dedicated to defining and clarifying the links between the main concepts, and then the main directions and perspectives of the field are presented. The influence of technological innovation on the development of financial markets is felt in several levels, and the research directions are oriented towards the newly developed categories, following the main trends at global level.

## 2. Theoretical background. Clarifying on technological innovation in financial markets

Artificial intelligence (AI) is enjoying a growing interest in more and more fields. The availability of large data, improved technology, new possibilities for storing information were the factors that determined the emergence of innovative applications in the financial field using AI.

The Financial Stability Board (2017) defines artificial intelligence as "the theory and development of computer systems capable of performing tasks that have traditionally required human intelligence". Also, in the opinion of this Council, the application of this technology in finance is in an early stage of development, but is evolving rapidly. Therefore, complete statistical data on use are unavailable and any analysis should be considered preliminary. This is a promising area, but developments need to be closely monitored to properly manage potential risks.

The concept was developed a few decades ago, but was followed by the "winter of IA" (about 1976 - mid-2000s) for limited possibilities of use. A strong revival has been felt in recent years due to the increase in the volume of data available (very large increase from 2014-2015; the concept of Big Data appears), the increase in computing power of computers (a very large increase since 2010) and the development computational algorithms.

In the literature, but also in practice, several concepts have been developed that have a certain ordering structure:

- Artificial intelligence (AI) - automation algorithms; previously seen or thought actions can be imitated without other new interventions; is represented by the largest circle in the Figure no. 1 and comprises the following two concepts;
- Machine Learning (ML) - statistical algorithms for data analysis; is a customization of AI, able to take data and algorithms and apply them to new scenarios and models; is represented by the middle circle in Figure no. 1 and in turn includes another concept;
- Deep Learning (DL) - algorithms that use neural networks; provides the necessary algorithms to understand the basic principles of action.

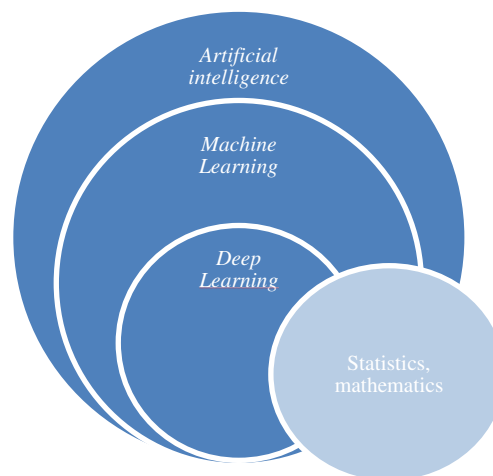
Many tools rely on statistical methods such as extending regression models, optimization and classification operations, or using statistical techniques to facilitate data visualization.

AI applications are increasingly used by economists, but also by other categories of specialists, to help understand complex relationships, being used alongside other analysis tools.

Among other areas with economic and social impact in which AI applications are used, we specify: music industry (copy write), the real estate market, health (data security), politics (voting system), internet and communications, legal field.

The relationship between IA, ML, DL, on the one hand, and statistics, mathematics, on the other hand, is presented in Figure no. 1. Sometimes the intersection between the two categories is called data science.

*Figure no. 1. The relationship between artificial intelligence, Machine Learning, Deep Learning and statistics, mathematics*

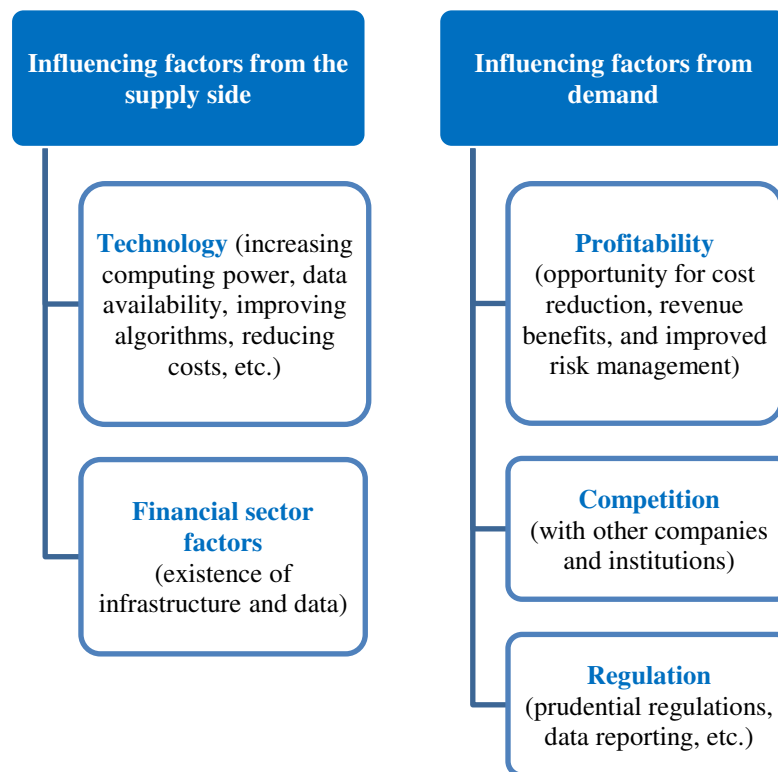


Source: Processing and simplification after Goodfellow et al. (2016)

In addition to various applications in other areas with strong economic and financial impact, the best known direct applications of IA, ML and DL in finance are in activities associated with stock trading, asset valuation, fraud detection, portfolio investment, design, risk management, loan approval, compliance with regulations, market analysis.

The increasing use of AI in the financial field was determined by several factors. A classic division into two categories (demand and supply) was summarized by the Financial Stability Council (2017) and is presented in Figure no. 2.

Figure no. 2. Synthesis on the factors influencing the adoption of artificial intelligence in the financial field



Source: Adapted from the Financial Stability Board (2017)

The supply side is most influenced by the technological evolution and specific factors of the financial sector that allow the application of new technologies, and the demand side shows the opportunities to increase profits, competition with other companies and institutions and compliance with regulatory requirements.

### 3. Research methodology

The methodology used in this paper consists in descriptive and comparative analyses, interpretation of realities, enriched with examples and the use of statistical data.

The first step of the analysis consists in identifying the main trend regarding the mergers and acquisitions in the field of artificial intelligence in the period January 2010- August 2019 and the value and number of start-ups' financing in the field of artificial intelligence for the period between quarter I 2014 and quarter II 2019, starting from a comparative analysis for the mentioned periods.

The analysis of the Fintech adoption rate by countries and for the five categories of financial services (money transfers and payments, savings and investments, budgeting and financial planning, insurance, loans), is the it is the core of the second stage, with the final objective to identify the main trends in the field.

In the last stage it is considered the issue of the main revenues for the large technology companies, that is analysed taking into account the activities assimilated (information technology, production and marketing of consumer goods, communication services, financial services and other activities).

In order to carry out the study we used the specialized literature and the official documents of international institutions. The sources of the statistical data are the Bank for International Settlements, EY Global Financial Services and CB Insights.

#### 4. Main findings

##### 4.1 Fintech expansion

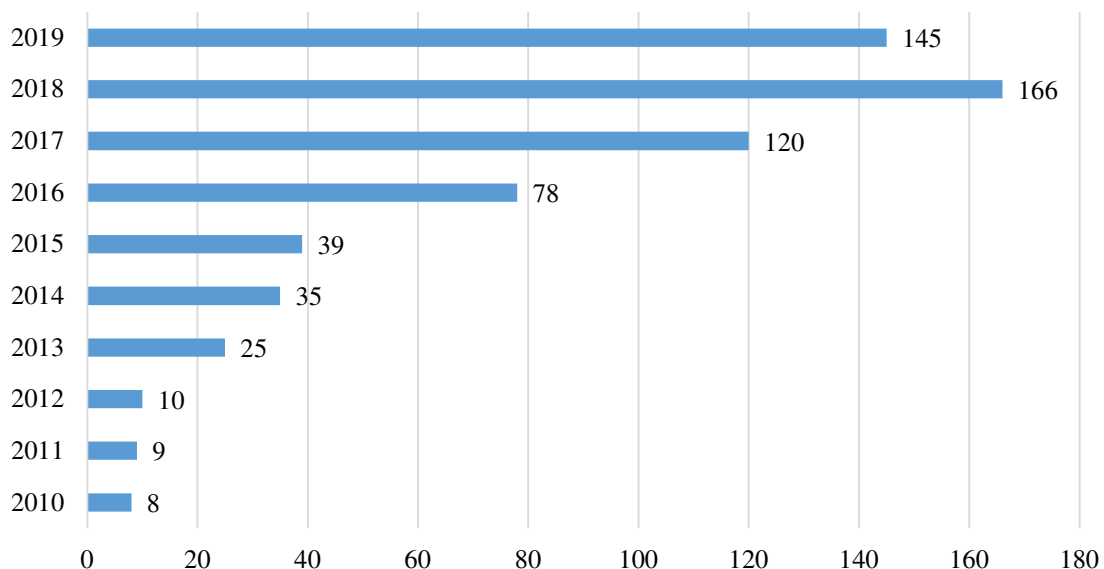
The development of AI is undeniable in recent years. The diversity of technological developments in the financial sector has concurred to the creation of infrastructures and data sets. Among the influences we can observe in the financial system we can mention:

- the emergence of new products and services, new modes of operation;
- influence on the functioning of the banking system, capital markets, monetary policy, insurance industry, etc.;
- impact on the efficiency of resource allocation, on transparency;
- influence on the way financial markets are supervised (mechanism and subject).

Therefore, more and more institutions considered it appropriate to expand into this field and purchased start-ups and/or intensified research in this field. The evolution of the number of mergers and acquisitions has been impressive in recent years (Figure no. 3).

During the analysed period (January 2010 - August 2019) 635 mergers and acquisitions of companies in the field of AI were registered. The rate at which this type of activity has increased from year to year is growing. During 2011-2012 (Financial Stability Committee, 2017), the algorithms used by ML and DL began to become more and more attractive, and large companies became interested in acquiring the start-ups that develop them. High growth have been recorded since 2016, 2018 being a year with records. Pursuant to the newest data, the evolution in 2019, was expected to exceed the level in 2018.

Figure no. 3. Mergers and acquisitions in the field of artificial intelligence (number, January 2010 - August 2019)

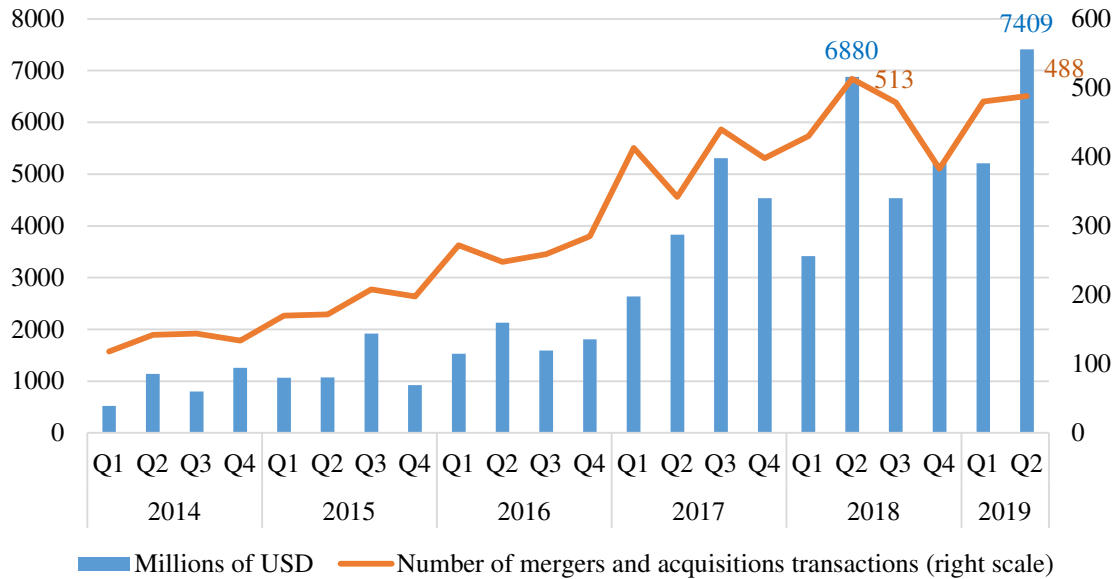


Source: Processing after CB Insights (2019a)

According to CB Insights data (2019b), the value of financing start-ups in AI has increased by approximately 593% in the last 5 years (quarter II 2019 compared to quarter I 2015) and reached a record value of 7.4 billion USD in the second quarter of 2019.

A detailed presentation of start-ups financing after quarters for the period quarter I 2014 - quarter II 2019 is pictured in Figure no. 4, including both, the value and the number of merger and acquisitions transactions.

Figure no. 4. Financing of start-ups in the field of artificial intelligence (quarter I 2014 - quarter II 2019, number of mergers and acquisitions and their value in millions of USD)



Source: Processing after CB Insights (2019a)

Most acquisitions of AI companies are made by large technology companies. During the above-mentioned period, Apple, Google, Microsoft, Facebook, Intel, and Amazon made the most such purchases (with 20, 14, 10, 8, 8 and 7 purchases, respectively). The remaining up to 635 acquisitions are made by other companies, the interest being growing in recent years. We note that the business environment goes from circumspection and moderate interest in such solutions, to openness and preparation for implementation.

#### 4.2 Fintech expansion

The development of AI and its components has stimulated the emergence and growth of Fintech, an innovative development in financial services that brings new opportunities with its development, but also has the potential to generate new risks or amplify existing ones. Broadly speaking, this term describes new technologies, services, and companies that have changed the financial services market. Among others, this new field includes cryptocurrencies, blockchain, robot consulting, smart contracts, crowdfunding, mobile payments, AI platforms, etc.

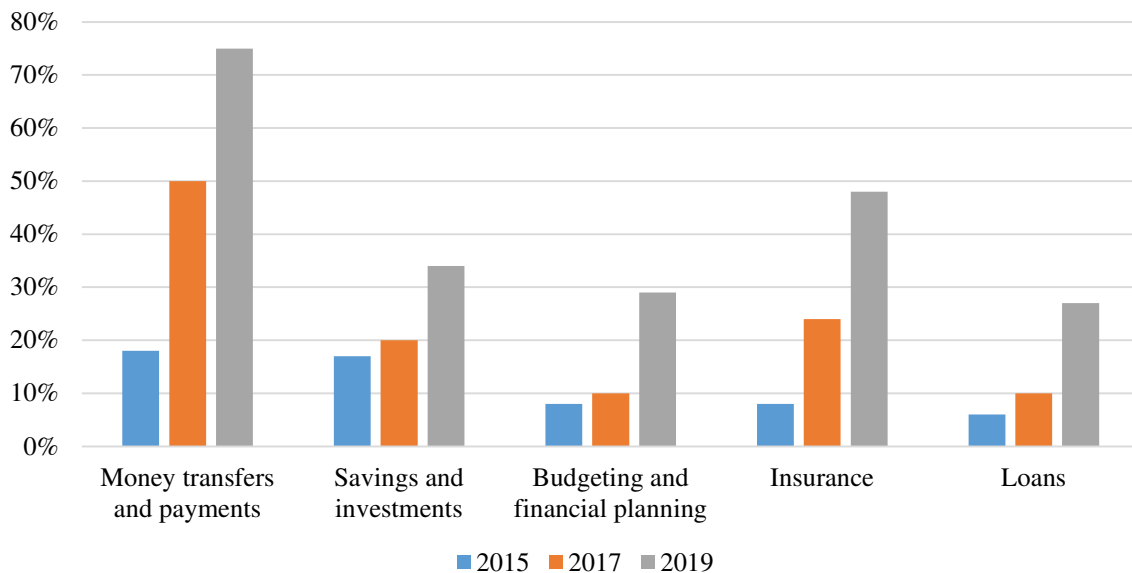
The financial field has always been constantly changing, but the intensity of recent transformations seems higher than in previous innovative periods. The importance given to AI developments can also be seen in the growth of start-up acquisition activities by large technology companies and other companies (Figure no. 3), thus showing that they are interested in innovation and market share growth. Fintech start-ups have opened a new direction for the development of financial innovation. In general, they promise to provide better and more secure services compared to traditional financial institutions. They started to be known in the period 2010-2012, and starting with 2013, several articles about this field started to be published. This is an example of how competition changes the direction of innovation.

In 2015, EY Global Financial Services (2015, 2017, 2019) launched an index of Fintech adoption globally, which is in 2019 in its third edition. The study started in 2015 from an analysis of 6 countries and 10,131 consumers, reached 20 countries and 22,000 consumers in 2017, and in 2019 reached 27 countries (of which 10 are emerging economies) and 27,000 of consumers (EY Global Financial Services, 2015; 2017; 2019). In 2017 the methodology was slightly modified, and the results in 2015 were adjusted to obtain comparable information. The introduction of more

emerging economies in the sample is a signal of recognition of their importance for Fintech's expansion. In fact, their introduction changed the ranking of countries with the highest adoption rate in the last edition. China and India are in the top two positions in 2017 and 2019, with adoption rates of 69% and 52% in 2017 and 87% (both) in 2019, respectively. The overall adoption rate increased from 16% in 2015 to 33% in 2017 and 64% in 2019. According to EY Global Financial Services (2019) the adoption rate has increased much more than the estimates made in the 2017 edition of only 52%. One explanation would be that Fintech services have become more and more common in the range of services offered by banks, insurance companies, stockbrokers, etc., which has also led to strong increases in the adoption rate in countries such as Ireland, the Netherlands and Singapore, from 2017, in 2019.

An important result of the study is the Fintech adoption rate for five categories of financial services (money transfers and payments, savings and investments, budgeting and financial planning, insurance, loans) and its evolution over the three years of analysis. Although there were significant increases for all five categories of financial services, a spectacular increase was observed in the category of money transfers and payments, from 18% in 2015 to 50% in 2017 and 75% in 2019. this being in every year on the first position. Another significant increase was registered in the case of insurances which increased from 8% adoption rate in 2015 to 24% in 2017 and 48% in 2019; if in 2015 it was on the fourth position, in the next two years it reached the second position. A detailed presentation can be found in Figure no. 5.

Figure no. 5. Fintech adoption rate for five categories of financial services (percentages)



Source: Authors' processing based on EY Global Financial Services (2015, 2017, 2019)

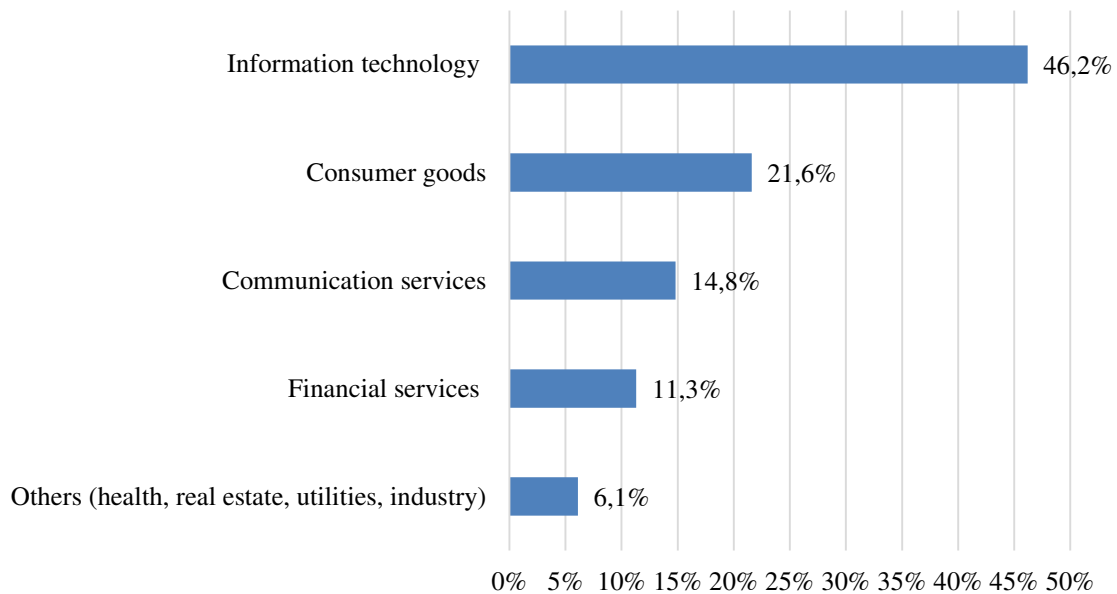
As the range of financial innovations and the prevalence of their use have greatly increased, regulators are challenged to keep up with technological developments on an ongoing basis. In the newly created context, regulation is an important element in seeking an appropriate balance between increasing efficiency, meeting customer needs and risk management. Regulation and supervision must allow the further development of business models based on Fintech, customer protection, stability of the financial system.

Rapid progress has led to the emergence of a combination of regulation and technology, called Regtech, and between surveillance and technology called Suptech, which have evolved in parallel and adapted to a period of innovation.

### 4.3 Large technology companies in finance

A special case of Fintech financial innovation is the activity of large technology companies that have included in the core business, dominated by activities in the field of information technology and consulting, and financial services (especially payment services, money management, insurance and loans) which represented in 2018, according to BIS (2019), 11.3% of their revenues (Figure no. 6).

Figure no. 6. Revenues of large technology companies by sector of activity (percentages)



Source: Authors' processing based on Bank for International Settlements (2019)

The main revenues of large technology companies come from activities assimilated to information technology (46.2%), production and marketing of consumer goods (21.60%) and communication services (14.8%). These companies have evolved a lot in the last two decades and have developed a new business model, based on a large amount of user data and network effects.

Although serving customers worldwide, the subsidiaries of these companies are located mainly in the Asia-Pacific region (approximately 43%) and North America (37%), in Europe they are less represented (only 13.8%) (according to the data of Bank for International Settlements, 2019).

The ability to cover a wide range of consumers and the very high speed of distribution give these companies a systemic importance, an influential factor for financial stability. These characteristics can give them a dominant position, which adds to the problems of competition in the market.

Economies of scale (supported by a large base of stable customers, reduced trading costs and obtaining information), the complementarity of activities with financial services has led to the expansion of large technology companies in finance.

The access of the big technology companies in the financial field presents a series of advantages, but also disadvantages, compared to the situation encountered at the big banks.

One issue that is under discussion is how the financial activities of these companies are regulated. Even if some regulations operating in the traditional financial system could have an influence in the case of large technology companies, the issues raised in the academic literature but also in practice are related to competition, access to data and ensuring their protection and confidentiality, imposing regulations for fading the activity of the shadow banking sector, ensuring the stability and health of the financial system. These approaches cannot be done without cooperation and adaptation to the very rapid digital evolution, by resorting to modern institutional mechanisms capable of learning skills to adapt quickly to changes with major potential impact.

## 5. Conclusions

The use of AI in the financial services industry is still in its infancy, but will become present everywhere, raising new legal, economic and social challenges and helping to increase the complexity of the global financial ecosystem. It is clear that there are links between the information technology and software services sectors and the financial sector. If there are specific supervisory systems and regulations for the financial system, there is a regulatory gap in the information technology sector.

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