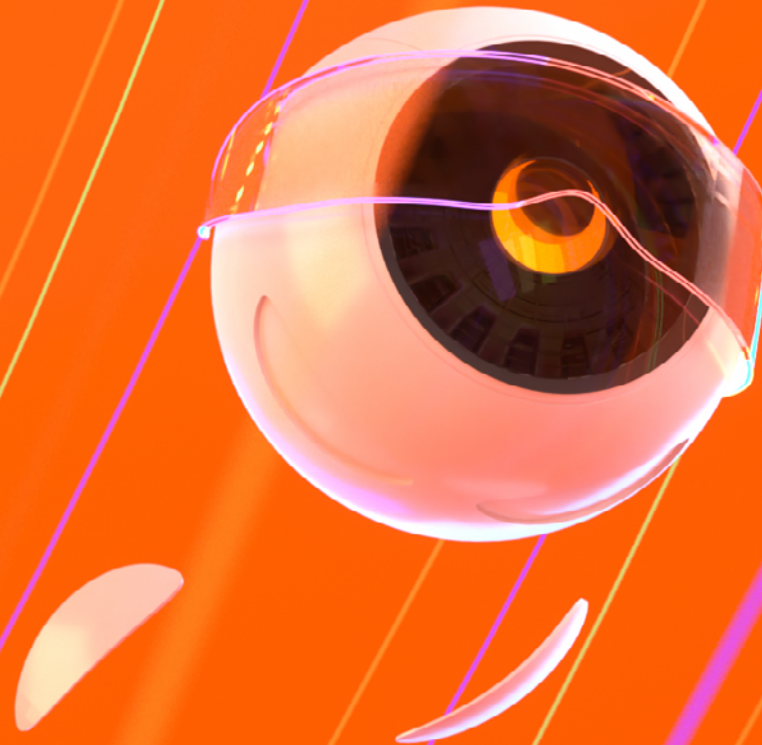


Investment Recipes

by  AtonRā Partners



25 AUGUST 2021

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AI & Robotics



Je dis, donc je suis

The one-minute pitch

Backed by generous public funding, huge databases, and giant talent pools, China is rapidly narrowing the technological gap in AI development. It is doing so also by leveraging its peculiarities to lead the field, notably when it comes to one of the fundamental AI algorithms – natural language processing.

NLP & CONVERSATIONAL AI

DATA INFRASTRUCTURE

COMPUTING COMPONENTS

ROBOTICS

AUTONOMOUS VEHICLES

AUGMENTED AND VIRTUAL REALITY

PROCESS AUTOMATION

KNOWLEDGE AUTOMATION

NOVEL MANUFACTURING

JE DIS, DONC JE SUIS

Smart Voice In China Is Echoing

The ABC of NLP

As we wrote, the lack of computing chips may slow down China's dream of being an all-around AI champion, but it can't deter China from leading in given fields. Benefiting from easy access to enormous data and substantial talent pools, China is at the edge in conversational AI and natural language processing (NLP).

- NLP is the automated processing by machines to understand human languages.

Mandarin, the home advantage

For a machine to have a normal conversation with humans requires tackling the intrinsic ambiguity of human languages. However, the natural barrier of deconstructing and understanding the Mandarin language brings an edge to Chinese developers.

- Mandarin is a tonal language, meaning a single word can have different meanings or multi-meanings in one character, which is a big challenge for AI players.

China's AI got talent

Backed by huge data pools, Chinese companies are being recognized abroad and gaining traction through the multi-faceted and versatile applications they offer.

- Baidu dominates the conversational AI software across the globe, and its platform outscored Google's T5 in the AI English competition, becoming the best English understander.
- Asia's voice-recognition leader iFLYTEK and highly-expected startup Xiaoice are sweeping the market at home and abroad with their impressive "smart ways" to interact with end-users.



Training A Machine To Talk Is Never Easy

NLP, the bedrock of any AI development

Natural language processing (NLP) is fundamental to AI applications. Computer scientists train computers to see, hear, act, and speak – the main feature distinguishing humans from animals. The goal of NLP is to help computers understand human languages, be able to communicate, and in the end, form artificial intelligence.

- NLP is scaled over seven levels, from basic to complex, according to use.

The hardest fence to hurdle

Enabling computers to understand the meaning of a specific context (natural language understanding - NLU) is difficult but possible, while generating corresponding answers (natural language generation – NLG) is extremely challenging. Most industrial applications remain at the NLU stage and face significant challenges to move forward to NLG.

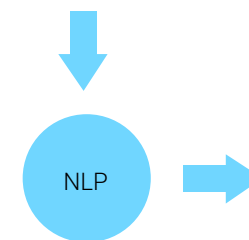
- Typical NLU applications include natural language interfaces for multilingual databases, various machine translation systems, information retrieval systems, and automatic summarizing systems.

Natural Language Understanding (NLU) mechanisms

NLU uses algorithms to deconstruct human speech into a structured ontology – intent classification and entity recognition.

- Intent classification forms the foundation of a chatbot – taking a written or spoken input and classifying what a user wants.
- Entity recognition is a subtask of information extraction – classifying which are the relevant words mentioned in an unstructured content (conversation), such as a name (subject), a place (location), and a date (time).

7 levels of basic NPL	
Phonetic	The pronunciation pattern of language
Morphological	How symbols and letters form words
Lexical	The relationship between words
Syntactic	How words form sentences
Semantic	The meaning corresponding to linguistic expressions
Pragmatic	The semantic interpretation in different contexts
Chapter	How sentences are combined into paragraphs



Applications
Machine translation
Answer questions
Dialogue
Text summarization
Sentiment analysis

SOURCE:
[Natural Language Analysis](#)

Is Mandarin The Most Confusing Language?

Mastering ambiguity is the goal

Words are considered semantically ambiguous if they can be used in multiple ways or have different meanings depending on context. The wide variety of ambiguities or multiple meanings existing at all levels of natural language texts and conversations is particularly challenging to develop NLU.

- How humans construct a sentence – in an indirect or direct expression – is an issue of cognitive science that doesn't have a well-defined solution.
- The bottleneck is how to convert natural language input with potential ambiguity into a certain level of specific command that a program may understand.

The Chinese language has ambiguity as a cornerstone

Mandarin is a context-based language due to the absence of tenses or plurality for nouns. Many words (or characters) don't have a unique meaning unless binding in exclusive combinations.

- Multiple meanings in one character or word related to multiple pronunciations often frustrate and confuse non-Chinese Mandarin practitioners.
- Meanings could be altered drastically just through a different sentence segmentation: where to pause or place a comma.

Pragmatic ambiguity builds a natural barrier to enter the Chinese market

Learning Chinese grammar is challenging and confusing for any human, not to mention AI systems. A system designed under the English paradigm will find itself dysfunctional in Chinese text, increasing non-Chinese speakers' difficulty in developing NLP for a Mandarin interface.

- Current applications may work fine for translation but poorly for conversational use.

SOURCE:
[Ambiguity in Natural Language Processing](#)

One character with two meanings 他3天沒有吃“飯”了		
He has not eaten “rice” for three days	OR	He has not eaten any “meal” for three days
One character with two parts of speech		
在冬天(winter), 能穿多少是多少		在夏天(summer), 能穿多少是多少
As much : Adverb		Least: Adjective
In winter, put on as much cloth as you can	OR	In summer, wear at least as you can
The importance of where to add a comma		
不要, 用壞了 Don't damage it	OR	不要用, 壞了 Don't use, it is broken
One pronunciation with three meanings		
The word “he(他)” “she(她)”, and “it(它)” all pronounce the same as “ta”, but referring to three distinct subjects		

Baidu: The Language Processing Leader

A semantic understanding platform: ERNIE 3.0

Baidu's team recently introduced its ERNIE 3.0, a large-scale knowledge-enhanced multilingual model that understands 96 languages.

- ERNIE addresses this issue, presenting a pretraining model that can easily be tailored for NLP, NLU, and generation tasks due to its auto-encoding network.
- Over 20,000 Chinese AI developers across finance, telecom, education, and e-commerce have applied ERNIE to their NLP systems.

Robust data is the foundation for developing AI and machine learning

A "large and clean" dataset is vital to train and test the algorithms. With limited data to feed the machine, the processing errors will significantly impact the outcomes. Mandarin specifically requires special treatment to be converted to a binary form recognizable by computer systems.

- Baidu has the world's largest Chinese NLP database, surpassing that of Google.

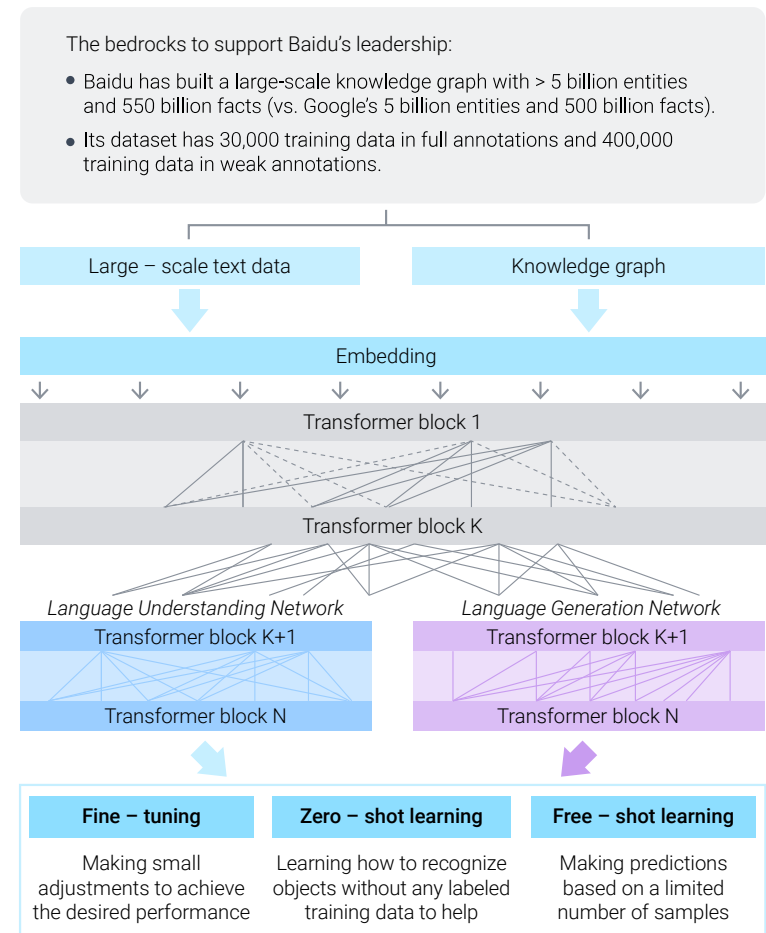
The double champion in dual linguistics

ERNIE 3.0 can conduct creative writing in Mandarin, composing novels, lyrics, and poems without special training on texts and knowledge. Its English version surpassed Google's T5, Open AI's GPT-3, and others on SuperGLUE.

- Founded by NYU, University of Washington, and DeepMind, SuperGLUE is a series of evaluations to measure the performance of AI's language understanding.
- ERNIE 3.0 topped the global SuperGLUE ranking with a score of 0.8% above human performance (90.6% vs. 89.8%).

SOURCE:
[Baidu Team Introduces ERNIE-M](#)

THE FRAMEWORK OF ERNIE 3.0



iFLYTEK : An All-round AI Innovator

From smart voice to Super Brain Project

iFLYTEK, a partially state-owned company, is the pioneer in AI-powered voice-based technology in China and has evolved into a global leader in AI development.

- It offers voice recognition software and 10+ voice-based products, covering the education and communication industries and helping the government manage national security through voice biometrics.
- Its Super Brain is using big data to self-train and optimize its algorithms – the system actively processes data from interactions in real-world scenarios.
- The company has won 13 consecutive wins at the Blizzard Challenge, the world's leading speech synthesis contest.

Using Artificial Intelligence to improve academic intelligence

iFLYTEK's X2 flagship model is a smart learning machine covering the curriculums of K-12 education (the 12 years from primary to senior high), starting at 3,999 yuan.

- The machine can detect and translate the word "pointed out" on a textbook and correct English grammar on a scanned composition as well as pronunciations.
- By analyzing the wrongly answered questions through AI and big data, it can customize tests to help students quickly find their weak spots.

Your mouse can be your personal translator

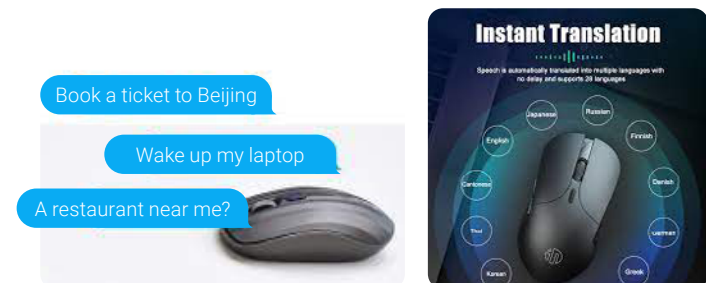
The iFLYTEK's smart mouse is an AI voice typing mouse that will understand (voice type) and do as your request (voice search). The content of the speech can be instantly transformed into texts and translated into 28 different languages with no delay.

- 500 words can be typed in a minute with a speech recognition rate of ~98%.
- Users can awaken laptops from sleep mode or voice search, just like asking Siri.

IFLYTEK'S AI Learning Assistant Pad



IFLYTEK'S AI Voice Typing Mouse



SOURCE:
[iFlytek: The voice of AI](#)

Xiaoice : An AI-based Virtual Friend

An NLP trailblazer

Spun-off from Microsoft last year, Xiaoice is a Chinese-based company that uses an emotional computing framework to develop an app that allows users to interact and become "friends" with an AI-powered chatbot,

- Portraying the personality of a Chinese teenager, Xiaoice has gained a huge fans base in China and the world with a >900mn using the app ("friends").
- The company just completed its A-round financing this July, with a post-investment valuation of over \$1bn.

Versatility makes "her" more humanized

Xiaoice 's multifaceted talents earned "her" a huge success: she is a poet, a painter, a TV show host, an accountant, an empathetic companion, and a lot more.

- The avatar can create the same quality of work as humans – composing a piece of hip-hop music with rap elements and performing.

The future of chatbots

Its AVATAR framework equips Xiaoice with 230 different skills (ranging from answering questions to recommending movies to holding non-stop conversations) that can be applied to various contexts and, most importantly, businesses.

- Xiaoice has an average of 23 conversation-turns per session (a metric used to measure users' engagement) vs. voice-based personal assistant at 1~3 and voice-based task completion at 3~7.
- Today, about 60% of the worldwide AI-human interaction traffic goes through the AVATAR framework, although presented with different virtual names.

SOURCE:

6 LESSONS LEARNED FROM 1B+ BOT CONVERSATIONS, [Microsoft spins out 5-year-old Chinese chatbot Xiaoice](#)

Chat with EQ

User A :

I asked Xiaoice to order fast food for me, but she refused and told me "don't eat junk foods it's unhealthy"

Image commenting

	Description: 比萨斜塔 (Pisa tower)
	Comment from Xiaoice: 我要不要帮你扶着? (Should I help you to hold it?)
	Description: 图中有两只猫。 (Two cats in the picture.)
	Comment from Xiaoice: 小眼神太犀利了[大笑] (Eyes are so sharp [LOL])

Avatar Xiaoice



Catalysts

- **Greater access to open-source databases.** Talented but smaller scale AI companies can access open-source networks and build the models without the need to create their own datasets, speeding the development process.
- **The Chinese government support.** Over the next five years, China set a new target to spend > 7% YoY of R&D on innovative technology and builds more national laboratories to research artificial intelligence, providing strong tailwinds for local AI developers.
- **Huge talent pool.** Heeding the call to join the project of national rejuvenation at home, the homecoming computer science graduates and engineers replenish China's AI industry with a rich supply of high-quality talents.

Risks

- **Tightening grip on data protection.** A sizeable dataset is the key to train AI to be smarter. The likely-passed data protection law may hinder data collecting activities for Chinese AI companies and related technology development.
- **Chips shortage.** NLP development requires high-performance computing power (HCP) to perform complex or high-volume computations. Undersupply of HCP chips will drag down the pace of innovation and development.
- **Excessive guidance from the government.** The government's priorities may overpower enterprises', steering the NLP focus from open market commercialization to national security or surveillance.

Bottom Line

- China has become the global leader in AI research thanks to crucial developments in natural language processing and image recognition. With generous funding, massive datasets, and quality talents, China's AI industry is poised to unleash its full economic potential.
- Doubling down on innovation such a AI is the path China has chosen to upgrade to the next level and leapfrog its competitors. Our portfolio is well-positioned to capture the unprecedented opportunities offered by China's AI-based solid development.

Companies mentioned in this article:

Google (GOOGL US), Microsoft (MS US), Open AI (unlisted), Baidu(9888.HK), IFLYTEK(002230.SZ), Xiaoice (unlisted)



GENETIC MEDICINE

OUTSOURCING SERVICES

IN VITRO DIAGNOSTICS

PROTEIN-BASED THERAPEUTICS

ORGANISM-BASED THERAPEUTICS

SMALL MOLECULES

LIFE SCIENCE TOOLS

TISSUE & CELL THERAPY

AI / ANALYTICS SERVICES

COPYCAT DRUGS

Where is the vaccine money going?

The one-minute pitch

Moderna and Pfizer/BioNTech will generate ~\$100bn between 2021 and 2022 from the Covid-19 vaccines. This amount, unprecedented, is solely based on the contracts already signed. Different scenarios are possible going forward, the more likely being the move from a pandemic to an endemic. When (and if) the Covid-19 opportunity will fade away, these companies will have plenty of possibilities to invest their war chest: (1) conducting as many clinical trials as they want and (2) acquire selected targets to complement their research platforms.

WHERE IS THE VACCINE MONEY GOING?

Saving Lives, Changing Companies' Destiny

A world to vaccinate

Seen as part of the solution to navigate through the Covid-19 pandemic with limited damages, Covid-19 vaccines did not wait long to represent a lucrative market. Vaccines based on messenger RNA (mRNA), which turned out to be safer and more efficient than rival inoculations, are among the winners.

- >1bn people will have received one or two mRNA shots in 2021.

Increased interest for mRNA

Covid-19 vaccines pave the way for other therapeutics using the same technology. Spotlights were put on mRNA, and stakeholders are scaling up their effort to find the next cash cow.

- The number of preliminary studies and clinical trials on mRNA is reaching records.
- It took >20 years of development to come with the first mRNA-based treatments – the next ones will come quicker.

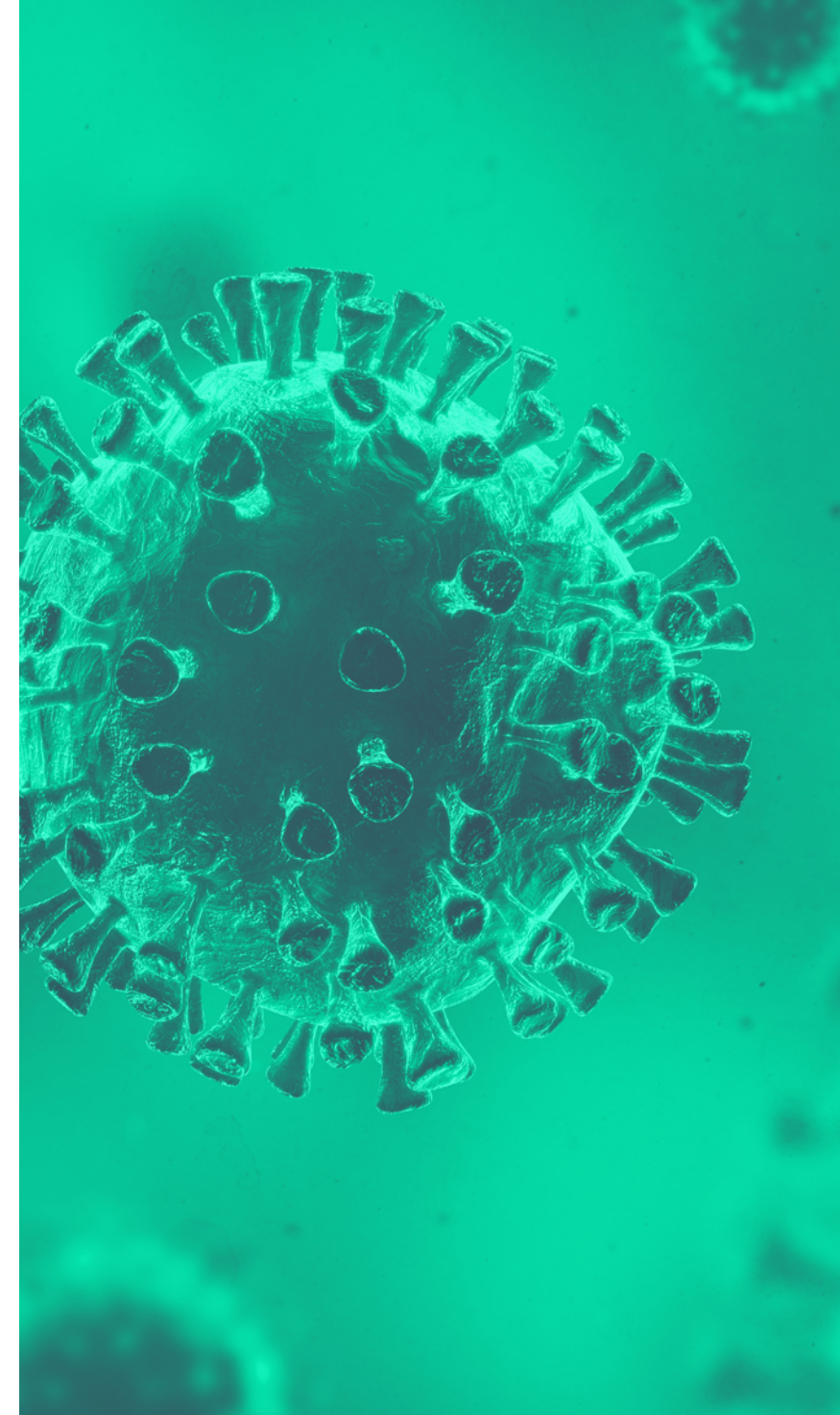
Investing for the future

The cash generated on the Covid-19 vaccines is gigantic, even for a multi-trillion-dollar industry. Moderna and BioNTech will not need to rely on the capital markets to survive anymore. They have enough cash to invest for the future and develop their pipeline – once and if the Covid-19 opportunity fades away.

- Moderna has \$12bn of cash on its balance sheet, BioNTech €0.9bn (but must still receive billions from Pfizer for their collaboration).
- Moderna and Pfizer/BioNTech will generate >\$50bn of free cash flow in the next 18 months.
- M&A in biotech reached \$159bn in 2020 – mRNA vaccine developers have the firepower to impact this market significantly!

SOURCE:

Companies' reports, Ernest & Young, AtonRâ Partners



Foreword About Our Exposure

Exposed to mRNA before the Covid-19 outbreak

Our conviction regarding mRNA technology started before the Covid-19 pandemic. From the beginning, the promises of this technology, such as scalability and filling the gaps of conventional treatments, were promising.

- We initiated a position in Moderna in January 2019, shortly after its IPO (December 2018).
- We held a thematic breakfast on gene therapy in September 2019, referring to Moderna as an investment case.
- In January 2020 already, Moderna was ahead in the race for the mRNA vaccine.

The day mRNA became known by ordinary people

Although Moderna demonstrated its proof of concept on a flu shot back in 2013, the coronavirus propelled the mRNA technology onto center stage. The superiority of this technology compared to traditional vaccines against this threat became apparent; the rest belongs to history.

- Seduced by their Covid-19 exposure and promising oncology pipeline, we initiated our position in BioNTech shortly before the FDA emergency approval.

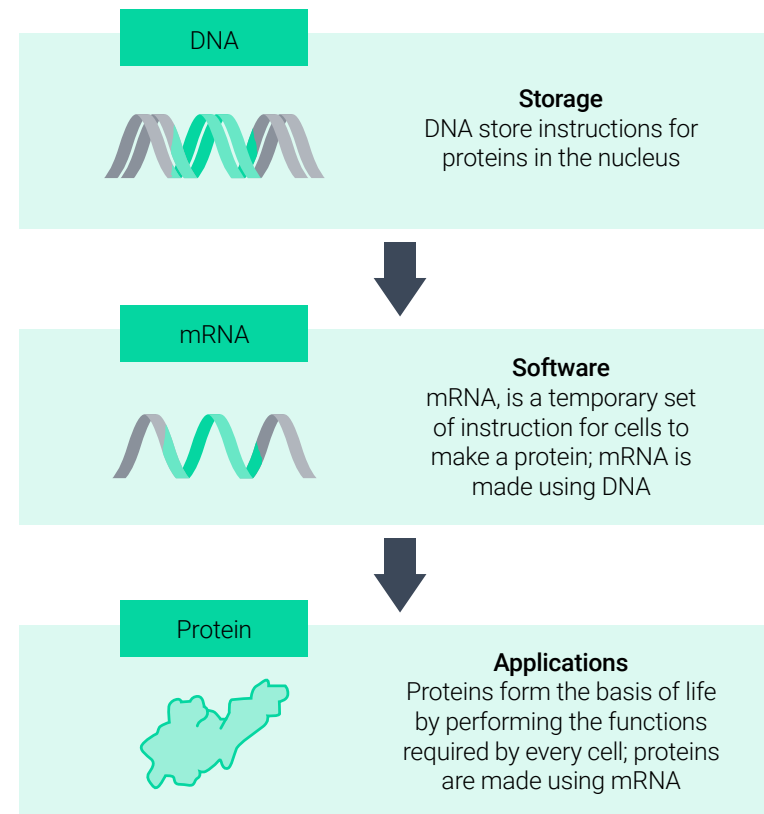
A good story always lasts longer than expected

Both Moderna and BioNTech have had a wild ride since the beginning of the sanitary crisis. We expect the volatility to remain high as long as the Covid-19 outbreak monopolizes the headlines. In the meantime, both stocks may command a premium – and traditional valuation models may be hard to apply.

- 1-year volatility of Moderna and BioNTech is >3x the volatility of the NYSE ARCA Biotechnology Index.

SOURCE:
Refinitiv Eikon, Moderna, AtonRâ Partners

mRNA OVERVIEW



A Money Machine For Drugmakers

From \$0 to \$100bn

Since conditional approvals were announced in late 2020, production capacity has substantially increased. Moderna and Pfizer/BioNTech signed order contracts for billions of doses in 2021 and 2022, representing revenue of ~\$100bn over the period.

- Prices are confidential but depend on the number of doses ordered, the government support during the development phase, and income levels.
- Profitability is substantial as well, with gross margins reaching ~80–85%.
- Different tax rates (~10% for Moderna, ~31% for BioNTech) impact the companies' free cash flows and thus valuation.

Simply the best-selling drug in the world

No other drugs will generate globally as much revenue as mRNA vaccines in 2021 and 2022. In a few months, Moderna and BioNTech moved from startups looking for financing to support their research to behemoths competing with the biggest pharmaceutical companies.

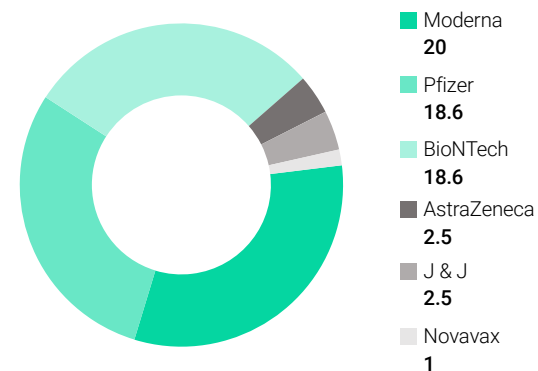
- In 2020, the top-3 best-selling drugs were (1) Humira (AbbVie, \$20bn), (2) Keytruda (Merck, \$14bn), and (3) Eliquis (Bristol-Myers and Pfizer, \$14bn).

Competitors are in no way close

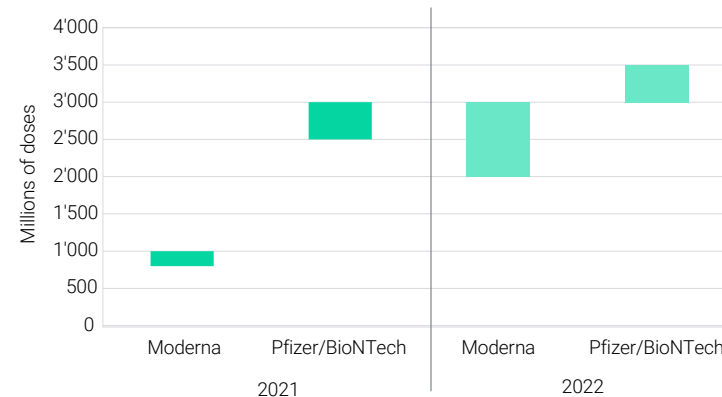
Other Covid-19 vaccines have been approved around the globe, but revenues generated are far from Moderna's or Pfizer/BioNTech's. Despite efficacy questions, especially against variants, other vaccines have been used as geopolitical tools by governments or sold at cost.

- For instance, Johnson & Johnson and AstraZeneca expect vaccine sales of just ~\$2.5bn in 2021.

2021 ESTIMATED REVENUES FROM COVID-19 VACCINES (\$BN)



VACCINE MANUFACTURING CAPACITY



SOURCE:
Companies' reports

Reasons Of A Commercial Success

A quick development

mRNA vaccines reached the market at an unprecedented speed due to the global emergency. Sufficient resources and high virus prevalence allowed to conduct clinical trials in parallel without compromising safety.

- >15 years of strong research on RNA vaccines following the SARS and MERS outbreaks maximized the probability of success.
- Using the genetic instruction of the virus and artificial intelligence, Moderna designed the vaccine in 2 days.
- Moderna's first batch was delivered 42 days after the virus genome sequencing.

Securing the supply chain

Being the first movers, mRNA vaccine developers were able to quickly secure manufacturing capacity for the vaccines and their ingredients. Significant investments have been made to meet the huge demand. Any excess capacity will be used for future mRNA programs as the same facility can be used to make RNA for different diseases, unlike other therapeutics.

- All CMOs, including Lonza, Catalent, Siegfried Holding, Wuxi Biologics, etc., are scaling up and investing in facilities meeting mRNA production needs.

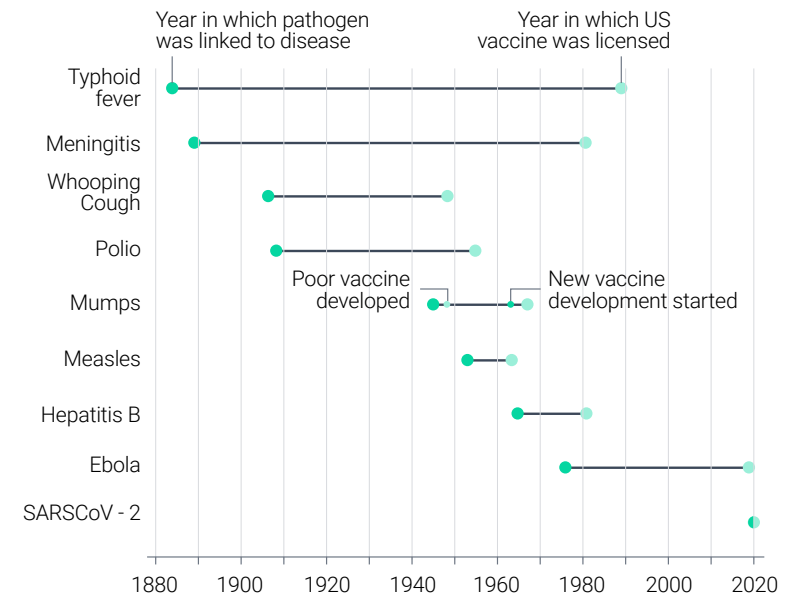
Modularity in case of new variants

The mRNA technology platform has advantages over conventional drugs: (1) the ability to redesign the vaccine quickly to face new variants at a cheap cost, and (2) the production of a multivalent vaccine, i.e., a vaccine protecting against several variants in one dose.

- Batches specifically targeting the Delta variant could be quickly on the shelves but must go through clinical trials first.

SOURCE:
Nature, Companies' reports

DEVELOPMENT TIMEFRAME OF VARIOUS VACCINES



Scenarios For Covid-19 mRNA Vaccines

Base case: From the pandemic to the endemic

The probability is high that the world will have to deal with Covid-19 for longer than expected. Like the flu, Covid-19 could be consistently present, with outbreaks happening in different regions at different periods of the year. The most vulnerable people will need a booster periodically, ensuring a form of recurring revenue.

- There are ~90mn people in the E.U. and ~55mn in the U.S. aged 65+.
- Many countries have signed contracts for millions of doses for 2023 and 2024.

Bear case: Falling vaccines revenue beyond 2023

What used to be the consensus is becoming the bear case scenario. Covid-19 vaccines could fall short of expectations in the future under various possibilities, such as plunging confidence in the technology due to lower efficacy against variants or the discovery of a miracle drug.

- The Delta variant raised concerns about the efficacy of the mRNA vaccines (likely <60% vs. >90% for the other variants).
- Current mRNA vaccines seem to maintain high protection against severe forms of the disease, even against the Delta variant.

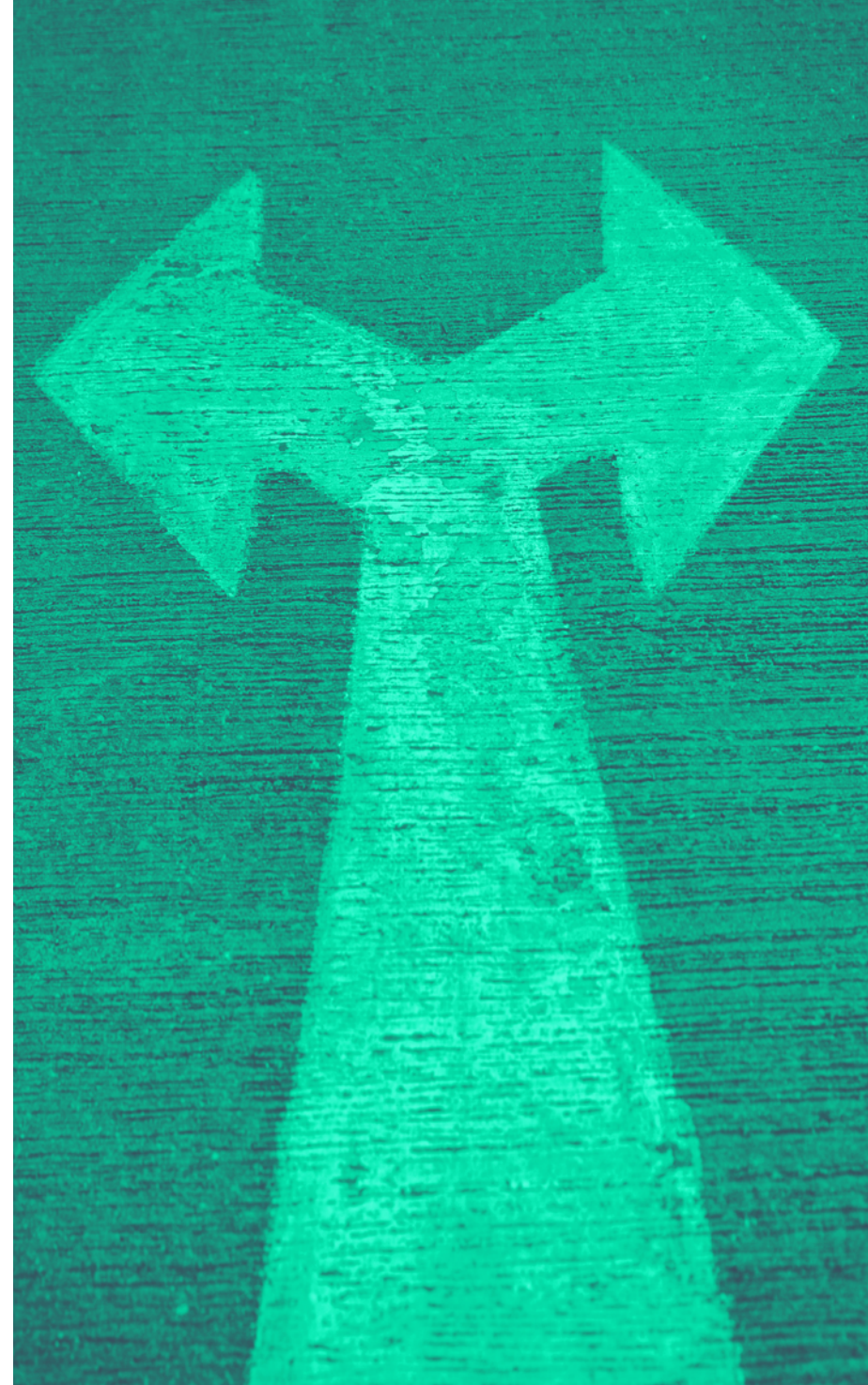
Blue sky: Replacing other Covid-19 vaccines

In the best-case scenario, mRNA vaccines will prove superior compared to other vaccines against any upcoming variants – faster design, easier production, higher efficacy. Governments worldwide will put all their effort into securing mRNA vaccines (and only mRNA vaccines) and convince unvaccinated people.

- China is reviewing mRNA vaccines, despite having its own vaccines.
- 70% of the world population has not received a jab yet, especially in EM countries.
- 2021E revenues would be just the tip of the iceberg in such a scenario.

SOURCE:

United States Census Bureau, Eurostat, Companies' press releases, Our World in Data, AtonRâ Partners



A Game Changer For The Industry

A renewed interest in mRNA

Covid-19 vaccines proved that mRNA-based therapeutics work. The design and the review of future clinical trials in conjunction with the FDA or the EMA will be facilitated. At some point, dozens of mRNA treatments will be approved.

- >50 mRNA candidates are in clinical trials, >200 candidates are in pre-clinical development (probably much more, as companies don't show all their cards).
- The pipeline has tripled within the last two years.

A catch-up race for big pharma and investors

Not all stakeholders have been able to jump on the mRNA train. Big pharmaceutical firms announced significant measures to fill the technological gap, while investors are pouring money hoping to find the next Moderna or BioNTech.

- Vaccine giant Sanofi, distanced in the Covid-19 race, plans to invest €400mn per year in a dedicated mRNA center of excellence for vaccines.
- Moreover, Sanofi is acquiring for \$3.2bn the mRNA firm Translate Bio who focuses on infectious diseases (with Sanofi) and cystic fibrosis, among others.
- In 2020, \$5.2bn was invested in companies developing mRNA therapeutics.

Collected data: A giant leap for vaccinology

Moderna's and Pfizer/BioNTech clinical trials are among the top-10 most extensive studies with experimental agents. The companies have collected volunteers' precious data on demographics and antibody and cellular responses – they have acquired decades of knowledge on human vaccine response in a few months.

- Moderna and Pfizer/BioNTech enrolled 30'420 and 43'988 participants, respectively.

LARGEST CLINICAL TRIALS

Company	Target	Enrolment
Merck & Co	Rotavirus vaccine	69'274
GlaxoSmithKline	Rotavirus vaccine	63'227
Johnson & Johnson	Covid-19 vaccine	60'000
Pfizer/BioNTech	Covid-19 vaccine	43'998
GlaxoSmithKline	Influenza vaccine (abandoned)	43'695
CanSino Biologics	Covid-19 vaccine	40'000
Merck & Co	Shingles vaccines	38'456
Merck & Co	Cholesterol inhibitor (abandoned)	30'449
Moderna	Covid-19 vaccine	30'420
AstraZeneca	Covid-19 vaccine	30'000

SOURCE:
Roots Analysis, ClinicalTrials.gov

Spending Billions Wisely

Freedom to think long-term

Government support was essential in the global research effort on Covid-19. Public help often goes beyond funding for the better (partner through the process) and the worse (controls, priority over other programs). Being cash-rich, Moderna or BioNTech will have the ability to develop therapeutics at their own will.

- Moderna got ~\$2.5bn from the U.S. government in R&D and supply funding.

Vaccines, just the beginning of the journey

Despite the billions of doses injected, mRNA remains a new class of drugs. Most clinical trials of Moderna and BioNTech are still in early phases. The de-risking potential of the platforms after positive announcements is significant. mRNA could offer an advantage over conventional drugs for several diseases.

- However, it will still require a few years to go through all clinical trial phases before having other mRNA-based therapeutics approved.

Increased M&A activity

We expect BioNTech and Moderna to be very active on the M&A scene in the future. Targeted companies will complement in-house research capabilities, extend development programs, or secure manufacturing capacity. Targeted companies will be small biotech with high-tech profiles – not traditional approaches!

- BioNTech acquired in July 2021 Kite, a Gilead subsidiary, for its manufacturing facility and an R&D platform focusing on individualized cancer therapies.
- Moderna expressed interest in nucleic acid technologies (mRNA, gene therapy, gene editing, etc.) and additional investments in AI, IT, and robotics.

SOURCE:
Companies' reports, Pharma Manufacturing



Finding The Next Revenue Stream

Promising pipeline

The current research efforts by Moderna and Pfizer/BioNTech are naturally related to the Covid-19. Short-term opportunities are too big to be missed. But both companies have already announced what will be their primary areas of focus in the future.

- ~50% of the mRNA clinical trials in the world are run by Moderna or BioNTech.

BioNTech: On a mission to individualize cancer medicine

BioNTech came to the Covid-19 vaccine somewhat opportunistically. The company has been focusing on oncology, a juicy market, wanting to bring immunotherapy to the next generation.

- Melanoma, ovarian, breast, or prostate cancers are among BioNTech fields of research, representing potentially billions of dollars of revenue.
- Data on several programs are expected this year; BioNTech is evaluating the design of late-stage studies.

Moderna: Infectious diseases and a new approach against influenza

mRNA flu vaccines could substitute conventional ones, often criticized for their low efficacy. Clinical trials with humans started this year. In the future, Moderna aims to develop a single vaccine against several respiratory diseases (flu, Covid-19, RSV) and launch breakthrough vaccines.

- Current flu vaccines are only 40–60% effective (vs >90% for Covid-19 vaccines).
- The global flu vaccine market is ~\$5bn, growing at a mid-single-digit. The total vaccine market is >\$50bn (excluding to-be-discovered treatments).
- The phase 1 of a clinical trial for a vaccine against HIV started in August 2021.

■ BioNTech ■ Moderna

	Oncology	Infectious Disease	Metabolic disorder/ Other
Pre-clinical	NSCLC 4 Multiple solid tumors	Flu Tuberculosis HIV	4 rare diseases (undisclosed)
		HIV EBV Nipah	Relaxin Autoimmune hepatitis MMA PKU GSD1
Phase I	Melanoma Prostate HPV16+ Head, Neck Triple Neg breast Ovarian (Local) solid tumors		
	KRAS Lymphoma IL-12	Flu RSV hMPV Chikungunya	IL-2 PA
Phase II	1L Melanoma with CPI		
	PCV	Zika CMV	Myocardial ischemia
Phase III			
Commercial		Covid-19	
		Covid-19	

BioNTech has other candidates using other technological platforms than mRNA. They also have other mRNA indications that have not been disclosed yet (pre-clinical stage).

SOURCE:
Companies' reports, WHO, CDC, AtonRā Partners

Catalysts

- **Full FDA approval.** mRNA vaccines by Moderna and Pfizer/BioNTech were granted only an emergency approval in most jurisdictions. The FDA just gave its full approval to Pfizer/BioNTech, which could spur a wave of vaccine mandates in the private sectors as well as schools and universities.
- **Higher prices.** As per the latest contracts for 2022 and beyond, countries are willing to pay more than for the 2021 batches to secure access to mRNA vaccines, given the threat of new variants.
- **Waning immunity.** Getting the proper dosage for the best protection is crucial. Periodic booster shots for older people or people with a weak immune system are being considered, if not recommended yet, in many places.

Risks

- **Patents.** A potential waiver on the Covid-19 vaccine intellectual property has been considered. The debate is highly sensitive and political. The production difficulty of the vaccine represents significant barriers to entry.
- **Substitutes.** The mRNA vaccines will become less essential if a truly efficient treatment is discovered. Moreover, other vaccine candidates are currently pursuing clinical trials (despite delays such as Novavax).
- **Failed clinical trials.** The mRNA technology is novel. Any adverse clinical trial results will reduce the hopes that mRNA can treat diseases for which conventional drugs are ineffective, causing concerns about the post-Covid-19 vaccines business.

Bottom Line

- mRNA vaccines have been so far one of the rare efficient barriers against Covid-19. Moderna and BioNTech have been gathering tens of billions of dollars in their crucial role as vaccine developers. Several signals indicate that the pandemic will not end any time soon, ensuring recurring revenues for Moderna and BioNTech as the immunity seems to wane over time. The cash gathered by the two companies is significant and could be used to reshape the industry in the coming years. The two companies will pursue as many clinical trials as they want and make selected acquisitions reinforcing their technological platforms.
- We maintain our confidence in the mRNA technology and continue to be exposed through its most famous ambassadors in our portfolios.

Companies mentioned in this article:

AstraZeneca (AZN LN), BioNTech (BNTX US), Catalent (CTLT US), Gilead (GILD US), Johnson & Johnson (JNJ US), Lonza (LONN SW), Moderna (MRNA US), Novavax (NVAX US), Pfizer (PFE US), Sanofi (SAN FP), Siegfried Holding (SFZN SW), Translate Bio (TBIO US), Wuxi Biologics (2269 HK)

Macro



Competition in the monetary system

The one-minute pitch

Today most of the money we use is created by commercial banks through a simple accounting entry when they provide credit. A more competitive environment (with Central banks/public banks/tech firms playing a more prominent role in the monetary system) may ensure a more stable economy and simplify lending and payments in the real world.



COMPETITION IN THE MONETARY SYSTEM

The Monetary System

Money – the different sides of the same coin

Our economy stands on one main pillar: one person's spending is another person's income. Spending happens in the form of transactions, the main building blocks of our economy. Money is what we settle a transaction with. It comes with various names and is created through different mechanisms by both commercial and central banks.

- Our economy is the sum of all the transactions in all the markets (total spending).
- While one person's spending is always another person's income, the opposite is not true.

Does money grow on trees?

According to the credit creation theory, commercial banks create scriptural (virtual) money out of thin air by providing credit, a promise to be paid in the future. Central banks are involved in money creation when credit circulates between commercial banks, when people withdraw from their accounts (creation of physical money) and when they buy financial assets (Quantitative Easing).

- Scriptural money is the most important and the most extensive form of purchasing power. Physical money represents only a tiny fraction of our economy.

Credit – the main growth driver

New money stems mainly from a mechanism of credit creation. Commercial banks, by extending credit, generate purchasing power, driving spending. Today, most of our economic growth is financed by money creation rather than increased productivity. A better money allocation directed towards the real economy could restore more sustainable growth.

- Central Banks and tech firms are exploring alternatives to simplifying real economy's lending and payments.

SOURCE:
[Positive Money](#)



What Is Money?

Who says money says trust

Money is simply a tool with no intrinsic value that allows to facilitate exchanging goods, services, and financial assets. It can be whatever we decide it to be, as long as we all agree to recognize it as a payment method. One of the Central Banks' primary roles is influencing its value (purchasing power) to maintain people's faith in the currency.

- Moderated inflation encourages people to spend savings and leverage up as, over time, the debt burden will be reduced. However, with too much inflation, money becomes worthless.

The end of U.S. dollars – gold convertibility

For thousands of years, gold was selected as our measuring stick of value. For most of the period between 1870 and 1971, the U.S. dollar used to be backed by gold (Bretton Woods System 1944–1971). The subsequent economic crisis lead U.S. President Nixon to end dollar convertibility to gold in 1971.

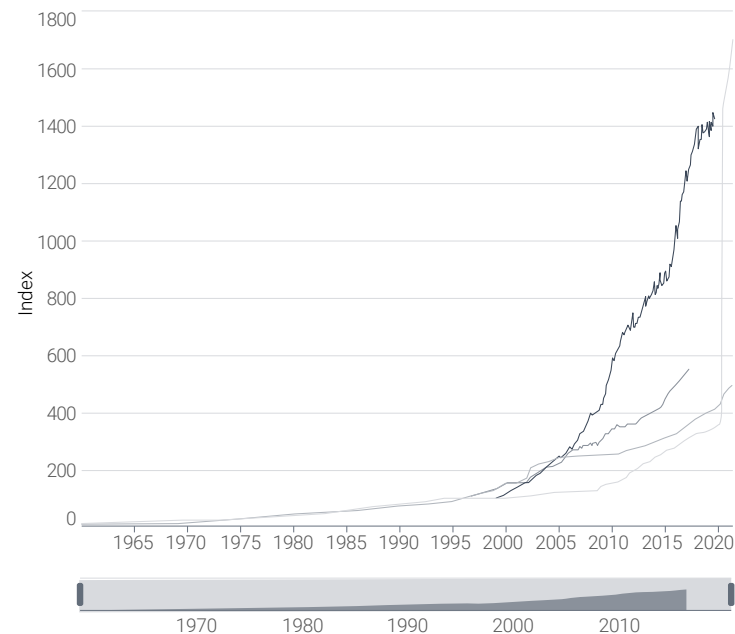
- Since the end of U.S. dollars-gold convertibility, the value of money is only granted by trust (fiat money) and the U.S. dollar is allowed to float freely.

Money creation with no limit

Until 1971, gold was a physical anchor keeping the money supply limited to the size of gold's reserves. The end of it provided far more flexibility for money creation. Three main models describe our monetary and banking system. Two of them include the process of money creation (the process by which money supply increases).

- The total money supply M1 (physical money and deposits in banks) has gradually increased year over year at the global scale.
- Money creation is necessary to follow high growth periods.

SOURCE:
[Credit Creation Theory of Banking](#)



Source: IMF; OECD

- M31 for Euro Area, Jan 1996 = 100
- M1 for the United states, Jan 1996 = 100
- M1 for Japan, Jan 1996 = 100
- M1 for China, Dec 1998 = 100

fred.stlouisfed.org

Three Models For Money Creation

Debt intermediation – deposits make credit

The first model describes commercial banks as intermediaries between those that have savings and those that need financing. Commercial banks use existing money (deposits) to extend credit. Therefore, one person’s income is always another person’s spending.

- This is not representative of the reality because it assumes a steady money supply.

Fractional reserve – money multiplication

Commercial banks are allowed to iteratively use deposits to make credit as long as they respect the reserve ratio (a percentage of deposit required to be kept at the central bank in case of cash withdrawal). This would allow multiplying the total money supply up to a 1/reserve ratio. According to this model, commercial banks are allowed to borrow only money issued by the Central Bank.

- Some banks (e.g., Bank of England) have no minimum reserve requirement set. In March 2020, to stimulate growth, the FED fixed a 0% reserve requirement. With no reserves required, banks can create money with no limit.

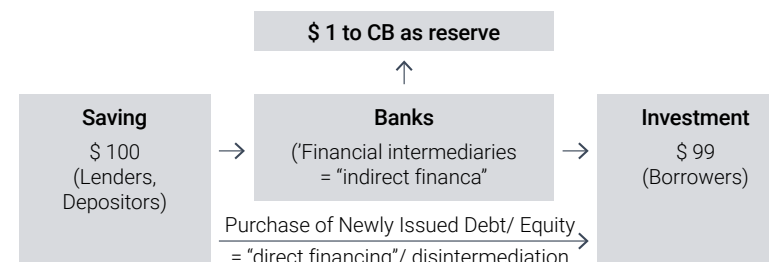
Credit creation – credits make deposits

According to this model, when commercial banks issue a loan, it is not necessarily somebody else’s money; it is brand-new money created virtually out of thin air (scriptural money).

- Commercial banks can also create new money by buying assets, although they rarely do it.
- Commercial banks are not the only lenders of our economy. People’s savings may be invested in the primary bond market. However, this type of credit does not create new money.
- In principle, money can be created at will with no limit; constraints are represented by demand, availability of natural resources, political will, and monetary policies.

SOURCE:
[Science Direct](#)

DEBT INTERMEDIATION THEORY



FRACTIONAL RESERVE THEORY

	Deposit	–	1% Reserve	=	Loanabl Funds
Bank A	\$ 100	–	\$ 1	=	\$ 99.00
Bank B	\$ 99	–	\$ 0.99	=	\$ 98.01
Bank C	\$ 98.01	–	\$ 0.9801	=	\$ 97.0299

	=====	–	=====	=	=====
	Σ \$ 10,000		Σ\$ 100		Σ \$ 9,900.00

What Model Is Real?

Testing the models empirically

An empirical experience (carried on by Richard Werner and published in 2015) demonstrated that credit creation is the model that closest describes reality. Looking at the balance sheet of a commercial bank, he observed that no money existed on the asset side before the loan, yet it appeared when the credit was provided. Scriptural money had been created virtually by a simple accounting entry.

- No deposit existed before the credit, neither the central bank’s money nor the request of money to the central bank.
- Some central banks (Bank of England and Bundesbank) have recently described the process of money creation through this theory.

Money does grow on trees

Empirical experience demonstrated that commercial banks have the power to create money out of thin air, without the need to previously obtain money from central banks or deposits. Commercial banks are responsible for most of the money created today.

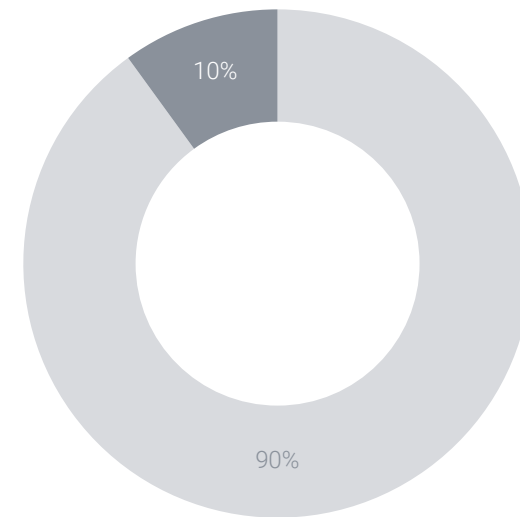
- Scriptural money represents about 90% of the money supply today, while physical central money (issued by Central banks) makes only around 10%.

When do central banks get in the game?

Central banks create money when credit circulates between commercial banks (central bank deposits) and when commercial banks are required to deliver physical money to clients (in case of withdrawal).

- Commercial banks receive central money (electronic) as collateral during bank-to-banks transfers.
- When bank A transfers money to bank B, probably bank B is simultaneously transferring money to bank A. Central Banks only create the difference.

TOTAL MONEY SUPPLY



SOURCE: [Science Direct, Money in the modern economy: an introduction, Money creation in the modern economy, The role of banks, non-banks and the central bank in the money creation process](#)

The Role Of Central Banks

Price stabilizers

Central Banks influence the total money supply by setting requirements, changing interest rates, and printing new money. They aim to stabilize prices and avoid massive devaluations.

- When spending rises faster than productivity, prices rise. Since one person's spending is another person's income, income increases, causing more spending and inflation in a self-reinforcing pattern.
- To avoid this situation, Central Banks aim to maintain inflation at around 2%.

The minimum reserve ratio

Central Banks use several tools to manage the money supply. One of them is the minimum reserve ratio. This ratio sets an upper limit for credit, allowing commercial banks to increase the money supply to a 1/reserve ratio. A low reserve requirement allows banks to borrow more.

- Some central banks do not set any reserve ratio.
- Commercial banks may also decide to hold a higher than required reserve ratio.

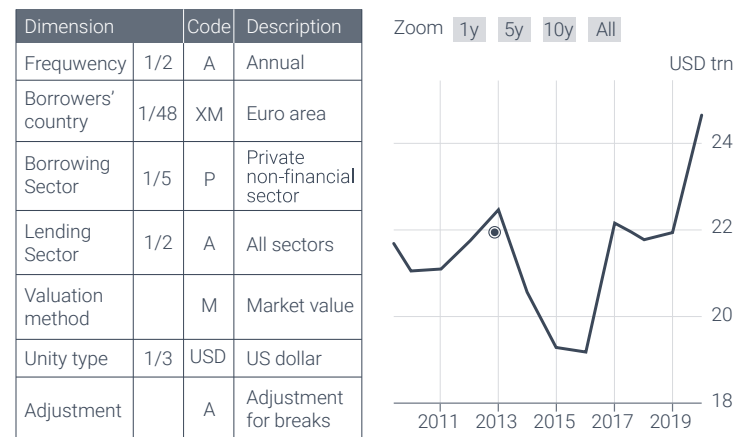
Interest rates

Commercial Banks pay interest rates on reserves held at the central bank accounts (central money). This sets the minimum level of interest rate at which commercial banks are willing to lend money. If Central Banks want commercial banks to lend more (or less), they lower (or increase) interest rates. This tool allows Central Banks to stimulate (hamper) spending.

- When the private sector doesn't want to go into debt, lowering the interest rates is not an effective tool to stimulate the economy. In this case, Central Banks may resort to other tools such as Quantitative Easing (QE).

SOURCE:
[European Central Bank](#), [BIS](#)

FRACTIONAL RESERVE THEORY



KEY ECB RATE/ EUROZONE



Source: European Central Bank | Chart: www.cbrates.com | without guarantee

The Extra Tools Of Central Banks

Quantitative Easing (QE) to the rescue

As we wrote in April, QE is a policy allowing Central Banks to buy financial assets (such as Government bonds) in the secondary market to lower yields and eventually inject money into the real economy.

- Central Banks direct this money to investment firms and corporations.
- Interest rates on newly issued bonds decrease, reducing payment burden.
- Governments pay interests to the Central Banks for the acquired Government bonds. Those profits are redistributed to Central Banks' main shareholders, which may include the Government itself.

Writing off Government debt: the real magic money

Technically and legally, Central Banks can write off Government debt (Central Banks cannot go bankrupt). However, this may have significant consequences for the economy.

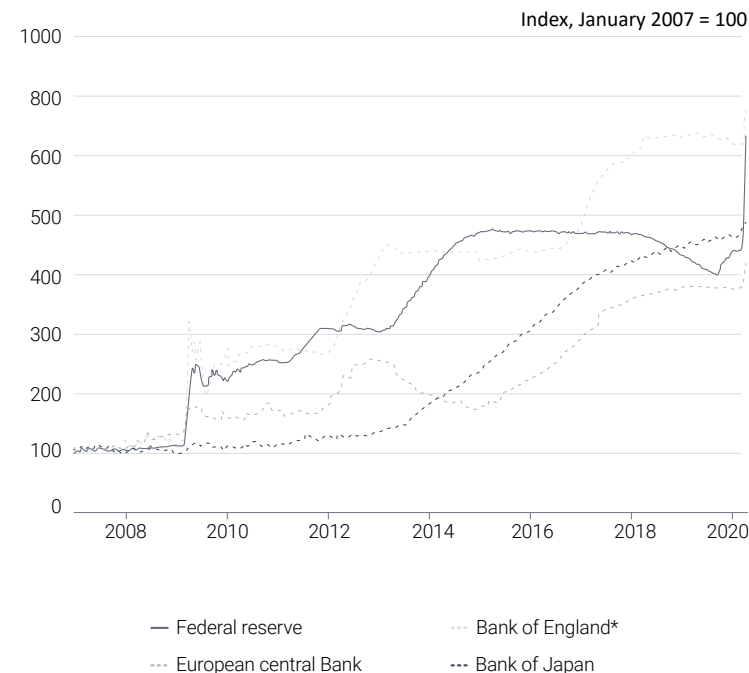
- By writing off the debt, money from QE, previously "attached" to a financial asset, becomes "free". Central banks would lose their ability to withdraw this money from the economy by selling the financial assets.

When QE misses the target

QE aims to stimulate the economy. However, this outcome is not guaranteed. When Governments set policies to cut spending, or companies and households don't want to increase their debt burden, or corporations don't choose productive investments, or investment firms don't target the primary market, money injected through QE never reaches the real economy – it only fuels the secondary market.

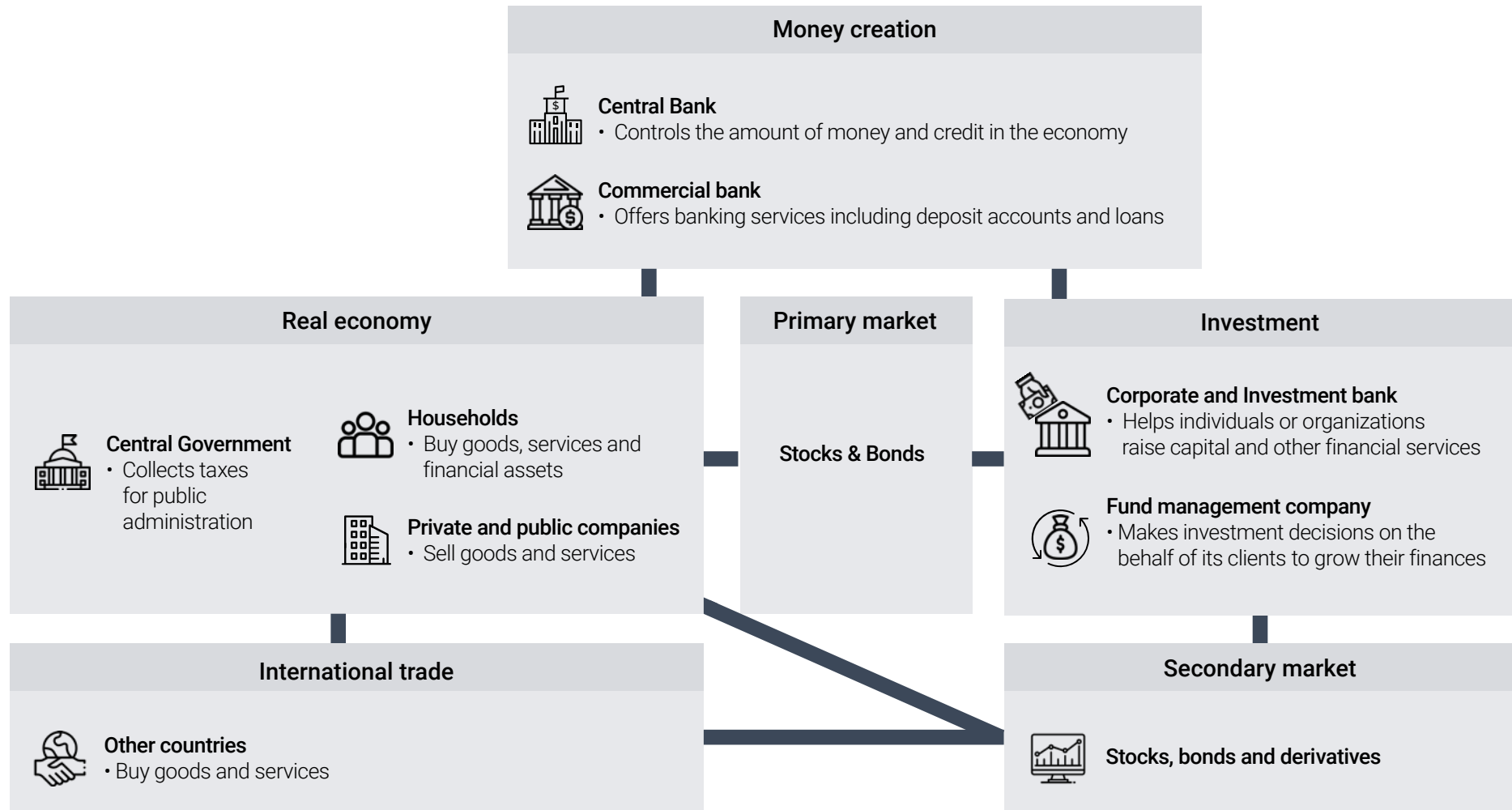
- The "helicopter money" policy, on the contrary, should allow central banks to distribute cash directly to individuals,
- Since the subprime crisis in 2008, Central Banks regularly use the QE.

CENTRAL BANK ASSETS



*As of October 2014, Bank of England series is sum of consolidated statement assets.

How Does Money Circulate In Our Economy?



Consequences

More money, more credit, more growth

Since 2008, most of the growth today is financed by money creation (credit). Since money is created out of thin air, when paid back, it disappears, driving down growth. For a debt-dependent economy to grow, in the long run, new money should exceed credit reimbursement.

- Since 2008, money supply has been growing faster than GDP.
- Money creation (by credit or QE) does not necessarily lead to inflation (in the real economy).

Good debt – supporting the real economy

Inadequate allocation of money leads to speculative bubbles and financial crises. Money should instead be used for productive investments. Some economic crises (especially demand shocks) could be better managed by allowing money to reach the real economy efficiently.

- Some argue that money creation should become a public service by giving public banks the role of ensuring lending to support enterprises and job creation.

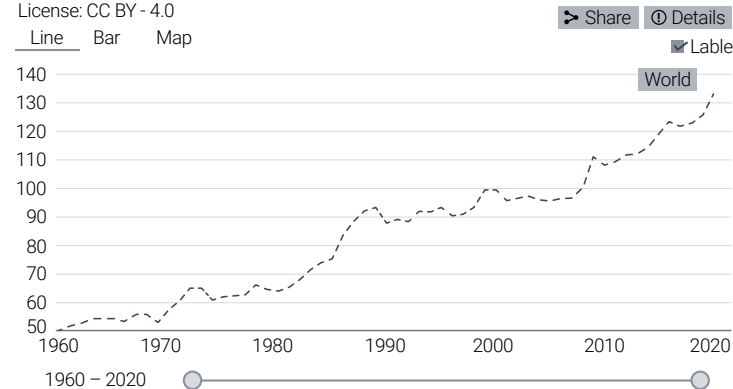
Exploring new alternatives

A more competitive environment, with Central banks/public banks/tech firms playing a more prominent role in ensuring an efficient allocation of money, may provide a more stable economy by simplifying lending and payments for the real economy.

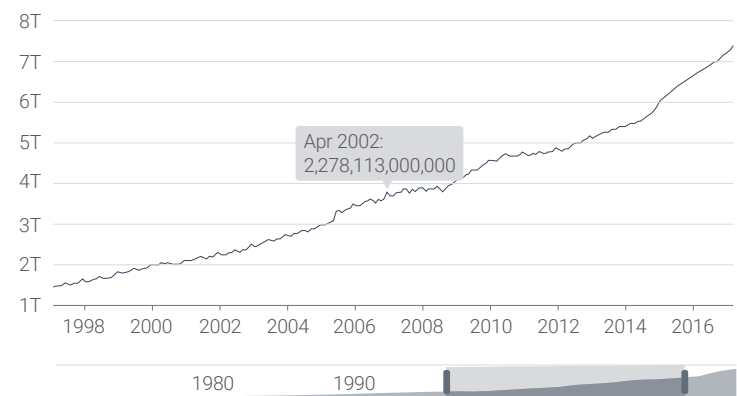
- Fintech firms are getting involved in providing more user-friendly ways of handling money and payments (e.g., peers-to-peers lending).
- Central Banks are exploring whether a central bank digital currency (CBDC) could be an effective alternative to scriptural money.
- CBDC may be more efficiently redirected to the intended economic target, liberate money from commercial banks' risk of bankruptcy and allow fintech firms to open accounts directly at the Central Bank, reducing transaction costs.

Board money(% of GDP)

International Monetary Fund, International Financial Statistics and data files, and World Bank and OECD GDP estimates
License: CC BY - 4.0



M1 IN EURO ZONE



Source: International Monetary Fund

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Catalysts

- **Covid pandemic.** The coronavirus crisis has shown up structural issues in our monetary and banking system (e.g., QE has served as a poor tool to stimulate the economy), spurring efforts to innovate.
- **Central digital bank currencies.** CBDC would allow storing money and sending and receiving payments without a bank account, liberating the money from commercial banks' risk of bankruptcy. CBDC would also enable fintech firms to open accounts directly at the Central Bank, reducing transaction costs.
- **Tech firms.** Tech firms are getting involved in providing more user-friendly ways of handling money and payments. Peer-to-peer lenders are starting to take away some of the banks' loan-making business.

Risks

- **High barriers to entry.** The current regulatory framework represents a high barrier to entry that protects banks from innovative competitors.
- **Uncompetitive transaction costs.** Tech firms still rely on commercial banks (opening accounts to protect people's funds), which decide how much they pay for each transaction.
- **Disinformation and trust.** Building trust is an essential element to ensure the establishment of new payment systems. Disinformation can hamper adoption.

Bottom Line

- Commercial banks create new money out of nothing when they provide credits. Central banks create money to support commercial banks' role in this process and influence how much money they can lend. Since 2008, most of the economic growth is financed by money creation (credit). For a debt-dependent economy to grow, new money (credit) should exceed debt reimbursement in the long run. Inadequate allocation of credit could lead to speculative bubbles and financial crises.
- A more competitive environment is shaping up, with Central banks/public banks/tech firms leveraging innovation and technology to ensure more efficient transfers to the real economy. Simplified lending and more efficient payment and money transfer mechanisms may contribute to providing a more stable economy.

Security and Space



TESTING, INSPECTION & CERTIFICATION

CYBERSECURITY

SPACE INFRASTRUCTURE

PEOPLE, BUILDINGS & GOODS SECURITY

EQUIPMENT AND SERVICES

COMMERCIAL SPACE

SPACE APPLICATIONS

Safer food for a healthier future

The one-minute pitch

Food safety is a cornerstone to our most basic physiological needs, the consumption of non-harmful nutrition. Often taken for granted, keeping a safe supply chain requires efforts mitigating productivity, safety, and distance. A globalized economy makes these efforts even more significant. Implementing disruptive technologies from other fields such as blockchain and gene-editing provides opportunities in a sector that is a public health priority.

SAFER FOOD FOR A HEALTHIER FUTURE

Trusting Your Food

A complex supply chain causing health scandals

The food value chain represents an \$8.1 bn industry with various stakeholders: producers, processors, distributors, and regulators. Aggregated ingredients travel an average of 40,000 miles, often resulting in a lack of visibility and traceability.

- In Europe, the horsemeat scandal in 2013 revealed the complexity and opacity of the supply and processing channels.
- Over three years (2015–2018), Chipotle, the fast-food burrito chain, reported E. Coli and norovirus contaminations resulting in the temporary closure of all its restaurants.

A human and financial cost

Unsafe food (bacteria, viruses, parasites, or chemical substances) is causing more than 200 diseases worldwide, leading to high human and financial costs.

- 600 million people are sickened each year after consuming contaminated food, causing 20,000 deaths per year, including 3,000 in the United States.
- In the U.S., there is a 1% chance of a food incident to occur, resulting in an estimated average cost of \$55bn per year (including loss of reputation, potential lawsuits cost, decreased sales, medical treatment, and inventory loss).

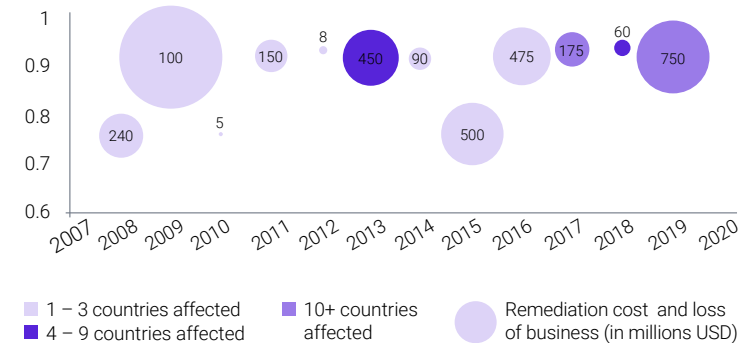
Tech and biological solutions

Advanced biotech tools with better pathogens detection improve food safety, while tech advances ensure better traceability throughout the supply chain.

- IoT, blockchain tools are being adopted to monitor food products from farm to plate.
- Agricultural biotech tools such as gene editing can considerably reduce the need for pesticides, antibiotics, and other chemicals.

SOURCE:
[Food Safety, QSR](#)

MAJOR FOOD SAFETY INCIDENTS HAPPEN NEARLY EVERY YEAR AND AREN'T LIMITED TO UNDERDEVELOPED COUNTRIES



- | | |
|--|--|
| 2008 – Milk scandal, China | 2014 – McDonald's meat scandal, Asia |
| 2009 – Peanut utter candal, USA | 2015 – Rotten frozen meat, China |
| 2010 – Contaminated green beans scandal, China | 2016 – Chipotle foodborne illness, USA |
| 2011 – Listeriosis outbreak, USA | 2017 – Fipronil egg scandal, Europe and Asia |
| 2012 – Salmonella outbreak, Netherlands | 2018 – Listeria outbreak, Australia |
| 2013 – Horsemeat scandal, Europe | 2019 – Salmonella---fected chickens, Brasil |

Food's Supply Chain: The Industry's Achilles Heel

A long journey to our plates

In the US, raw food and ingredients are estimated to travel 1'500 miles from source to plate. Identifying risks in the supply chain takes days, if not weeks, as companies struggle with traceability.

- In 2019, there were an estimated 350 major food recalls in the US, with an average cost per incident reaching \$30mn, presenting significant financial risk.
- Recent Issues with product traceability and food safety are leading regulatory agencies to demand new practices and modern technologies.

Food fraud

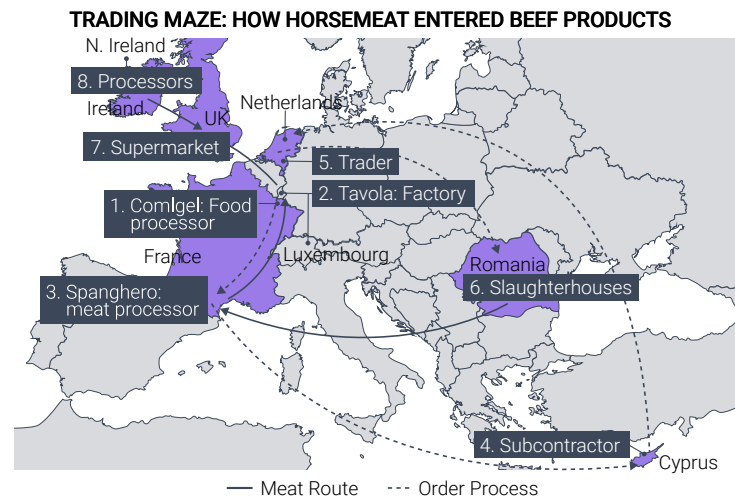
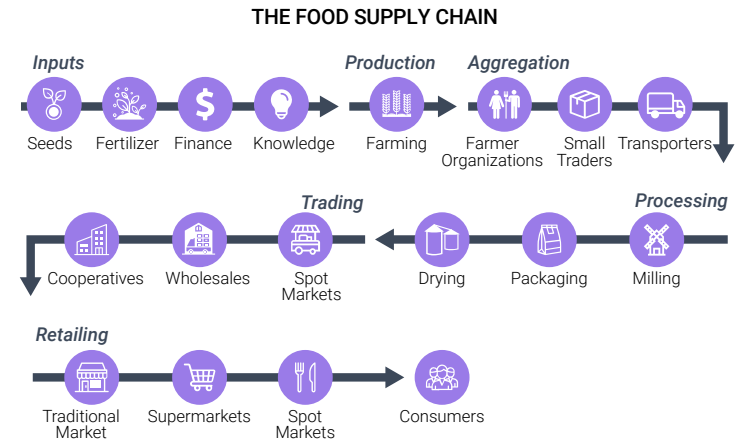
Food fraud refers to altering, misrepresenting, or tampering with a food product along the farm-to-table value chain. Food fraud is a lucrative business worth \$50bn annually.

- The UK horsemeat scandal in 2013, one of the largest food frauds in recent years, was caused by criminal activity spanning the European continent.
- Fraudulent meat could pose a significant health risk: horses' euthanasia often involves injecting toxins dangerous for humans.

Covid impact

The Covid-19 pandemic presented numerous challenges from a food safety point of view that could have long-term implications on this domain.

- While coronaviruses are generally thought to spread from person to person, suppliers were obliged to adopt rigorous disinfection measures to assure virus clearance from food products.
- Food shortages during the heat of the pandemic have accelerated the local sourcing trend, emphasizing local sustainability.



SOURCE:
[FDA source labeling](#)

When Food Can Make You Sick

Foodborne illnesses

Food-related illnesses can usually be infectious or toxic and may have wide-ranging health implications. They are typically caused by bacteria, viruses, parasites, or chemical substances, and their effects span from simple infections to cancer.

- The World Health Organization determined that 420,000 deaths were associated with foodborne diseases (mostly in developing countries).
- The World Bank estimated at 15bn the annual cost of treating foodborne illnesses.

Zoonotic diseases are a scare

An infectious disease that “jumped” from animals to humans is called Zoonosis. Pathogens usually are bacterial, viral, or parasitic and can be transmissible through food.

- HIV began as a Zoonosis but later mutated into a human-only strain.
- A dominant theory regarding the Covid-19 pandemic origins is that the novel coronavirus jumped to humans within the Wuhan wet market.

We are what we eat (antibiotics)

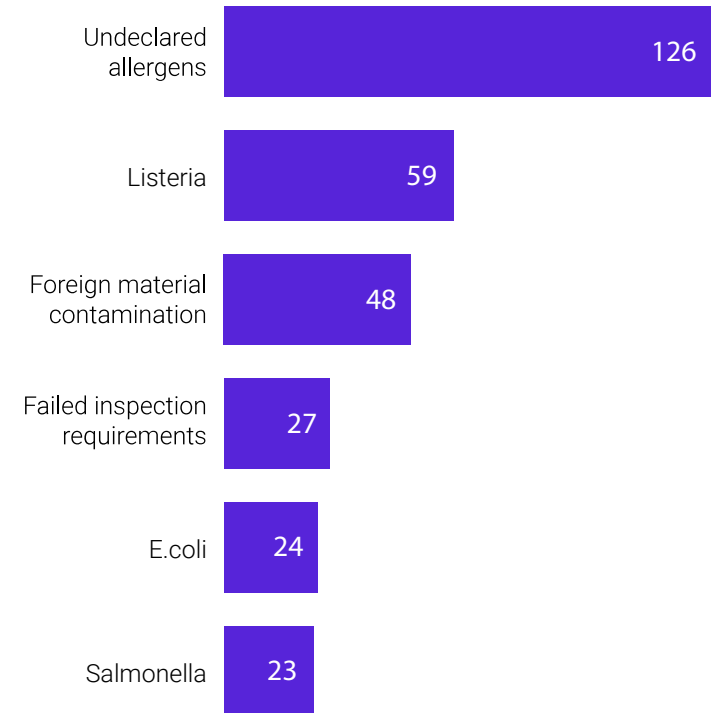
The treatment of infectious diseases has been revolutionized by antibiotics. But their excessive use, especially in farming, has led to the development and spread of antibiotic resistance. Antibiotic use in intensive animal farming allows resistant bacteria to spread to humans through the food chain.

- Antimicrobial resistance is considered an urgent public health threat.
- The CDC estimates antimicrobial resistance annual costs at \$55bn.

SOURCE:
[WHO report](#)

WHY FOODS ARE BEING RECALLED

Most common causes for food recalls in the U.S. in 2019



Major recalls listed on USDA, FDA websites only

Source USDA, FDA



Tech And (Bio)Tech Solutions

Gene editing becoming a widespread practice

The gene-editing capabilities of CRISPR technology in crops resulted in a boom in the study and production of genetically modified food, potentially disruptive for food safety.

- Agri-focused gene-editing companies have raised close to \$1bn in funding over the past two years.
- The plant breeding and gene editing segment is expected to grow at a CAGR of 20%, from \$7.5bn in 2018 to \$14.5bn in 2023.

Pathogen detection and agricultural biotech

Diagnostics plays an essential role in identifying food safety threats. It included traditional methods such as culture, immunoassays, and genetic-based platforms.

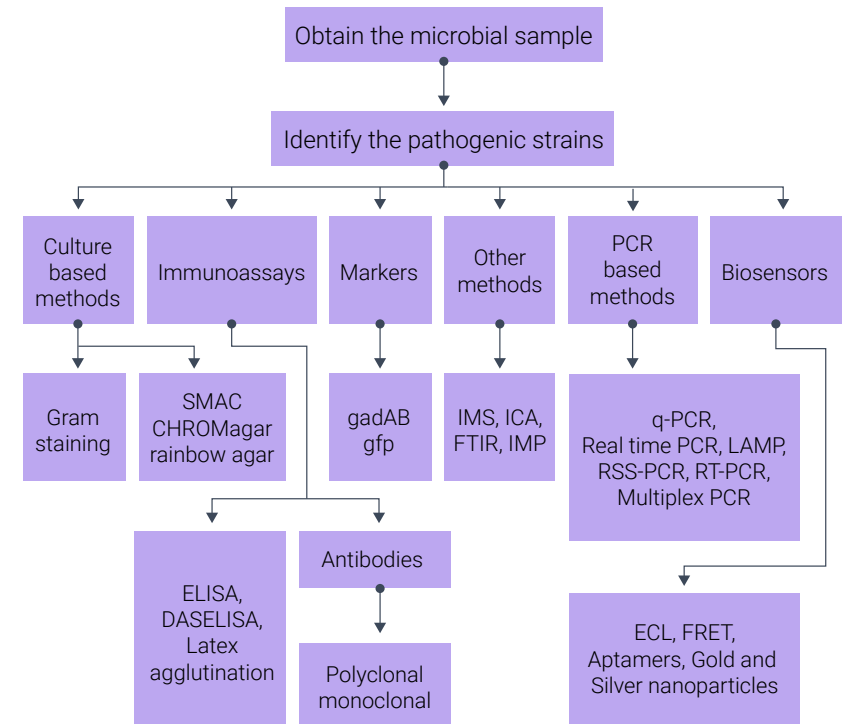
- The agricultural testing market is estimated to reach \$6.3bn in 2022, growing at a 6.6% CAGR.
- Thermo Fisher launched the SureTect PCR Assays enabling rapid and accurate detection of foodborne pathogens such as salmonella and E.coli.

Tech-enabled traceability tool

Blockchain, IoT devices, and non-invasive sensing technologies are implemented to ensure rapid traceability within the food supply chain. Complete location of any food item and related information such as test data or temperature can be available in seconds.

- Walmart, Nestle, Unilever are working with IBM Food Trust, the first blockchain food safety solution.
- The market of IoT and traceability for food & beverage manufacturing is expected to grow from \$4.1bn in 2017 to \$8.4bn by 2027 at a CAGR of 9.5%.

DETECTION OF FOODBORNE PATHOGENS



SOURCE: [Agriculture Testing](#)

Catalysts

- **Regulation.** The FDA has already begun adopting a transformative regulatory framework. Food safety technologies are crucial to user protection and regulatory compliance.
- **Broad tech adoption.** Disruptive technologies such as Blockchain and CRISPR are making their way into the space, and their broad adoption could help accelerate the sector's growth.
- **Financing.** Food safety start-ups are getting backing from globally leading VC investors, suggesting increasing interest in the space. Further growth and capital market support could support expansion.

Risks

- **Local consumption.** Adoption on a large scale of local consumption could incrementally reduce the opportunities in traceability and diagnostics.
- **Safety.** A safety incident relating to genetically modified grains and food products could lead to higher regulatory and public scrutiny.
- **Concentration.** The food safety industry could get further dominated by food and healthcare conglomerates, which could hinder innovation and increase the barriers to entry into the field.

Bottom Line

- Food safety has broad implications on our everyday life, and risks associated with areas such as Zoonotic diseases, bacterial resistance, and food contamination are expected to gain broader attention. Technology and innovation will continue to drive advancements in the space; from modified crops to real-time diagnostics techniques and blockchain empowered traceability tools, this space is ripe for long-awaited disruption.
- The food safety space is currently dominated by large technology, agriculture, and healthcare players, offering little opportunity for a pure-play exposure. But recent innovation and favorable financing are setting the stage for the emergence of pure-players that we will monitor as possible future candidates for our portfolio.

Companies mentioned in this article:

IBM (IBM US), NESTLE (NESB CH), Thermo Fisher (TMO US), Unilever (ULVR LN), Walmart (WMT US)

Sustainable Future



CLEAN TRANSPORTATION

SMART BUILDING

ENERGY STORAGE

SMART GRID

FOOD & AGRICULTURE

SOLAR

WIND

HYDROGEN

WATER

Decarbonizing transportation

The one-minute pitch

The impact of carbon emissions on climate change is now a widely accepted fact. Due to its significant participation in generating greenhouse gases and its central place in modern societies, transportation has a pivotal role in cutting global emissions. Stricter regulation and shifting public opinion have spurred innovation and created business opportunities, but change will come at different speeds depending on the modes of transportation.

DECARBONIZING TRANSPORTATION

Hoping To Avoid A Highway To Hell

When humankind literally reaps the whirlwind

Steadily rising temperatures and higher occurrence of extreme climatic events have finally led to a broad acceptance of the responsibility of human activities in climate change. Governments are now rushing to prevent too drastic impacts on populations.

- According to the latest IPCC report, massive immediate action is required to limit temperature rise to 2°C by the end of the century.
- Such an increase would still mean reaching critical tolerance thresholds.

Transportation is a crucial part of the problem

Transportation accounts for a large part of carbon emissions due to its reliance on fossil fuel and its footprint in modern societies. Both regulation and public opinions are now converging to curb its impact.

- Transportation accounts for >20% of CO2 emissions.
- Public opinion has become more ecologically conscious, turning towards electric vehicles and sowing some signs of defiance over aerial transportation.

Various stages of progress

Not all means of transportation are showing the same progress towards zero-emission due to physical and practical reasons. However, the most significant sources of emissions among transportation methods, notably cars and trucks, show the most straightforward technological pathway towards decarbonization.

- Terrestrial transportation has started its shift, with a consensus progressively crystallizing around batteries.
- The road appears longer for aviation and shipping.

SOURCE:
[IPCC](#)



Carbon Is Getting Mankind Carbonized

Humanity is destroying its cradle

The link between human activity and global warming is now irrefutable, with the root cause being carbon emissions. Consequences are countless, among which ever-growing temperatures and a higher occurrence of catastrophic climatic events.

- The 2010s have been the warmest decade ever recorded, with 2016, 2019, and 2020 being the three warmest years.
- This temperature increase is correlated with a record carbon concentration in the atmosphere compared to the pre-industrial era.

Life and lifestyle threatened

Wildfires, heatwaves, hurricanes, sea level rises will take a heavy human toll. Their impact on ecosystems will also bring further danger to daily lives by disrupting natural processes essential to our food supply, potentially leading to drastic habit changes.

- Agriculture yields could be negatively impacted by 30% by 2050.
- Sea level rose by 9cm since 1993, threatening ~600mn people in coastal areas.

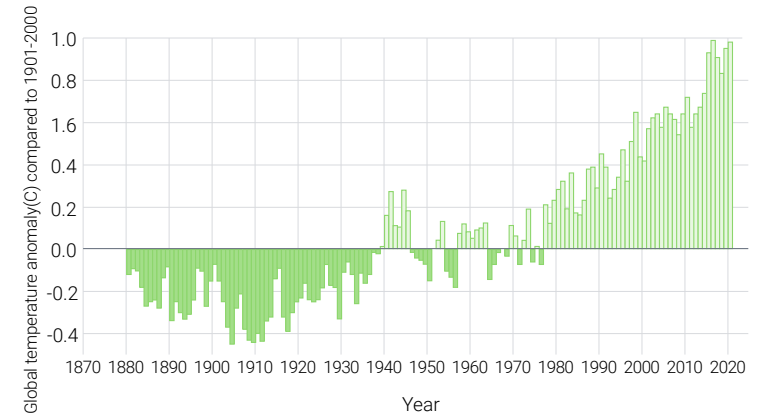
A major economic impact

Climate change also has a substantial economic cost: direct costs linked to the consequences of climate catastrophes, indirect for the measures implemented to anticipate and mitigate their effects, and finally, those yet unaccounted by models.

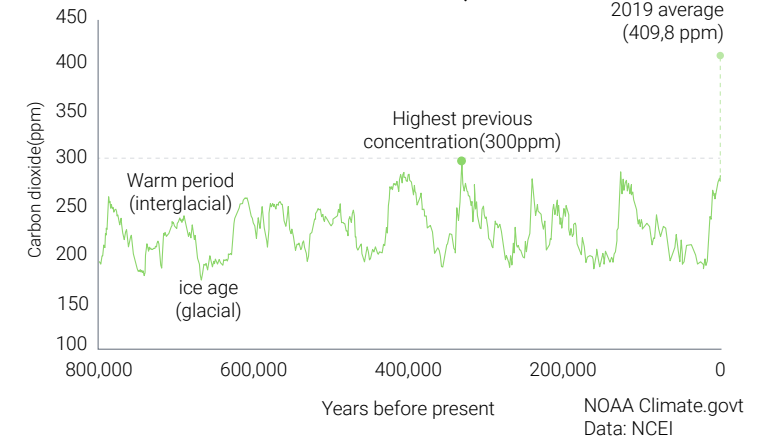
- The 2010s have witnessed a 50% surge in natural disasters costs compared to the previous decade.
- The impact on the economy has been estimated at \$23tn by 2050 if nothing is done, corresponding to ~18% of global GDP.

SOURCE:
[Nasa](#), [Swiss Re](#), [Kearney](#)

HISTORY OF GLOBAL SURFACE TEMPERATURE SINCE 1880



CARBON DIOXIDE OVER 800,000 YEARS



Transportation Is A Key Piece Of The Puzzle

A major source of emissions

Transportation is a significant source of CO2 emission due to the importance of human and goods exchanges. It also has the particularity of being at the center of modern life, defining infrastructure and enabling many aspects of the Western lifestyle.

- Transportation directly accounts for 16% of greenhouse gases emissions and 23% of CO2 emissions, and 30% of global final energy use with a low rate of efficiency (~32%).

Shifting dynamics

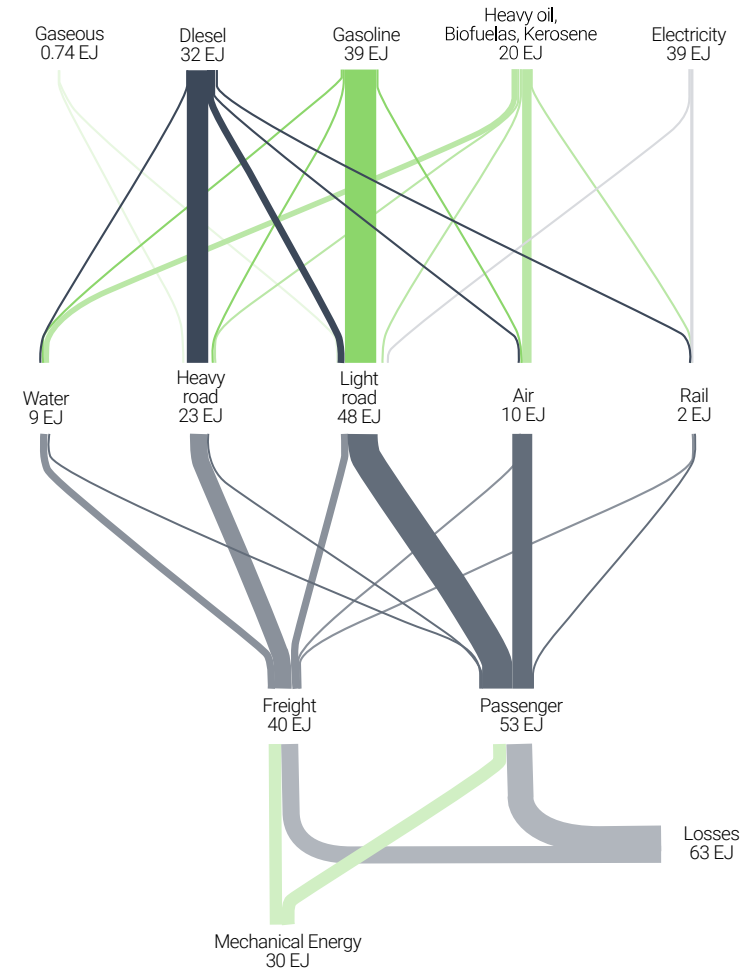
After years of indifference, public opinion is progressively awakening and pressuring governments to act. Regulation is therefore increasingly tightening in favor of low-emission technologies, especially as economics are becoming more favorable.

- Movements such as “flight shame” are popping up and gaining popularity.
- The EU wants to ban the sales of combustion-engine cars by 2035.

Technology creates opportunities

Technology has now improved enough for some neutral-emission transportation being today possible, or even advantageous. Demand for clean mobility is rapidly growing, and additional business opportunities are offered by regulation.

- Electric vehicles should become cost-competitive by the end of the decade.
- Europe has witnessed a 2016–20 CAGR of 60% for electric vehicles.
- Tesla has generated \$1.4bn of revenues in 2020 thanks to unused carbon credits.



SOURCE:
[OurWorldInData](#), [IEA](#), [Reuters](#)

Land Transport: Full Speed Towards Batteries

What's the situation?

Terrestrial transportation accounts for a significant share of transportation emissions. Passenger cars and trucks take the lion's share within this segment, while rail is almost non-existent, highlighting deeply entrenched societal characteristics and divergent technological solutions.

- Terrestrial transportation accounts for ~77% of global transportation emissions.
- Passenger cars and trucking account for >60%, vs. less than 3% for rail.

What can be done?

Due to its importance, zero-emission technology for terrestrial transportation is well advanced with a broad range of solutions depending on the application needed, including biofuels, hybridization, batteries, and hydrogen.

- Batteries have the advantage of a certain level of technological maturity and compatibility with existing infrastructures.
- Price parity with combustion engines is expected by the second half of the 2020s.

Is it investible?

Today, some players are well established when it comes to electric vehicles (EVs), both on the production and supply-chain side, while traditional car OEMs are also accelerating their transition. Hydrogen remains not mature enough, plagued by production concerns and a longer-term bet probably restricted to trucking.

- Prominent EV OEMs include Tesla and Nio, but nearly all traditional OEMs are rushing to roll out EV platforms, albeit at varying stages of progress.
- Battery makers such as CATL benefit from even stronger perspectives as their technology is both the industry's cornerstone and in limited supply.

SOURCE:
[IEA, Bloomberg](#)



Aviation Struggling To Take-Off

What's the situation?

Aviation accounts for a relatively minor part of global emissions. However, planes are particularly energy-intensive to use, especially when it comes to freight, while passenger transportation is better optimized.

- Aviation accounts for ~12% of global transportation emissions.
- Short-haul cargo emits up to ~2,9kg of CO₂ per km per ton transported, ~50x as much as diesel freight trains.

What can be done?

Due to the law of physics, planes need to be as light as possible, requiring high-density fuels. This rules out current batteries, even accounting for electric motor efficiencies, leaving biofuels and hydrogen as existing only viable solutions.

- Fossil fuels have an energy density >100x higher than lithium-ion batteries, which, unlike fuel tanks, do not lose weight along with flight.
- Aviation will likely be the last stronghold of combustion engines – but this does not mean fuels have to be of fossil origin as new sustainable biofuels are developed.

Is it investible?

Like land transportation, hydrogen remains at a very early stage in major plane makers' and motorists' design offices. Biofuels, however, are already entering on some commercial routes blended with traditional jet fuel.

- Players such as Neste, Gevo, or Eni have established positions, but biofuel's share remains marginal, with an expected penetration rate of 10% in 2040.
- Airbus does not expect its hydrogen aircraft to be commercially available before 2035, and the problem of sustainable hydrogen production has yet to be solved.

SOURCE:
[IPCC](#)



Shipping Turns Towards Optimization

What's the situation?

Despite its importance in international trade, shipping accounts for a minor part of carbon emissions and can boast a relatively high efficiency. However, sulfur emissions constitute a significant source of environmental concern.

- Shipping accounts for ~11% of global transportation emissions.
- While container ships are as efficient as electric freight trains in CO2 equivalent, heavy fuels contain 0.5% of sulfur (3.5% before 2020) vs. <0.001% for cars.

What can be done?

Most promising shipping emission reduction is mainly based on optimizing designs and operating processes, as well as on the use of biofuels. Non-carbon emissions are tackled through particulates removers called scrubbers.

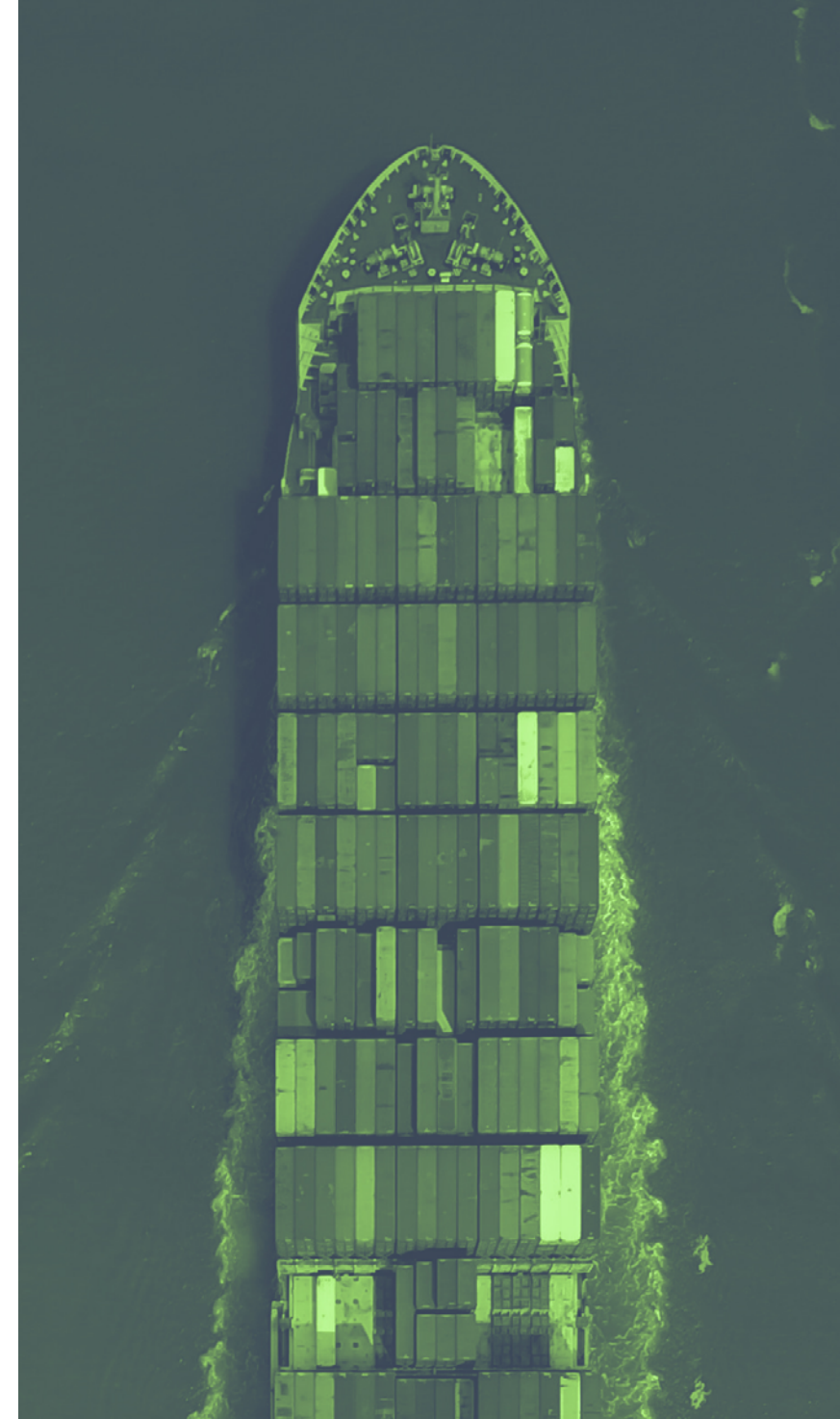
- Alternative fuels such as LNG offer lower carbon emissions and are compatible with existing infrastructure.
- Slow steaming, i.e., cutting speeds by 25%, results in ~60% fuel savings.
- Scrubbers have the advantage of being retrofittable on existing ships.

Is it investible?

Due to the sector taking the optimization route, there is just a limited number of pure-players outside of biofuels. Even for scrubbers, the primary optimization tool today, there are no pure players.

- Alfa Laval or Wartsila have scrubbers-related activities within their portfolio.
- Aveva helps designing more efficient ships by leveraging digital twin techniques.

SOURCE:
[Xchange](#)



Catalysts

- **Regulation.** Governments are increasingly tightening regulations to offset the effects of rising temperatures on climate. A global consensus is being reached, with the U.S. reintegrating the Paris Climate Agreement and the E.U.'s Fit for 55 will shape the field in the coming years.
- **Cost parity.** The shift towards zero-emission transportation will accelerate past 2025 with the progressive rollout of cheaper technology making non-subsidized ownership profitable compared to fossil-fuel vehicles.
- **Public perception.** A combination of major extreme climatic events and the availability of more desirable products will shift the mainstream perception of clean transportation.

Risks

- **Oil price collapse.** An inverted oil shock would slow down the transition towards greener transportation, although the engaged momentum appears to be strong enough for it not to be durably hampered.
- **Population decline.** The ongoing demographic transition means the population may start to shrink in the wealthiest countries, where zero-emission technologies will be introduced, reducing their need.
- **Autonomous vehicles.** Autonomous vehicles mean optimized transportation and a fewer vehicles required, suitable for global emissions but not for technology suppliers.

Bottom Line

- Due to its substantial share in global carbon emissions, transportation is bound to undergo significant changes. Despite some inertia caused by powerful lobbies, deeply entrenched habits, or not mature enough technology, the climate change issues are now becoming an all too pressing matter for the sector to be granted a derogatory status. These changes will be forced upon businesses either through regulation or by an ongoing shifting public opinion.
- This writing is on the wall and has triggered intense innovation, opening attractive business potential for those who understood first what was at stake. Although not every type of transportation will transition at the same speed, there is no shortage of investment opportunities.

Companies mentioned in this article:

Airbus (AIR FP), Alfa Laval (ALFA SS), Aveva (AVE LN), Eni (ENI IM), Gevo (GEVO US), Neste (NESTE FH), Nio (NIO US), Telsa (TSLA US), Wartsila (WRT1V FH)

CHARTS FOR THOUGHTS

Vaccines And PMIs

Purchasing Manager Index (PMI)

PMIs are good indicators of the current economic perspective and are generally highly correlated with stock market returns.

- PMI is a diffusion indicator that outlines market conditions viewed by purchasing managers. Above 50 it is expanding, below 50 it is contracting compared to the previous month.
- On the first charts, we observe the high correlation between PMI and stock market returns (SPX YoY) for the United States.

State of vaccination

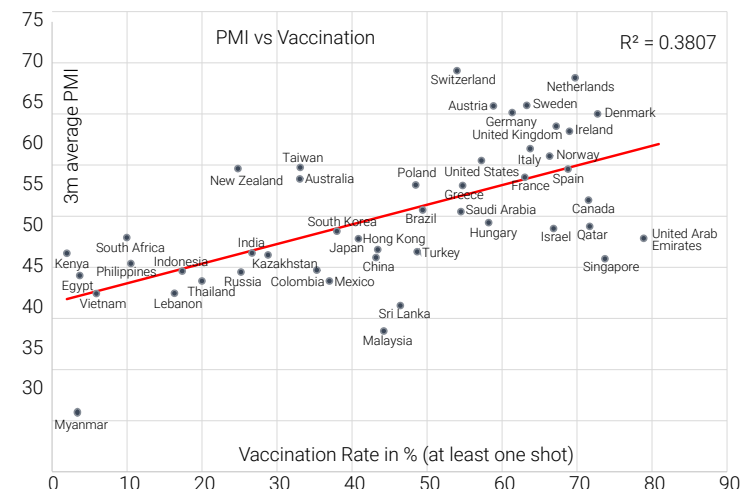
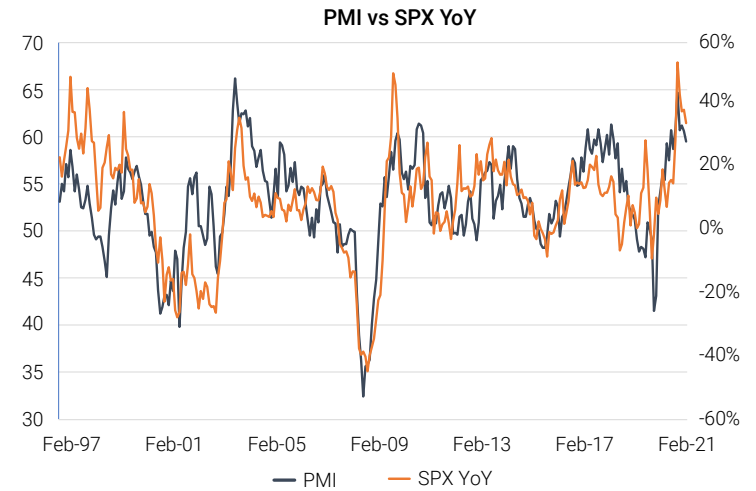
Governments' measures designed to curb the spread of Covid had significant impacts on businesses worldwide. The vaccination led governments to ease many of those measures and brightened sentiment from purchasing managers.

- There is a clear positive relationship between the average of the last 3 PMIs and the current state of vaccination in a country.
- All countries with most of their population having at least one shot had an average PMI above 50 over the last three months.

Positive sentiment is crucial

Vaccinations provide better health and positive economic sentiment, reflected in PMI, thanks to subsequent governments' easing of restrictive policies.

- Even if many measures (e.g., job markets, supply shocks) suggest that the economies did not yet recover, positive sentiment is the driving force behind the stock market.



SOURCE:
[Investing.com](https://www.investing.com), [Ourworldindata.org/covid-vaccinations](https://www.ourworldindata.org/covid-vaccinations)

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